StarLite

StarLite

Laser Power/Energy Meter

User Manual

Ophir Optronics Solutions Ltd.

www.ophiropt.com/photonics

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Chapter 1. Introduction: How to Use This Manual

Ophir StarLite is a simple to use microprocessor-based Laser Power/Energy meter that operates with thermopile, pyroelectric and photodiode sensors. Laser position and spot size can also be measured when operating with a BeamTrack sensor. Based on smart connector technology, just connecting the sensor configures and calibrates the instrument.

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

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

Chapter 2. Quick Reference

2.1. Getting Started

To connect a sensor to the StarLite meter, simply insert the 15 pin D type connector of the measuring sensor cable into the socket marked "Sensor Input" on the rear panel of the StarLite meter (see Figure 2.1).

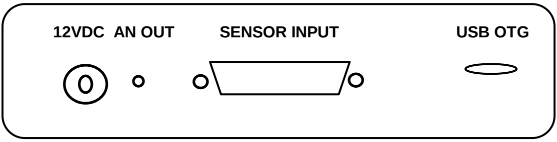


Figure 2.1 StarLite Rear Panel

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

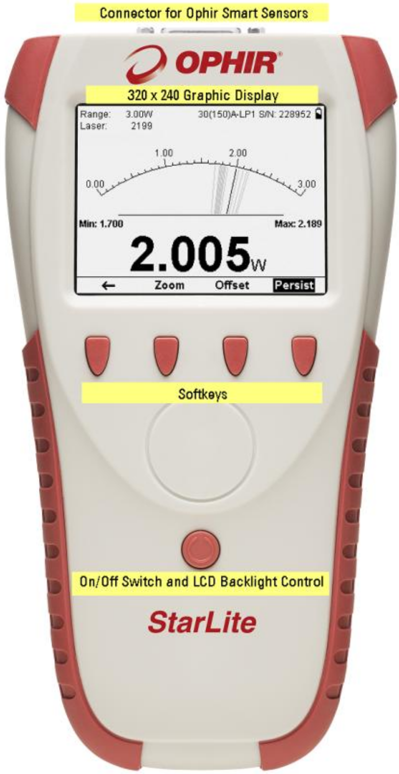


Figure 2.2 StarLite Front View

2.2. Functions with no Sensor Connected

2.2.1. Turning on and off.

To switch the StarLite on:

Briefly press the on/off switch (Figure 2.2). The unit will switch on, and after a few moments of initialization, the display will appear.

Note:

With StarLite, sensors are hot swappable. Even after the meter is switched on, you can remove one sensor and insert a different one. StarLite will recognize the switch and reconfigure itself according to the settings of the new sensor.

To toggle the state of the LCD backlight:

The backlight for StarLite's LCD can be toggled between 3 different levels of illumination. This toggling will be performed by briefly pressing the on/off switch after the StarLite has been switched on.

To switch the StarLite off:

Press the on/off switch and hold it for about 2 seconds until the display blanks.

2.2.2. Configuring the Instrument.

To zero instrument:

1. Make sure that the instrument is not in an electrically noisy environment and is undisturbed.
2. Verify that no sensor is connected. If one is connected, then detach before continuing.
3. Press the **Zero** key**.** This will bring you to the Zeroing screen
4. Press the **Start** key. When zeroing finishes press the **Save** key.

To show or hide settings

1. Press the Down arrow until Show Settings is highlighted and press the Enter arrow.

2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.

To set Line Frequency

1. Setting Line Frequency correctly removes electrical noise that may be introduced to the measurements.
2. Press the Down arrow until Line Frequency is highlighted and press the Enter arrow.
3. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.

To select Language

The StarLite display can be configured to one of several languages. In order to select the display language:

1. Press the Down arrow until Language is highlighted and press the Enter arrow.
2. Set to English, Japanese, Russian, or Chinese.

To set Date and Time

1. Press the Down arrow until the Date and Time are highlighted and press the Enter arrow.
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow. Change the selected item with the Down arrow.

Note:

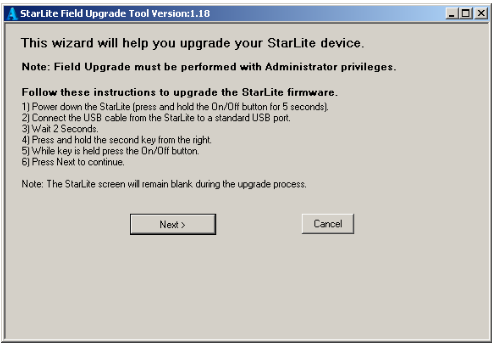
The present settings are automatically saved for the next time StarLite is turned on.

2.2.3. Updating the StarLite Firmware.

1. Download the latest StarLite firmware upgrade package from the Ophir website:

www.ophiropt.com/photonics and copy to your target directory.

2. Run the upgrade executable and follow the on screen instructions



2.2.4. Enabling USB.

The User can upgrade his StarLite to support USB communication with a host PC. See section 3.5.7 USB Activation for details.

2.3. Thermal Sensors

2.3.1. Use of StarLite with thermal type sensors.

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

Thermopile 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

To set type of laser being used:

With sensors with fixed wavelengths:

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Laser is highlighted and press the Enter arrow.
3. Select the appropriate laser wavelength and press the **OK** key.

With continuous spectral curve:

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Laser is highlighted and press the Enter arrow.
3. Select the appropriate laser wavelength and press the OK key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the Modify key.
5. Use the Right and Down arrows to adjust the wavelength as desired. Then press the **OK** key.

To select a range for power measurement:

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Range is highlighted and press the Enter arrow.
3. Select the appropriate manual range or AUTO to select autoranging and press the **OK** key.

To choose power or energy measurement:

1. In the main measurement screen, press the **Mode** key.
2. Select Power or Energy.
3. Press the **OK** key to return to the measurement screen

2.3.2. Other Settings and Saving the Startup Configuration

1. When measuring power, you can set the period over which to Average the measurements
2. When measuring energy you can set the threshold level in order to screen out false triggers.
3. The present settings are automatically saved for the next time StarLite is turned on.

2.3.3. Power or Single Shot Energy Measurement

Warning:

Do not exceed maximum sensor limits for power, energy, power density and energy density as listed in Table 5 and Table 6 in **Error! Reference source not found.** Otherwise, there is a risk of damaging the absorber.

To simulate an analog needle display on StarLite:

1. Press the **Display** key and select Needle.
2. Press **OK** to continue with measurements.

To expand the graph (Bargraph or Needle) scale ±5x about the present reading:

1. Press the **Zoom** key.
2. Press the **Zoom** key again to return to the full scale graph. See Section 4.3.1.2 for full details.

To subtract background and set current reading to zero:

1. Press the **Offset** key.
2. Press the **Offset** key again to cancel. See Section 4.3.1.2 for full details.

To use StarLite to measure laser power:

1. Press the **Mode** key and select Power
2. Select AUTO for autoranging or the lowest manual range whose maximum is greater than the expected power readings.
3. Power is measured 15 times per second.

To use StarLite to measure laser energy:

1. Press the **Mode** key and select Energy
2. Energy measurement is performed in manual ranges only. The correct range to select is the lowest one that is larger than the expected pulse energy to be measured.
3. Thermal sensors measure energy in single shot mode. When StarLite flashes "READY," on and off, fire the laser.

2.4. Photodiode Sensors

2.4.1. Selecting Wavelengths

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Laser is highlighted and press the Enter arrow.
3. Select the appropriate laser wavelength and press the **OK** key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the **Modify** key.

5. Use the Right and Down arrows to adjust the wavelength as desired. Then press the **OK** key.

2.4.2. To select a range for power measurement:

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Range is highlighted and press the Enter arrow.
3. Select the appropriate manual range, AUTO to select autoranging, or dBm to display power in a logarithmic scale. Press the **OK** key

2.4.3. Other Settings and Saving the Startup Configuration

1. Select Average in order to set the period over which to average the measurements
2. Select Filter to IN or OUT according to if the Filter is in place or not.
3. The present settings are automatically saved for the next time StarLite is turned on.

2.4.4. Power Measurement

Warning:

Do not exceed maximum sensor limits for power, energy, power density and energy density as listed in Table 5 and Table 6 in Sensor Specifications. Otherwise, there is a risk of damaging the absorber.

To simulate an analog needle display on StarLite:

1. Press the **Display** key and select Needle.
2. Press **OK** to continue with measurements.

To expand the graph (Bargraph or Needle) scale ±5x about the present reading:

1. Press the **Zoom** key.
2. Press the **Zoom** key again to return to the full scale graph. See Section 5.3.1.2 for full details.

To subtract background and set current reading to zero:

1. Press the **Offset** key.
2. Press the **Offset** key again to cancel. See Section 5.3.1.2 for full details.

2.5. Pyroelectric Sensors

2.5.1. Zeroing Instrument against Sensor

For the most accurate calibration, you must zero the pyroelectric sensor against the StarLite it is being used with. Proceed as follows: Make sure the sensor is in a quiet environment and not subject to pulsed radiation. Plug sensor into StarLite and turn on. Press the **Setup** key to enter the Setup screen. Press the **Zero** key to enter the Zero screen. Press the **Start** key. When "Zeroing completed successfully" appears, press the **Save** key and then press the **Exit** key. 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 of meter, then a different value has been saved and when used with this StarLite again you should zero it again.

2.5.2. To set type of laser being used:

For metallic types only:

1. From the measurement screen, press the **Setup** key.

2. Press the Down arrow until Laser is highlighted and press the Enter arrow.
3. Select the appropriate laser wavelength and press the **OK** key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the Modify key.
5. Use the Right and Down arrows to adjust the wavelength as desired. Then press the **OK** key.

For all other types

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Laser is highlighted and press the Enter arrow.
3. Select the appropriate laser wavelength and press the **OK** key.

2.5.3. To select a range for energy measurement:

1. From the measurement screen, press the **Setup** key.
2. Press the Down arrow until Range is highlighted and press the Enter arrow.
3. The correct range to select is the lowest one that is larger than the expected pulse energy to be measured. Press the **OK** key.

2.5.4. Other Settings and Saving the Startup Configuration

1. Select "Pulse Length" and choose the shortest pulse length setting longer than your laser's pulse length. **Warning:** Incorrect readings will result if pulse length is not set up correctly. For sensors with only one Pulse Length, N/A will be displayed.
2. For sensors with an optional diffuser, Select Diffuser and set to IN or OUT according to if the Diffuser is in place or not. For sensors without an optional diffuser, N/A will be displayed.
3. Select Threshold and set to level that will screen out erroneous readings due to false triggers.
4. Select Average in order to set the period over which to average the measurements, or set to NONE.

5. The present settings are automatically saved for the next time StarLite is turned on.

2.5.5. Energy or Average Power Measurement

Warning:

Do not exceed maximum sensor limits for power, energy, power density and energy density as listed in Table 5 and Table 6 in Sensor Specifications. Otherwise, there is a risk of damaging the absorber.

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 shows damage, then either enlarge your beam or lower the laser energy until damage is no longer seen.

Note:

High sensitivity pyroelectric sensors (PE9-C, PE10-C) 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.

To choose Energy or Average Power Measurement

1. To measure average power, press the **Mode** key and select Power.
2. To measure energy pulses, press the **Mode** key and select Energy.
3. If the laser is pulsing at greater than 1Hz, the frequency will be shown on the screen as well.

Warning:

While measuring pulsing lasers, erroneous energy reading will result if energy range, pulse length, or threshold levels are not set up correctly. See Section 6.3 for details.

To simulate an analog needle display on StarLite:

1. Press the **Display** key and select Needle.
2. Press **OK** to continue with measurements.

To expand the graph (Bargraph or Needle) scale ±5x about the present reading:

1. Press the **Zoom** key.
2. Press the **Zoom** key again to return to the full scale graph. See Section 5.3.1.2 for full details.

To subtract background and set current reading to zero:

1. Press the **Offset** key.
2. Press the **Offset** key again to cancel. See Section 5.3.1.2 for full details.

Chapter 3. The StarLite Display Unit

3.1. General Description

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

The StarLite's large size TFT 320x240 screen enhances measurement readouts in ways that smaller displays cannot.

StarLite displays power measurements in both digital and analog form at the same time and also has a needle type display. It can be set to autorange, so you do not have to set scales; or to a 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. StarLite reads the calibration information that is stored in the sensor's smart connector and is ready to measure from the moment it's powered up. You can also zero the StarLite at the touch of a button.

StarLite's user interface is self-explanatory; you should not have to refer to this manual very often. Above all, the StarLite 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.

StarLite has all the infrastructure for field upgrading of the embedded software, should the need arise.

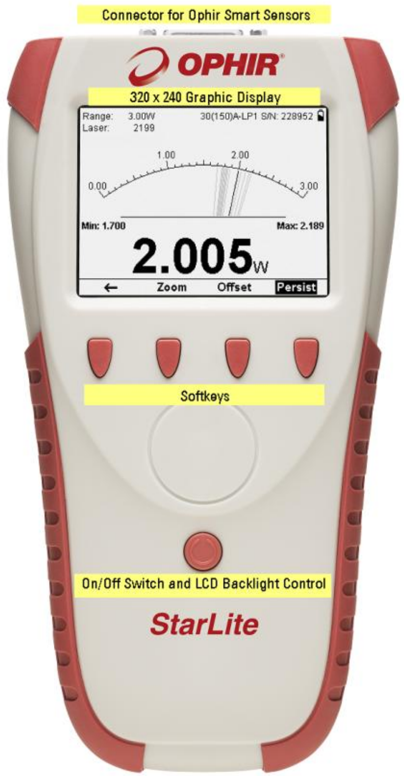


Figure 3.1 StarLite displaying power measured with a Thermopile sensor. Displayed in analog needle mode with persistence on.

3.2. Smart Connectors

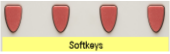
The StarLite meter is versatile and can operate with either thermal, pyroelectric or photodiode type laser measuring sensors. The sensor configuration and calibration information is stored in an EEROM in the sensor connector plug. This means that when the sensor is plugged in, StarLite automatically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

Note:

With StarLite, sensors are hot swappable. Even after the meter is switched on, you can remove one sensor and insert a different one. StarLite will recognize the switch and reconfigure itself according to the settings of the new sensor.

When no sensor is plugged in, the StarLite meter gives the user the opportunity to hide or show settings, change the line frequency setting, and set the real time clock. It also shows the serial number of the instrument, last calibration date and firmware version. The user can also re-zero the instrument. See section 3.5.

3.3. Soft Keys



The soft keys have functions defined by the legend above the key. The legend usually indicates what will happen when pressing the key. For example, if "Mode" appears above a key, pressing that key will open a menu to allow user to select between Power and Energy measurement modes. 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 StarLite has certain conventions as to the meaning of standard key strokes and these are as follows:

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

OK: Returns to the previous screen with the selected setting for immediate use and saved for next startup.

Cancel: Cancels the selection and returns to the previous screen, leaving the settings unchanged.

3.4. Power Up and Shut Down

To turn the StarLite on:

Briefly press the On/Off Switch.

The unit will switch on, and after a few moments of initialization, the display will appear. If no sensor is connected, the Setup screen will appear. If a sensor is connected, the appropriate default measurement screen will appear.

To toggle the state of the backlight on and off:

The backlight for the StarLite's LCD can be configured to toggle between low, half, and full intensity (see Section 3.7.1 for full details). This toggling will be performed by briefly pressing the On/Off switch after the StarLite has been switched on.

To switch the StarLite off:

Press the On/Off switch and hold it for about 2 seconds until the display blanks.

The current measurement settings will be saved automatically for the next time the StarLite is powered up.

3.5. StarLite Functions that are Independent of Sensor Type

When no sensor is connected, the StarLite setup screen will be displayed. This gives the user the opportunity to hide or show settings, change the line frequency setting, and set the real time clock. It also shows the firmware version, serial number of the instrument, and last calibration date. The user can also re-zero the instrument.

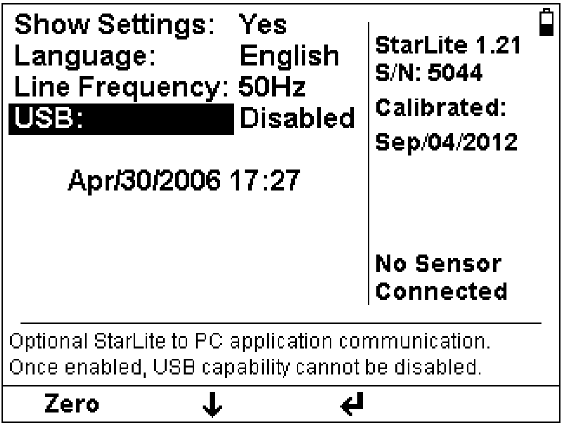


Figure 3.2 StarLite Setup Screen with no sensor connected.

3.5.1. Show or Hide Settings

1. Press the Down arrow (↓) until Show Settings is highlighted and press the Enter arrow (↵).
2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.
3. Press the **OK** key to keep the new setting.

3.5.2. Line Frequency

1. Setting Line Frequency correctly removes electrical noise that may be introduced to the measurements
2. Press the Down arrow (↓) until Line Frequency is highlighted and press the Enter arrow (↵).
3. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
4. Press the **OK** key to keep the new setting.

3.5.3. Language

1. The StarLite display can be configured to one of several languages.
2. Press the Down arrow (↓) until Language is highlighted and press the Enter arrow (↵).
3. Set to English, Japanese, Russian, or Chinese.
4. Press the **OK** key to keep the new setting.

Warning:

In the event that you mistakenly selected a non-English language as the StarLite startup language, the way to switch back to English is as follows:

a. Disconnect the sensor from the StarLite.

b. StarLite will automatically switch to the Setup screen.

c. Press the Down arrow (↓) once.

d. press the Enter arrow (↵). This will open a window to select the instrument language.

e. Press the Down arrow to select "English".

f. Press the **OK** soft key. StarLite is now configured for English.

Note:

The present settings are automatically saved for the next time StarLite is turned on.

3.5.4. Analog Output

The StarLite has an analog output with a full-scale output of 1 Volt.

For thermal and photodiode sensors in power mode, the analog output is continually updated 15 times per second with the latest power measurement. For thermal sensors in single shot energy mode, the analog output is held fixed until the next pulse triggers. For pyroelectric sensors, the analog output is updated at up to 10 times per second with the latest pulse energy.

3.5.5. Clock Settings

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

To set Date and Time

1. Press the Down arrow (↓) until the Date and Time are highlighted and press the Enter arrow (↵).
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow (→). Change the selected item with the Down arrow (↓).
3. When finished, press the **OK** key to keep the new setting.

3.5.6. Zero Adjustments

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

To zero instrument:

1. If a sensor is connected, disconnect it.
2. Press the **Zero** key to enter the Zeroing screen
3. Make sure that the instrument is not in an electrically noisy environment and is undisturbed
4. Press the **Start** key and wait for message, "Zeroing completed successfully".
5. Press the **Save** key to save the new zero settings.
6. Press the **Exit** key to return to the Setup screen.

Note (for Thermal Sensors only)

For best results with thermal sensors, it may be necessary to do the procedure once with the sensor disconnected and a second time with it reconnected.

After completing steps 1 - 6 above, Connect the sensor and make sure it is at room temperature and well shielded from any stray thermal power. It may be best advised to lay the sensor with the absorber face down on the table.

7. Connect the thermopile sensor. Ensure that is at room temperature and well shielded from any stray thermal power. It may be best advised to lay the sensor with the absorber face down on the table. Press the **Zero** key to enter the Zeroing screen
8. Press the **Start** key and wait for message, "Zeroing completed successfully".
9. Press the **Save** key to save the new zero settings.
10. Press the **Exit** key to return to the Setup screen.

Note (for BeamTrack sensors only)

When a BeamTrack sensor is attached, the zeroing function of the StarLite will zero the BeamTrack's measurement circuitry as well.

Note: For Pyroelectric Sensors

In addition to zeroing the meter as described above, it is important to zero the meter against the sensor you are using the first time. Please see section 2.5.1 on how to do this.

3.5.7. USB Activation

The StarLite meter can be upgraded to support USB communication with Ophir's full range of PC offerings. This includes our flagship StarLab application as well as our LabVIEW library and COM object-based applications.

This is done by acquiring a USB Activation Code (P/N 7Z11049). Another option is to have the StarLite meter shipped to you with the Activation Code already enabled. Contact your local Ophir distributor for details.

To Enable USB

1. Press the Down arrow (↓) until USB is highlighted and press the Enter arrow (↵). This brings you into the Activation Screen
2. Set each digit to its respective Activation Code digit. Scroll through each of the digits with the Right arrow (→). Change the selected digit with the Up (↑) and Down (↓) arrows.
3. When finished, press the **Exit** key to keep the new setting.

3.6. StarLite Measurement Screens

3.6.1. 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. The Bargraph display is available when measuring power or energy.

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 gotten into the measurement, you can press the **Offset** key to remove it from the measurement.

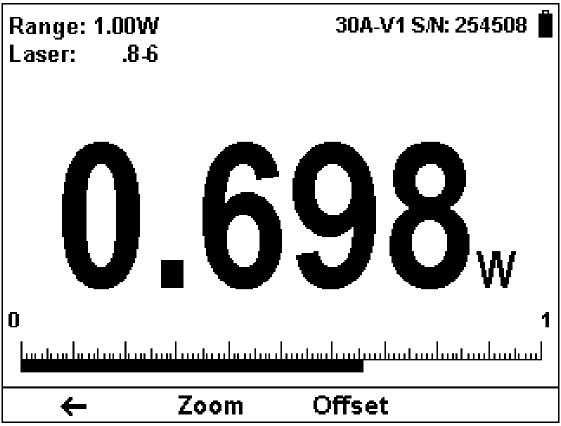


Figure 3.3 Bargraph with Thermopile Sensor.

3.6.2. Needle

A Needle graph simulates an analog display, similar to the style of an analog voltmeter or a car's speedometer. The Needle display is available when measuring power or energy.

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 gotten into 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.

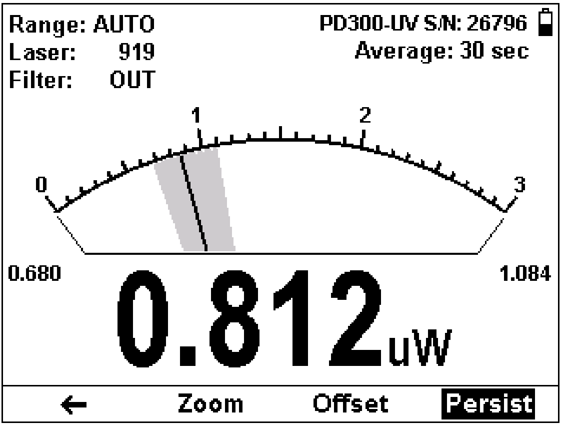


Figure 3.4 Analog Needle with Photodiode Sensor with Persistence Enabled

3.6.3. Position

This screen shows the position of the laser beam as measured by the sensor as well as its size. This type of display is available for BeamTrack sensors (thermopile sensors with additional circuitry for measuring position and size) with the measurement mode set to Track.

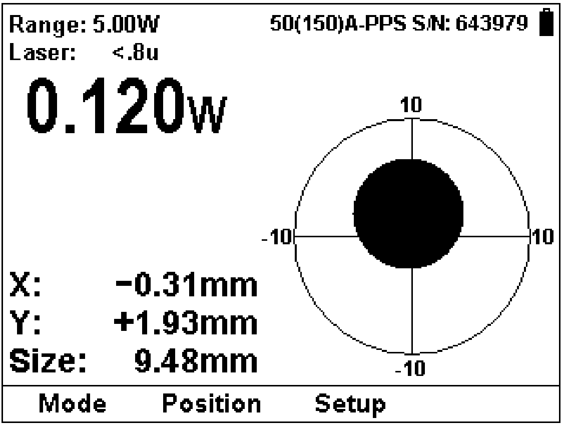


Figure 3.5 Position and Size measurement with BeamTrack Sensor in Track Mode

3.7. Hardware Functions

3.7.1. LCD Backlight

The LCD backlight is actually a set of LED's that illuminate the display from behind. Because the StarLite uses a TFT 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. The backlight level is toggled by a short press on the On/Off switch.

The StarLite 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.

3.7.2. Charging

The StarLite 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 back panel (see Figure 3.3). The battery will be charged at the same rate whether the StarLite is switched on or off, and whatever the backlight level. The battery will fully recharge in around 4-5 hours.

Note: The charger circuit of the StarLite 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 the following table for various configurations:

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

The battery charge is indicated by the ▮ icon. The battery charge is shown approximately by each segment of the icon, e.g. if 2 segments are shown the battery is ½ full. When the battery is charging, the segments turn on in sequence. When the battery is low, the charger should be plugged in.

3.7.3. Analog Output

The instrument provides an analog voltage output via the 2.5mm mono jack socket on the rear panel marked "AN OUT" (see Figure 3.3). The StarLite 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 1.00V.

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.

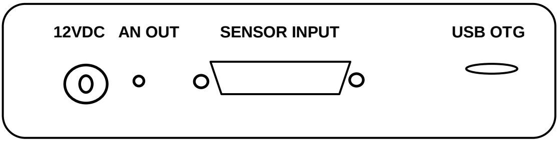


Figure 3.3 StarLite Rear Panel View

For thermal and photodiode sensors in power mode, the analog output is continually updated 15 times per second with the latest power measurement. For thermal sensors in single shot energy mode, the analog output is held fixed until the next pulse triggers. For pyroelectric sensors, the analog output is updated at up to 10 times per second with the latest pulse energy.

3.7.4. Field Upgrade

StarLite 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

To Update the StarLite Firmware:

1. Download the latest StarLite firmware upgrade package from the Ophir website: www.ophiropt.com/photonics and copy to your target directory.
2. Run the upgrade executable and follow the on screen instructions

3.7.5. Sensor Disconnect / Connect Recognition

With StarLite, sensors are hot swappable. Even after the meter is switched on, you can remove one sensor and insert a different one. StarLite will recognize the switch and reconfigure itself according to the settings of the new sensor.

3.7.6. USB Communication

StarLite is capable of USB communication with the PC. This is an optional feature that must be activated by acquiring an Activation Code (Ophir P/N 7Z11049).

Chapter 4. Operation with Thermopile Absorber Sensors

Warning:

> Before using the sensor for power or energy measurement, check that your laser power, energy and energy density do not exceed the sensor ratings. See the tables in Sensor Specifications.

If the sensor is a water-cooled type, ensure that the cooling water is flowing at an adequate rate; see table below. Also, note that the reflectance from the absorber could be as much as 10% and with 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.

Sensor Type	Liters per Minute At Full Power	Min Pressure Bar	US Gallons per Minute
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

Table 1 Minimum Flow Rates for Water-Cooled Sensors

4.1. Thermopile Absorber Sensors

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 meter's electronics amplifies this signal and indicates the power level received by the sensor. At the same time, signal processing software causes the meter to respond faster than the actual thermal rise time of the detector disc, thus reducing the response time of the StarLite. Energy of a single pulse is measured on the StarLite by digitally integrating the pulse power over time.

4.2. Startup Configuration

On power up, the StarLite 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.

4.3. Power Measurement

Thermopile sensors measure power continuously at an update rate of 15 times per second. To best ensure measurement accuracy, center the laser beam carefully on the absorber surface.

Power measurements can be displayed in Bargraph or Needle graphical formats. Updating measurement parameters is performed in the easy-to-reach Setup screen.

4.3.1. Bargraph Display

4.3.1.1. Screen Layout

The Bargraph is a ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale.

The Bargraph display is composed of 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.
- Softkey legends at the bottom of the screen.

4.3.1.2. Softkey Functionality

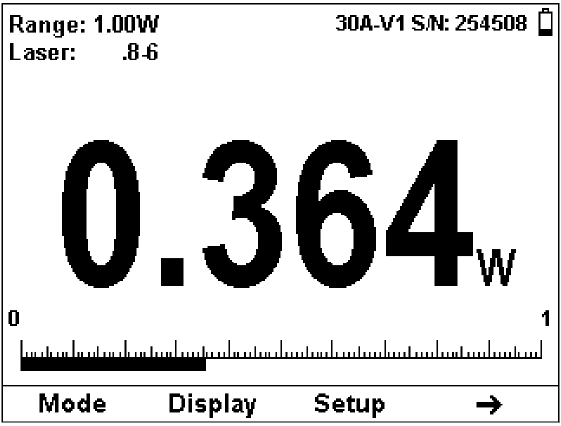


Figure 4.1 Bargraph display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (⇕) to set the measurement mode to power or energy (or Track if this is a BeamTrack sensor)
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (⇕) to set the display mode to Bargraph or Needle.

- Press OK to return to the measurement screen with the new selection.
- Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Power measurement parameters. This will be described in Section 4.3.3 Power Setup Screen.

- **Right Arrow (→):** Press this for additional Bargraph screen functions.

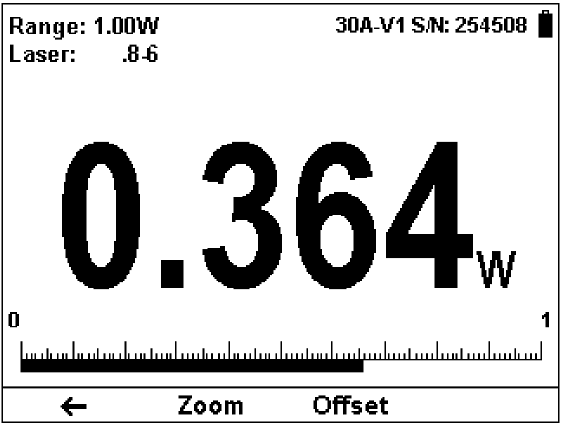


Figure 4.2 Bargraph display with second set of Softkeys

- **Left Arrow (←):** Press this for previous set of Bargraph functions.

- **Zoom:** Press this 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 watts, and your reading is 15 watts, pressing **Zoom** will make the Bargraph scale range between approximately 13 and 17 watts. Small fluctuations in power are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

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

  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. To deactivate, press Offset again.

  If you suspect that StarLite has a permanent zero offset, the instrument's internal zero should be reset. See Section 3.5.5.

4.3.2. Needle Display

4.3.2.1. Screen Layout

A 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.

The Needle display is composed of the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- Needle displayed prominently in the middle of the screen.
- Large numeric display.

- Softkey legends at the bottom of the screen.

4.3.2.2. Softkey Functionality

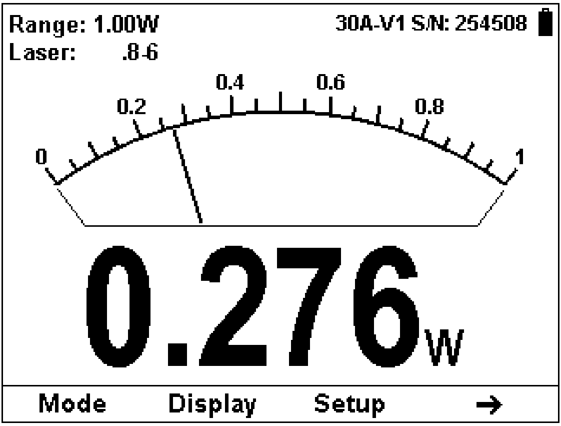


Figure 4.3 Needle display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
    - Press the Up/Down arrow (↕) to set the measurement mode to power or energy (or Track if this is a BeamTrack sensor)
    - Press **OK** to return to the measurement screen with the new selection.
    - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
    - Press the Up/Down arrow (↕) to set the display mode to Bargraph or Needle.
    - Press OK to return to the measurement screen with the new selection.
    - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Power measurement parameters. This will be described in Section 4.3.3 Power Setup Screen.

- **Right Arrow (➔):** Press this for additional Needle screen functions.

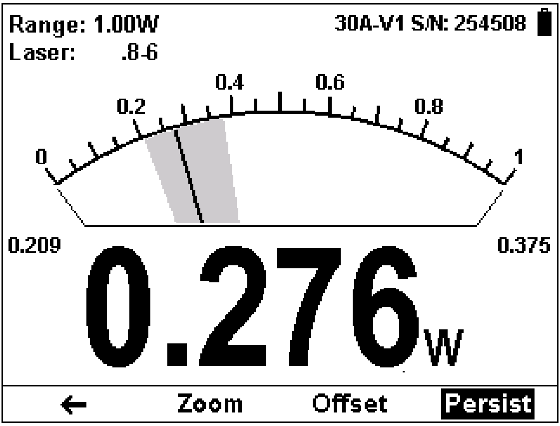


Figure 4.4 Needle display with second set of Softkeys and Persistence active

- **Left Arrow (←):** Press this for previous set of Needle functions.

- **Zoom:** Press this key to focus the Needle on the present reading. The Needle arc will show 20% of the full scale centered on the present reading. Thus, if the full scale of the Needle is 20 watts, and your reading is 15 watts, pressing **Zoom** will make the Needle scale range between approximately 13 and 17 watts. Small fluctuations in power are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Needle display.

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

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. To deactivate, press Offset again.

If you suspect that StarLite has a permanent zero offset, the instrument's internal zero should be reset. See Section 3.5.5.

4.3.3. Power Setup Screen

The StarLite meter can be set to various chosen settings while operating. These configuration settings are automatically saved for the next time the meter is turned on with this sensor.

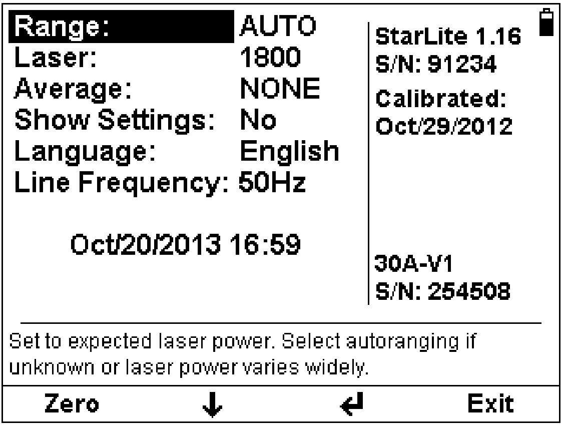


Figure 4.5 Setup Screen

4.3.3.1. Power Range

Autorange

In autorange mode, you do not have to change scales. When the reading of the meter is more than 100% of full scale of the present range, StarLite will reconfigure itself to the next higher range. The ranges are arranged in factors of 1, 10, 100, etc. When the reading falls below 7% of full scale of the present range, StarLite will reconfigure itself one range down. This change only occurs after a few seconds delay, thereby providing overlap (hysteresis) that limits StarLite from flipping back and forth when reading close to the end of the scale.

Manual Range

There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure in the same range all the time, it is better to use manual range.

The correct range to select is the lowest one that is larger than the largest expected measurement.

To Set the Power Range

1. Press the Down arrow (↓) until Range is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available ranges until you reach the one that is correct for your measurement needs.
3. Press the OK key to keep the new setting.

4.3.3.2. Laser

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

Thermopile 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

To set type of laser being used:

With sensors with fixed wavelengths:

1. Press the Down arrow (↓) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available lasers until you reach the appropriate laser wavelength.
3. Press the **OK** key.

With continuous spectral curve:

1. Press the Down arrow (↓) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available lasers until you reach the appropriate laser wavelength.
3. If your wavelength is listed, use the Down arrow (↓) to scroll through the wavelengths until reached and press the **OK** key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the **Modify** key.
5. Use the Right (→) and Down (↓) arrows to adjust the wavelength as desired. Then press the OK key.

4.3.3.3. Average

How Averaging Works

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

As soon as the main power measurement screen (See Figure 4.2) is entered and the instrument is set to average mode, the instrument displays the average of readings over the period since the screen was entered up to the present. When the time period of the average is reached, the average becomes a running average over the average period backward in time. For instance, if the average period is 1 minute, at 30 seconds, the average is over 30 seconds, at 1 minute it is over 1 minute, at 5 minutes, it is over the period from 4 to 5 minutes (1 minute back from the present).

To Set the Average Period:

1. Press the Down arrow (🡻) until Average is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (🡻), scroll through the list of average periods until you reach the one that is correct for your measurement needs. Set the average period to NONE to disable averaging.
3. Press the **OK** key to keep the new setting.

4.3.3.4. Other Settings

Show or Hide Settings

1. Press the Down arrow (🡻) until Show Settings is highlighted and press the Enter arrow (↵).
2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.
3. Press the **OK** key to keep the new setting.

Language Selection

The StarLite display can be configured to one of several languages. In order to select the display language:

1. Press the Down arrow (↓) until Language is highlighted and press the Enter arrow (↵).
2. Set to English, Japanese, Russian, or Chinese.
3. Press the **OK** key to keep the new setting.

Line Frequency

StarLite has built-in circuitry to screen out electrical noise from the local power grid that can introduce errors to the measurements.

Set Line Frequency to your power grid's frequency to screen out the noise correctly.

1. Press the Down arrow (↓) until Line Frequency is highlighted and press the Enter arrow (↵).
2. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
3. Press the **OK** key to keep the new setting.

Clock Settings

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

To set Date and Time

1. Press the Down arrow (↓) until the Date and Time are highlighted and press the Enter arrow (↵).
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow (→). Change the selected item with the Down arrow (↓).

3. When finished, press the **OK** key to keep the new setting.

4.3.3.5. Additional On Screen Information

On the right hand side of the Setup screen the following information is provided to the user

- Instrument
  - Firmware Version
  - Serial Number
  - Date of Last Calibration
- Sensor
  - Name
  - Serial Number
  - Date of Last Calibration (if supported by the sensor

4.4. Energy Measurement

4.4.1. Measuring Energy with Thermopile Sensors

Although thermopile sensors are used primarily to measure power, they can 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 thermal 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 after the pulse.

4.4.1.1. Standard Case of Energy Measurement

To measure energy of a single pulse, first set up the Energy Range, Laser, and Threshold as described in **Section 4.4.4 Energy Setup Screen**.

1. Wait until READY is flashed on the screen. This indicates that the sensor is ready for a new measurement
2. Fire the laser. The display will go blank while the energy is being integrated.
3. After about 2 - 4 seconds (depending on the sensor), the correct energy will be displayed.
4. Return to Step 1 for the next measurement. Note: If you fire another pulse before "READY" appears, the reading may be inaccurate or may not be displayed.

4.4.1.2. Measuring Pulses of Very Low Energy

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

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

   Average Energy per pulse = Average power /
   Pulse Repetition Rate

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

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

4.4.1.3. Measuring Energy of Rapidly Repeating Pulses

With a typical thermopile sensor, StarLite 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:

Average Energy per Pulse = Average Power / 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 StarLite and just have to be plugged in to be used.

4.4.2. Bargraph Screen

4.4.2.1. Screen Layout

The Bargraph is a ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale.

The Bargraph display is composed of the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- READY will be flashed on the screen to indicate that StarLite is ready to measure the next laser pulse to be fired.
- Large numeric display shown prominently in the middle of the screen.
- Bargraph displayed close to the bottom.
- Softkey legends at the bottom of the screen.

4.4.2.2. Softkey Functionality

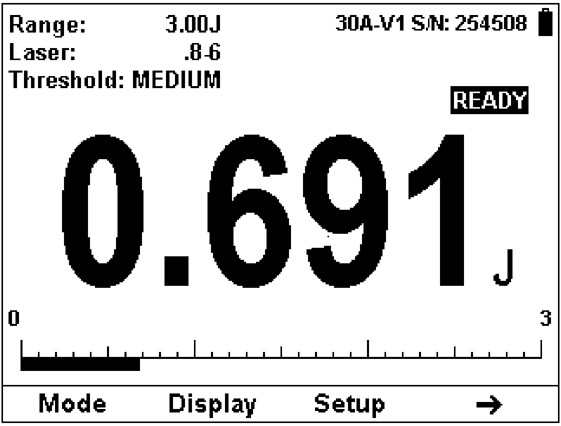


Figure 4.6 Bargraph display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (⇕) to set the measurement mode to power or energy (or Track if this is a BeamTrack sensor)
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (⇕) to set the display mode to Bargraph or Needle.
  - Press OK to return to the measurement screen with the new selection.
  - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Energy measurement parameters. This will be described in Section 4.4.4 Energy Setup Screen.

- **Right Arrow (→):** Press this for additional Bargraph screen functions.

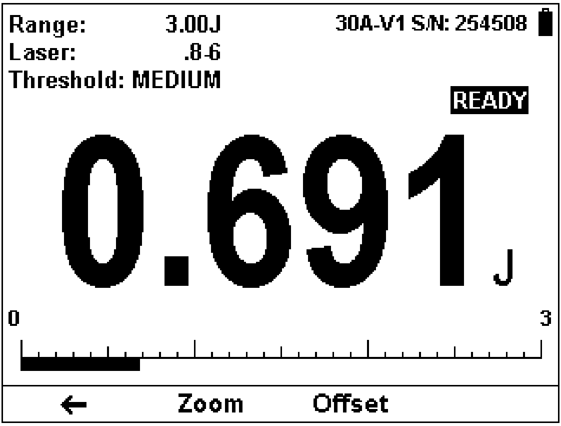


Figure 4.7 Bargraph display with second set of Softkeys

- **Left Arrow (←):** Press this for previous set of Bargraph functions.

- **Zoom:** Press this 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 30 Joules, and your reading is 15 Joules, pressing **Zoom** will make the Bargraph scale range between approximately 12 and 18 Joules. Small fluctuations in energy are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

- **Offset:** Unlike power, offset subtraction is not necessary to achieve accurate energy measurements. However it 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.

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. To deactivate, press Offset again.

4.4.3. Needle Screen

4.4.3.1. Screen Layout

A 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.

The Needle display is composed of the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- READY will be flashed on the screen to indicate that StarLite is ready to measure the next laser pulse to be fired.
- Needle displayed prominently in the middle of the screen.
- Large numeric display.
  Softkey legends at the bottom of the screen

4.4.3.2. Softkey Functionality

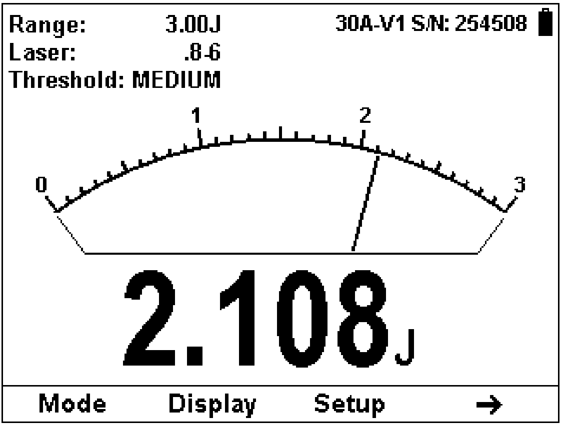


Figure 4.8 Needle display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (↕) to set the measurement mode to power or energy (or Track if this is a BeamTrack sensor)
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (↕) to set the display mode to Bargraph or Needle.
  - Press OK to return to the measurement screen with the new selection.
  - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Energy measurement parameters. This will be described in Section 4.4.4 Energy Setup Screen.

- **Right Arrow (→):** Press this for additional Needle screen functions.

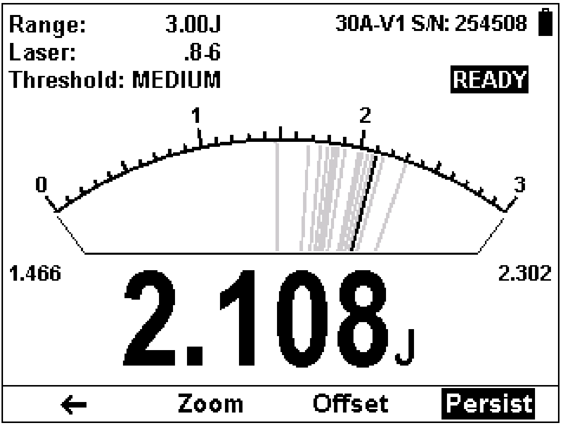


Figure 4.9 Needle display with second set of Softkeys and Persistence active

- **Left Arrow (←):** Press this for previous set of Needle functions.

- **Zoom:** Press this key to focus the Needle on the present reading. The Needle arc will show 20% of the full scale centered on the present reading. Thus, if the full scale of the Needle is 30 Joules, and your reading is 15 Joules, pressing **Zoom** will make the Needle scale range between approximately 12 and 18 Joules. Small fluctuations in energy are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Needle display.

- **Offset:** Unlike power, offset subtraction is not necessary to achieve accurate energy measurements. However it 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.

  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. To deactivate, press Offset again.

4.4.4. Energy Setup Screen

The StarLite meter can be set to various chosen settings while operating. These configuration settings are automatically saved for the next time the meter is turned on with this sensor.

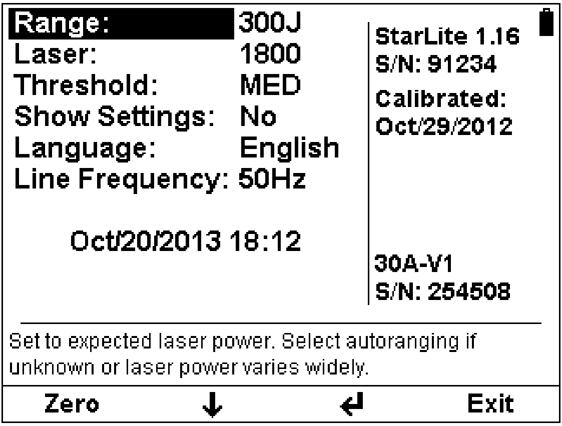


Figure 4.10 Setup Screen

4.4.4.1. Energy Range

Energy measurment is always made in a set manual range. The correct range to select is the lowest one that is larger than the largest expected measurement.

To Set the Energy Range

1. Press the Down arrow (↓) until Range is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available ranges until you reach the one that is correct for your measurement needs.
3. Press the **OK** key to keep the new setting.

4.4.4.2. Laser

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

Thermopile 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

To set type of laser being used:

With sensors with fixed wavelengths:

1. Press the Down arrow (🡻) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (🡻), scroll through the available lasers until you reach the appropriate laser wavelength.
3. Press the **OK** key.

With continuous spectral curve:

1. Press the Down arrow (🡻) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (🡻), scroll through the available lasers until you reach the appropriate laser wavelength.

3. If your wavelength is listed, use the Down arrow (↓) to scroll through the wavelengths until reached and press the **OK** key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the **Modify** key.
5. Use the Right (→) and Down (↓) arrows to adjust the wavelength as desired. Then press the OK key.

4.4.4.3. Minimum Energy Threshold

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

To Set the Minimum Threshold Level:

1. Press the Down arrow (↓) until Threshold is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the list of threshold levels until you reach the one that is correct for your measurement needs.
3. Press the **OK** key to keep the new setting.

4.4.4.4. Other Settings

Show or Hide Settings

1. Press the Down arrow (↓) until Show Settings is highlighted and press the Enter arrow (↵).
2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.
3. Press the **OK** key to keep the new setting.

Language Selection

The StarLite display can be configured to one of several languages. In order to select the display language:

1. Press the Down arrow (↓) until Language is highlighted and press the Enter arrow (↵).
2. Set to English, Japanese, Russian, or Chinese.
3. Press the **OK** key to keep the new setting.

Line Frequency

StarLite has built-in circuitry to screen out electrical noise from the local power grid that can introduce errors to the measurements.

Set Line Frequency to your power grid's frequency to screen out the noise correctly.

1. Press the Down arrow (↓) until Line Frequency is highlighted and press the Enter arrow (↵).
2. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
3. Press the **OK** key to keep the new setting.

Clock Settings

The StarLite is equipped with a real time clock which will show the date and time. This clock will also allow the

StarLite to query the sensor attached and notify you if the sensor is due for calibration.

To set Date and Time

1. Press the Down arrow (↓) until the Date and Time are highlighted and press the Enter arrow (↵).
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow (→). Change the selected item with the Down arrow (↓).
3. When finished, press the **OK** key to keep the new setting.

4.4.4.5. Additional On Screen Information

On the right hand side of the Setup screen the following information is provided to the user

- Instrument
  - Firmware Version
  - Serial Number
  - Date of Last Calibration
- Sensor
  - Name
  - Serial Number
  - Date of Last Calibration (if supported by the sensor

4.5. Position and Size Measurement

4.5.1. Measuring Position and Size with Thermopile Sensors

The BeamTrack line of sensors are thermal 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 we 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.

4.5.2. Position Screen

This screen 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.

4.5.2.1. Screen Layout

The Position display is composed of 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, position, and size along the left side of the screen.
- Position and size displayed graphically along the right side of the screen.
- Softkey legends at the bottom of the screen.

4.5.2.2. Softkey Functionality

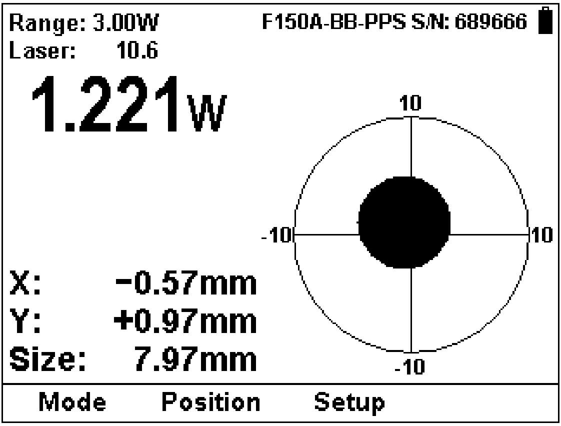


Figure 4.11 Position Screen

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (↕) to set the measurement mode to Track, Power, or Energy
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Position**: In Track mode, the only graph type available is position. Pressing this key will affect no change.

- **Setup:** Press this key to change the measurement parameters. In Track mode, the parameters available for configuration are the same as those in Power mode and have been described in Section 4.3.3 Power Setup Screen.

Chapter 5. Operation with Photodiode Type Sensors

Warning:

> Before using the sensor for power measurement, check that your laser power or energy and energy density does not exceed the sensor ratings. See Table 5 inSensor Specifications.

5.1. Photodiode Sensors

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

The PD300 and PD300-3W 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 StarLite meter amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the StarLite, the noise level is very low, and the PD300 /3A-IS series sensors with the StarLite meter 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 2 gives the actual maximum power as a function of wavelength.

Filter Out

Wave Length	PD300	PD300 -TP	PD300 -3W	PD300 -UV	3A-IS	Wave-Length	PD300 -IR	PD300 -IRG
250-350nm	N.A.	N.A.	N.A.	3mW	N.A.	800nm	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
900mm	10mW	1.5mW	100mW	2.5mW	3W	1.8µm	30mW	N.A.
1060nm	25mW	3mW	100mW	3mW	3W			

Filter In

Wave Length	PD300	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wave Length	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	300mW	N.A.	800nm	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
900mm	150mW	300mW	1.2W	150mW	3W	1.8µm	N.A.	N.A.
1060nm	250mW	500mW	2.2W	300mW	3W			

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

5.2. Startup Configuration

On power up, the StarLite 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 1064 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.

5.3. Power Measurement

Photodiode sensors measure power continuously at an update rate of 15 times per second. To best ensure measurement accuracy, center the laser beam carefully on the absorber surface.

Power measurements can be displayed in Bargraph or Needle graphical formats. Updating measurement parameters is performed in the easy-to-reach Setup screen.

5.3.1. Bargraph Display

5.3.1.1. Screen Layout

The Bargraph is a ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale.

The Bargraph display is composed of 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.
- Softkey legends at the bottom of the screen.

5.3.1.2. Softkey Functionality

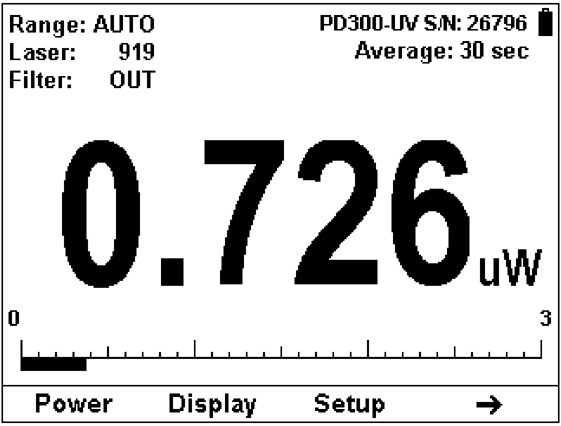


Figure 5.1 Bargraph display with first set of Softkeys

- **Power:** With Photodiode sensors, the only measurement mode available is Power. Pressing this key will affect no change.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (⇕) to set the display mode to Bargraph or Needle.
  - Press OK to return to the measurement screen with the new selection.
  - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Power measurement parameters. This will be described in Section 5.3.3 Power Setup Screen.

- **Right Arrow (➔):** Press this for additional Bargraph screen functions.

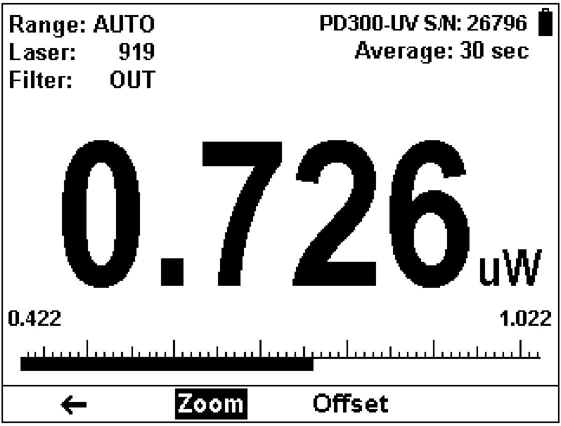


Figure 5.2 Bargraph display with second set of Softkeys and Zoom active

- **Left Arrow (←):** Press this for previous set of Bargraph functions.

- **Zoom:** Press this 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 mW, and your reading is 15 mW, pressing **Zoom** will make the Bargraph scale range between approximately 13 and 17 mW. Small fluctuations in power are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

- **Offset:** If the ambient environment has a thermal background, so that StarLite shows a nonzero power reading even when there is no laser, you can subtract the background using the Offset function. For example, the StarLite display reads 0.1 mW when the laser is blocked, and 20.5 mW with laser power applied. In this case, the true power is 20.5 - 0.1 = 20.4 mW. To subtract the background, press the **Offset** key while the laser is blocked. StarLite will now read zero, and the 0.1 mW background will be subtracted from all subsequent readings. The laser power reading displayed will thus be 20.4 mW.

  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. To deactivate, press Offset again.

If you suspect that StarLite has a permanent zero offset, the instrument's internal zero should be reset. See Section 3.5.5.

5.3.2. Needle Display

5.3.2.1. Screen Layout

A 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.

The Needle display is composed of the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- Needle displayed prominently in the middle of the screen.
- Large numeric display.
- Softkey legends at the bottom of the screen.

5.3.2.2. Softkey Functionality

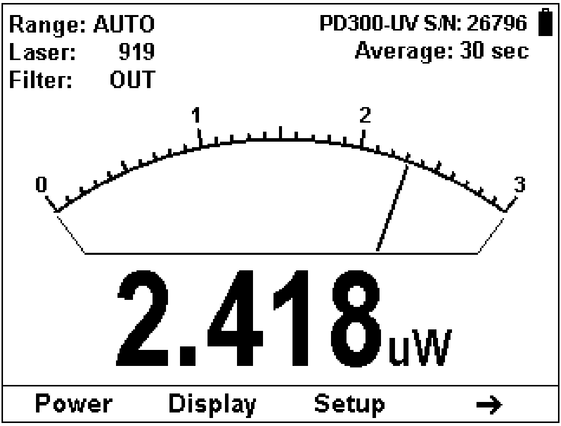


Figure 5.3 Needle display with first set of Softkeys

- **Power:** With Photodiode sensors, the only measurement mode available is Power. Pressing this key will affect no change.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (⇕) to set the display mode to Bargraph or Needle.
  - Press OK to return to the measurement screen with the new selection.
  - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Power measurement parameters. This will be described in Section 5.3.3 Power Setup Screen.

- **Right Arrow (➔):** Press this for additional Needle screen functions.

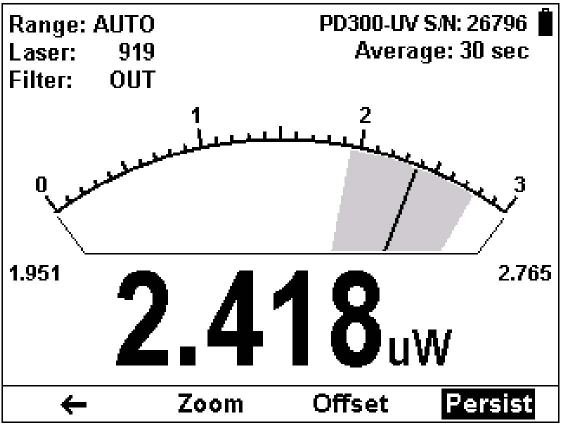


Figure 5.4 Needle display with second set of Softkeys and Persistence active

- **Left Arrow (←):** Press this for previous set of Needle functions.

- **Zoom:** Press this 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 mW, and your reading is 15 mW, pressing **Zoom** will make the Bargraph scale range between approximately 13 and 17 mW. Small fluctuations in power are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

- **Offset:** If the ambient environment has a thermal background, so that StarLite shows a nonzero power reading even when there is no laser, you can subtract the background using the Offset function. For example, the StarLite display reads 0.1 mW when the laser is blocked, and 20.5 mW with laser power applied. In this case, the true power is 20.5 - 0.1 = 20.4 mW. To subtract the background, press the **Offset** key while the laser is blocked. StarLite will now read zero, and the 0.1 mW background will be subtracted from all subsequent readings. The laser power reading displayed will thus be 20.4 mW.

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. To deactivate, press Offset again.

If you suspect that StarLite has a permanent zero offset, the instrument's internal zero should be reset. See Section 3.5.5.

5.3.3. Power Setup Screen

The StarLite meter can be set to various chosen settings while operating. These configuration settings are automatically saved for the next time the meter is turned on with this sensor.

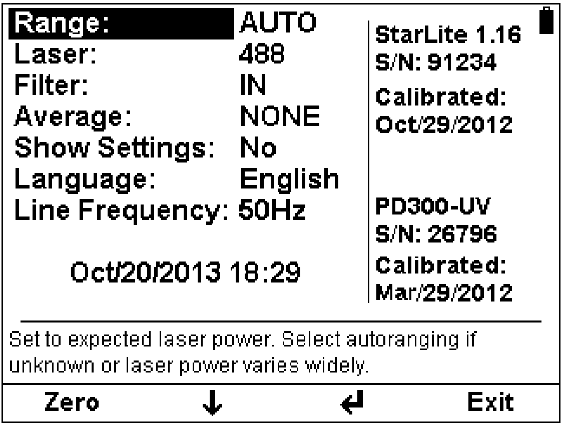


Figure 5.5 Setup Screen

5.3.3.1. Power Range

Autorange

In autorange mode, you do not have to change scales. When the reading of the meter is more than 100% of full scale of the present range, StarLite will reconfigure itself to the next higher range. The ranges are arranged in factors of 1, 10, 100, etc. When the reading falls below 7%

of full scale of the present range, StarLite will reconfigure itself one range down. This change only occurs after a few seconds delay, thereby providing overlap (hysteresis) that limits StarLite from flipping back and forth when reading close to the end of the scale.

Manual Range

There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure in the same range all the time, it is better to use manual range.

The correct range to select is the lowest one that is larger than the largest expected measurement.

Logarithmic Scale

StarLite allows the measurement to be made in units of dBm that is a logarithmic scale. This is useful if you expect the readings to vary over several ranges and want to everything in one scale.

The formula for dBm units is defined as 10 x Log (reading in mW). Therefore, at 1mW the reading will be 0 dBm, at 10mW it will be 10 dBm, at 100mW it will be 20 dBm etc.

To Set the Power Range

1. Press the Down arrow (↓) until Range is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available ranges until you reach the one that is correct for your measurement needs.
3. Press the OK key to keep the new setting.

5.3.3.2. Laser

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 wavelength, the correction factor for that wavelength is automatically introduced.

To set type of laser being used:

1. Press the Down arrow (🡇) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (🡇), scroll through the available lasers until you reach the appropriate laser wavelength.
3. If your wavelength is listed, use the Down arrow (🡇) to scroll through the wavelengths until reached and press the **OK** key.
4. If the wavelength you want is not among the wavelengths in the six wavelengths listed press the **Modify** key.
5. Use the Right (➔) and Down (🡇) arrows to adjust the wavelength as desired. Then press the OK key.

5.3.3.3. Filter

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 2 for the exact maximum as a function of wavelength.

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

Warning:

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

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

To choose the filter setting:

1. Press the Down arrow (↓) until Filter is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), toggle between OUT and IN to reach the appropriate Filter setting.
3. If you choose wish to work with filter IN, be sure to place the removable filter on the detector sensor.
4. If you choose wish to work with filter OUT, be sure to remove the removable filter from the detector sensor.
5. Press the **OK** key to keep the new setting.

5.3.3.4. Average

How Averaging Works

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

As soon as the main power measurement screen (See Figure 5.1) is entered and the instrument is set to average mode, the instrument displays the average of readings over the period since the screen was entered up to the present. When the time period of the average is reached, the average becomes a running average over the average period backward in time. For instance, if the average period is 1 minute, at 30 seconds, the average is over 30 seconds, at 1 minute it is over 1 minute, at 5 minutes, it is over the period from 4 to 5 minutes (1 minute back from the present).

To Set the Average Period:

1. Press the Down arrow (↓) until Average is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the list of average periods until you reach the one that is correct for your measurement needs. Set the average period to NONE to disable averaging.
3. Press the **OK** key to keep the new setting.

5.3.3.5. Other Settings

Show or Hide Settings

1. Press the Down arrow (↓) until Show Settings is highlighted and press the Enter arrow (↵).
2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.
3. Press the **OK** key to keep the new setting.

Language Selection

The StarLite display can be configured to one of several languages. In order to select the display language:

1. Press the Down arrow (↓) until Language is highlighted and press the Enter arrow (↵).
2. Set to English, Japanese, Russian, or Chinese.
3. Press the **OK** key to keep the new setting.

Line Frequency

StarLite has built-in circuitry to screen out electrical noise from the local power grid that can introduce errors to the measurements.

Set Line Frequency to your power grid's frequency to screen out the noise correctly.

1. Press the Down arrow (↓) until Line Frequency is highlighted and press the Enter arrow (↵).
2. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
3. Press the **OK** key to keep the new setting.

Clock Settings

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

To set Date and Time

1. Press the Down arrow (↓) until the Date and Time are highlighted and press the Enter arrow (↵).
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow (→). Change the selected item with the Down arrow (↓).
3. When finished, press the **OK** key to keep the new setting.

5.3.3.6. Additional On Screen Information

On the right hand side of the Setup screen the following information is provided to the user

- Instrument
  - Firmware Version
  - Serial Number
  - Date of Last Calibration
- Sensor
  - Name
  - Serial Number
  - Date of Last Calibration (if supported by the sensor

5.4. Special Cases of Power Measurement

5.4.1. Measuring dB 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 do so do as follows:

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

Note:

If there is a zero offset in the reference value, you cannot subtract this using the dB offset function. Instead, before the start of the measurement, press

"Offset" and subtract the zero offset. Then follow steps 1 and 2 above. The zero offset subtracted when "Offset" was pressed will be saved in the dBm scale and you can now use the dB Offset setting to measure true ratio without zero offset problems.

5.4.2. Measuring Very Low Powers

When measuring very low powers, such as picowatt measurements using the PD300-IRG or PD300-UV, there will be a rather large zero offset coming from the detector as well as a considerable noise fluctuation. Nevertheless, you can measure these low values by using the average function and pressing offset to eliminate the detector zero offset. In order to measure very low powers do as follows:

1. In the Setup screen, set the appropriate Average period. Return to the measurement screen.
2. Now block the power source you wish to measure, wait for a few measurement periods and press "Offset" to subtract the zero offset.
3. Now unblock the power source and measure.

Chapter 6. Operation with Pyroelectric Sensors

Warning:

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

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 shows damage, then either enlarge your beam or lower the laser energy until damage is no longer seen.

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.

6.1. Pyroelectric & Photodiode Energy Sensors

6.1.1. Supported Models

StarLite supports the PE-C and PD-C series of sensors. Older models of Pyroelectric and Photodiode Energy Sensors are not supported.

6.1.2. 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 pre-determined interval, amplifies it and holds it for a pre-determined 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 StarLite 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, StarLite is also able to display average power.

6.1.3. Photodiode Energy Sensors – method of operation

The PD10-C & PD10-PJ-C operates 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.

6.2. Startup Configuration

On power up, the StarLite 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 will be described fully in the following sections.

6.3. Measuring Energy with Pyroelectric Sensors

The Pyroelectric sensor is capable of measuring pulses up to very high repetition rates on the order of kilohertz or higher. The StarLite 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.

Energy measurements can be displayed in Bargraph or Needle graphical formats. Updating measurement parameters is performed in the easy-to-reach Setup screen.

6.3.1. Bargraph Screen

6.3.1.1. Screen Layout

The Bargraph is a ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale.

The Bargraph display is composed of 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.
- Frequency displayed above the energy reading, on the right side of the screen.
- Bargraph displayed close to the bottom.
- Softkey legends at the bottom of the screen.

6.3.1.2. Softkey Functionality

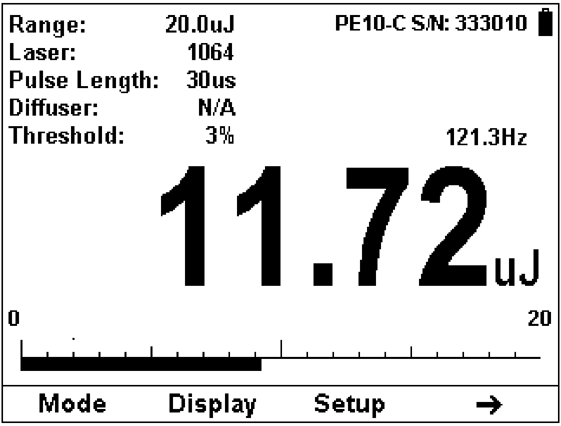


Figure 6.1 Bargraph display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (↕) to set the measurement mode to Energy or Power.
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
  - Press the Up/Down arrow (↕) to set the display mode to Bargraph or Needle.
  - Press OK to return to the measurement screen with the new selection.
  - Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Energy measurement parameters. This will be described in Section 6.3.3 Energy Setup Screen.

- **Right Arrow (➔):** Press this for additional Bargraph screen functions.

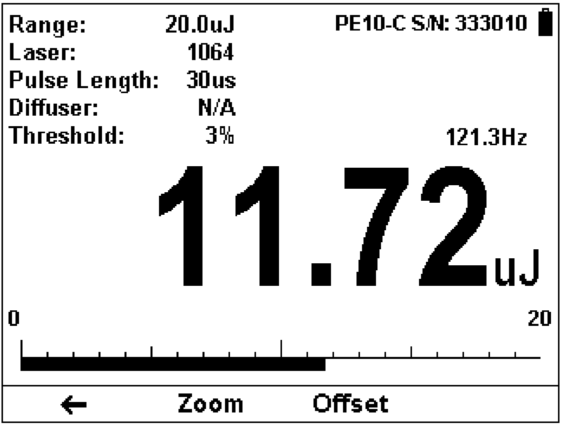


Figure 6.2 Bargraph display with second set of Softkeys

- **Left Arrow (←):** Press this for previous set of Bargraph functions.

- **Zoom:** Press this 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. Small fluctuations in energy are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

- **Offset:** 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.

  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. To deactivate, press Offset again.

6.3.2. Needle Screen

6.3.2.1. Screen Layout

A 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.

The Needle display is composed of the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- Needle displayed prominently in the middle of the screen.
- Frequency displayed above the needle, on the right side of the screen.
- Large numeric display.
- Softkey legends at the bottom of the screen

6.3.2.2. Softkey Functionality

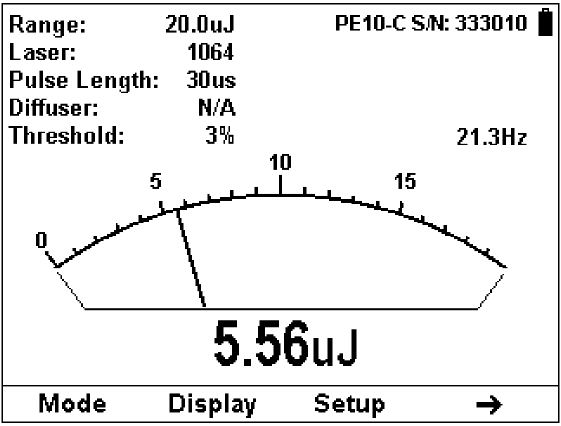


Figure 6.3 Needle display with first set of Softkeys

- **Mode:** Press this key to change the selected measurement mode.
    - o Press the Up/Down arrow (⇕) to set the measurement mode to Energy or Power.
    - o Press **OK** to return to the measurement screen with the new selection.
    - o Press **Cancel** to ignore any changes and continue in Power measurement mode.

- **Display:** Press this key to change the graphical display.
    - o Press the Up/Down arrow (⇕) to set the display mode to Bargraph or Needle.
    - o Press OK to return to the measurement screen with the new selection.
    - o Press Cancel to ignore any changes and continue with the Bargraph display.

- **Setup:** Press this key to change the Energy measurement parameters. This will be described in Section 6.3.3 Energy Setup Screen.

- **Right Arrow** (→)**:** Press this for additional Needle screen functions.

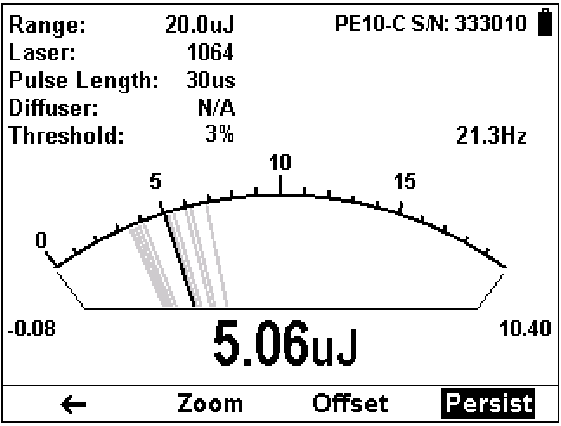


Figure 6.4 Needle display with second set of Softkeys and Persistence active

- **Left Arrow (←):** Press this for previous set of Needle functions.

- **Zoom:** Press this key to focus the Needle on the present reading. The Needle arc will show 20% of the full scale centered on the present reading. Thus, if the full scale of the Needle is 20 Joules, and your reading is 15 Joules, pressing **Zoom** will make the Needle scale range between approximately 13 and 17 Joules. Small fluctuations in energy are more easily seen in this mode. **Zoom** will be reverse highlighted to show that it is active. Press the **Zoom** key again to return to the unexpanded Bargraph display.

- **Offset:** 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.

  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. To deactivate, press Offset again.

6.3.3. Energy Setup Screen

The StarLite meter can be set to various chosen settings while operating. These configuration settings are automatically saved for the next time the meter is turned on with this sensor.

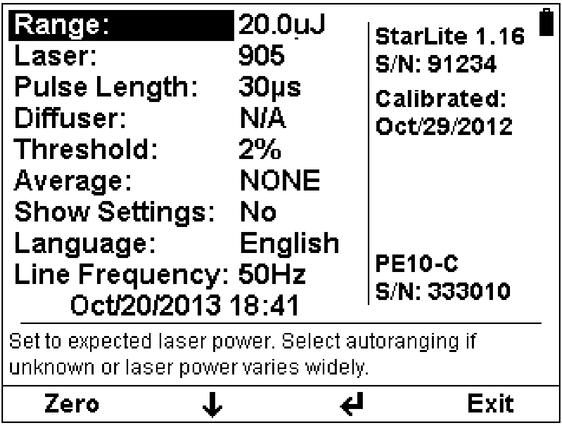


Figure 6.5 Setup Screen

6.3.3.1. Energy Range

Energy measurement with a Pyroelectric sensor is always made in a set manual range. The correct range to select is the lowest one that is larger than the largest expected measurement.

To Set the Energy Range

1. Press the Down arrow (🡇) until Range is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (🡇), scroll through the available ranges until you reach the one that is correct for your measurement needs.
3. Press the **OK** key to keep the new setting.

6.3.3.2. Laser

Metallic type absorbers (continous spectral curve):

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

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

1 Press the Down arrow (↓) until Laser is highlighted and press the Enter arrow (↵).
2 Using the Down arrow (↓), scroll through the available lasers until you reach the appropriate laser wavelength.
3 If your wavelength is listed, use the Down arrow (↓) to scroll through the wavelengths until reached and press the **OK** key.
4 If the wavelength you want is not among the wavelengths in the six wavelengths listed press the **Modify** key.
5 Use the Right (→) and Down (↓) arrows to adjust the wavelength as desired. Then press the OK key.

BB Type Absorbers (fixed wavelengths)

The BB type sensors have less variation with wavelength, and therefore are calibrated at fixed wavelengths

1. Press the Down arrow (↓) until Laser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available lasers until you reach the appropriate laser wavelength.
3. Press the **OK** key.

6.3.3.3. Laser Pulse Width

Most Ophir pyroelectric sensors can be configured to measure the energy of laser pulses of shorter or longer lengths. In order to operate properly, the StarLite must be set to a maximum pulse width setting longer than the actual laser pulse width. Therefore the pulse width should be set to the shortest pulse width longer than the actual laser pulse width.

Warning:

If the pulse width is incorrectly set to a pulse width shorter than the actual pulse width of the laser, the reading will be erroneously low. If it is set to a setting longer than necessary, the reading will be correct but noisier.

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

1. Press the Down arrow (↓) until Pulse Length is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the available pulse lengths until you reach the shortest one that is longer than the expected laser pulse width.
3. Press the **OK** key.

6.3.3.4. PE-DIF Diffuser Sensors

Some pyroelectric sensors are equipped with a removable diffuser. Using this diffuser enables the sensor to measure higher energy pulses.

To choose the diffuser setting:

1. Press the Down arrow (↓) until Diffuser is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), toggle between OUT and IN to reach the appropriate Diffuser setting.
3. If you choose wish to work with Diffuser IN, be sure to attach the Diffuser to the detector sensor.
4. If you choose wish to work with Diffuser OUT, be sure to detach the Diffuser from the detector sensor.
5. Press the **OK** key to keep the new setting.

Note:

The laser dependent calibration factors are different for the two Diffuser states. Therefore, after setting the Diffuser state, make sure that the Laser and Pulse Length settings are correct as well.

6.3.3.5. Minimum Energy Threshold

Pyroelectric sensors are sensitive to noise and vibration as well as the heat from the laser pulses. They can falsely trigger on such disturbances, especially on the lowest ranges. The PE-C series of sensors has a user settable threshold to suppress such false triggering. The default threshold setting is set to 3% of full scale. However, it can be set to smaller or larger values. If you are measuring very low energies, for highest accuracy, it is recommended to set the threshold to the minimum value, as long as this does not result in false triggering. For noisy environments with false triggering, it is recommended to set the threshold to the lowest value that eliminates the false readings. You can change the threshold as follows:

Ophir also offers a shock absorbing mounting post (P/N 7Z08268) that helps reduce vibration on the sensor.

To Set the Minimum Threshold Level:

1. Press the Down arrow (↓) until Threshold is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the list of threshold levels until you reach the one that is correct for your measurement needs.
3. Press the **OK** key to keep the new setting.

6.3.3.6. Average

How Averaging Works

When a laser output is fluctuating or unstable, it is useful to measure a number of pulses and display the average value of the energy over a certain period. The StarLite gives you this exclusive feature, allowing averaging over periods varying from ½ second to 30 seconds.

Pyroelectric sensors is capable of measuring pulses up to very high repetition rates, some on the order of kilohertz or higher. The StarLite meter actually captures each pulse up to 500Hz and will sample pulses at up to 25,000 pulses depending on the sensor. However, the display can only display at rates up to 10Hz. At higher rates, if the user has chosen "NONE", the StarLite will display individual pulses sampled at a rate of 5Hz. If the user has chosen to average over a time period, the instrument will display the average of readings over the period from the time the screen was entered up to the present. For instance, if the average period is 30 seconds, at 15 seconds, the average is over 15 seconds, at 30 seconds it is over 30 seconds, at 5 minutes, it is over the period from 4.5 to 5 minutes (30 seconds back from the present etc.).

To Set the Average Period:

1. Press the Down arrow (↓) until Average is highlighted and press the Enter arrow (↵).
2. Using the Down arrow (↓), scroll through the list of average periods until you reach the one that is correct for your measurement needs. Set the average period to NONE to disable averaging.
3. Press the **OK** key to keep the new setting.

6.3.3.7. Other Settings

Show or Hide Settings

1. Press the Down arrow (↓) until Show Settings is highlighted and press the Enter arrow (↵).
2. Set to Yes to display sensor settings in the measurement screens. Set to No to hide the sensor settings and show a larger graph.
3. Press the **OK** key to keep the new setting.

Language Selection

The StarLite display can be configured to one of several languages. In order to select the display language:

1. Press the Down arrow (↓) until Language is highlighted and press the Enter arrow (↵).
2. Set to English, Japanese, Russian, or Chinese.
3. Press the **OK** key to keep the new setting.

Line Frequency

StarLite has built-in circuitry to screen out electrical noise from the local power grid that can introduce errors to the measurements.

Set Line Frequency to your power grid's frequency to screen out the noise correctly.

1. Press the Down arrow (↓) until Line Frequency is highlighted and press the Enter arrow (↵).
2. Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
3. Press the **OK** key to keep the new setting.

Clock Settings

The StarLite is equipped with a real time clock which will show the date and time. This clock will also allow the

StarLite to query the sensor attached and notify you if the sensor is due for calibration.

To set Date and Time

1. Press the Down arrow (↓) until the Date and Time are highlighted and press the Enter arrow (↵).
2. Scroll through and select Month, Day, Year, Hour, and Minutes with the Right arrow (→). Change the selected item with the Down arrow (↓).
3. When finished, press the **OK** key to keep the new setting.

6.3.3.8. Additional On Screen Information

On the right hand side of the Setup screen the following information is provided to the user

- Instrument
  - Firmware Version
  - Serial Number
  - Date of Last Calibration
- Sensor
  - Name
  - Serial Number
  - Date of Last Calibration (if supported by the sensor

6.3.4. Zeroing Sensor against the StarLite Meter

There is a slight variation of pyroelectric reading from meter to meter. Therefore, for the most accuracy in pyroelectric energy measurements, it is necessary to zero the pyroelectric sensor with the StarLite it will be used with. After this is done, the sensor is “conditioned” to work with the particular StarLite the zeroing was done against. It is not necessary to do this procedure again unless the StarLite is used with a different sensor. If the procedure is not done, errors of 2% or so can occur.

To zero the sensor with the StarLite, proceed as follows:

Make sure the sensor is in a quiet environment and not subject to pulsed radiation. Plug sensor into StarLite and turn on. Press the **Setup** key to enter the Setup screen. Press the **Zero** key to enter the Zero screen. Press the **Start** key. When "Zeroing completed successfully" appears, press the **Save** key and then press the **Exit** key. 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 of meter, then a different value has been saved and when used with this StarLite again you should zero it again.

6.4. Measuring Average Power and High Energies

6.4.1. 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…

Average Power = Average Energy X Frequency

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

Note: StarLite use when measuring power is the same as when measuring energy and has been described in full in Section Measuring Energy with Pyroelectric Sensors.

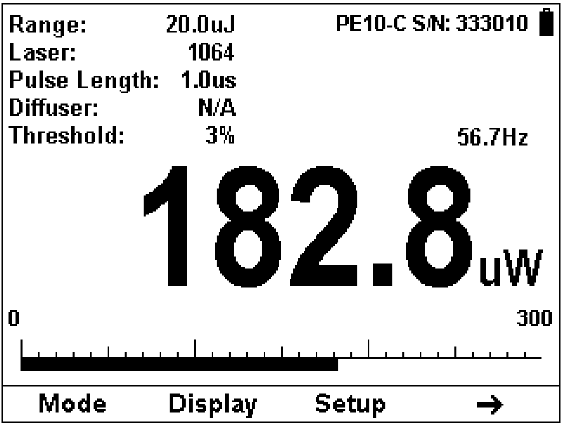


Figure 6.6 Bargraph display when measuring Power

6.4.2. Measuring Pulses of High Energy Density

Because 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:

1. You can enlarge your laser beam using a negative lens until the energy density is below damage threshold. You should test this using the test slide that is supplied with the sensor.
2. You can use a beam splitter, splitting off typically 8 - 10% of the light. If you use this method, note that there may be polarization effects.
3. 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.

Chapter 7. Special Sensors

In addition to the sensor types described in the previous chapters, Ophir offers sensors that are based on similar technologies that are geared towards other measurement applications.

7.1 Pyroelectric Radiometer

The Pyroelectric Radiometer uses a pyroelectric sensor in conjunction with chopped CW or quasi CW radiation, using a digitally synthesized lock-in amplifier to reduce external noise to a minimum. The signal is passed through an 18Hz chopper. This chopping enables the pyroelectric detector to detect and measure very low powers of lasers to which classical thermopile sensors do not respond and that are outside the range of responsivity of our photodiode sensors.

All of this intricacy is hidden from the user. StarLite presents the Pyroelectric Radiometer as a standard thermopile sensor that measures power only. See Operation with Thermopile Absorber Sensors for a detailed description of operation.

7.2 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

Except for the differences listed below, use of the PD300RM with StarLite is the same as power measurement with a standard PD300 (see Operation with Photodiode Type Sensors).

- **Measurement Mode:** With Photodiode sensors, the only measurement mode available is Power. Pressing the left softkey in the main screen will affect no change. With the PD300RM, the left softkey allows toggling between Irradiance and 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/cm²) or dosage as Joule per area (J/cm²).
- **Ranges.** The standard PD300 allows display of power in dBm and ranges are scales of W. The PD300RM doesn't allow dBm and ranges are scales of W/cm².

7.2.1. Irradiance Measurement

Irradiance is the power of light per unit area incident on a surface and is displayed as watts per square meter (W/cm²).

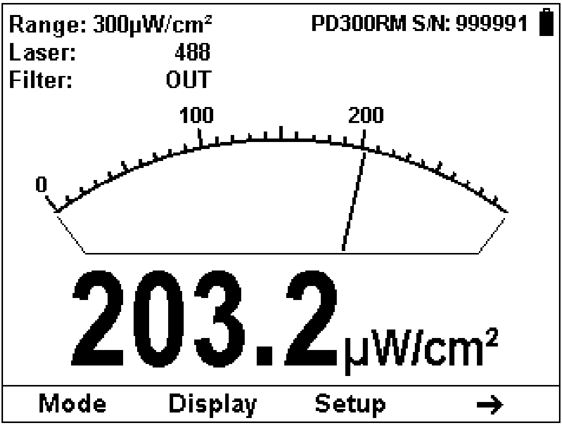


Figure 7-1 Irradiance measurement in Needle display

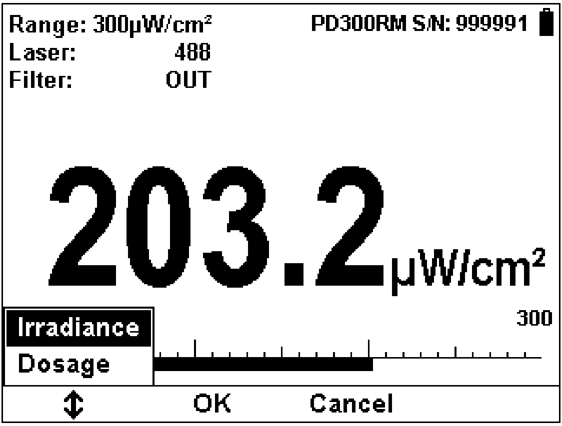


Figure 7-2 Irradiance Measurement in Barchart display. Note the left softkey allows selection of Irradiance or Dosage

For a full description of the Screen Layout and Softkey Functionality, please refer to section Power Measurement of Operation with Photodiode Type Sensors.

7.2.2. Dosage Measurement

Dosage is the integral of irradiance over time and is displayed as joules per square meter (J/cm²). This measurement mode is specific to the PD300RM.

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

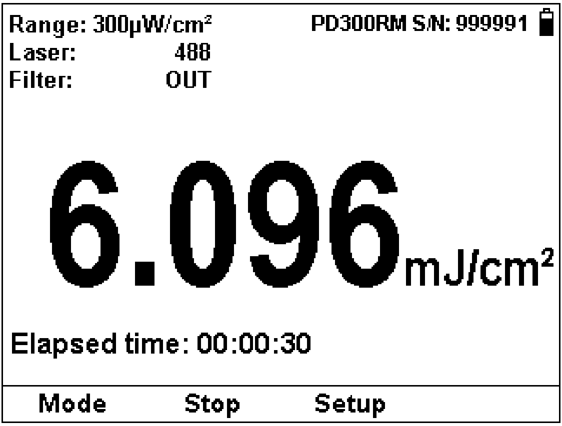


Figure 7-3 Dosage Measurement

7.2.2.1. Screen Layout

Dosage is displayed in a numeric format screen that is composed of 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.
- Timer that shows how much time has elapsed since the beginning of this session.
- Softkey legends at the bottom of the screen.

7.2.2.2. Softkey Functionality

- **Mode:** Press this key to change the selected measurement mode.
  - Press the Up/Down arrow (⇕) to set the measurement mode to Irradiance or Dosage.
  - Press **OK** to return to the measurement screen with the new selection.
  - Press **Cancel** to ignore any changes and continue in Dosage measurement mode.

- **Start/Stop:**
  - Press this key once to start the Dosage measurement session. The legend will change to **Stop**. Dosage summing continues until the **Stop** key is pressed or one hour has elapsed.

- o Pressing Stop (or if one hour has elapsed) will freeze the last Dosage sum on the screen and will return the key legend back to **Start**.
- o Pressing **Start** again will reset the timer to Dosage sum displayed to 0 and will start a new Dosage session.

- **Setup:** Press this key to change the measurement parameters.

7.2.3. Setup Screen

The setup screen can be reached in either Irradiance or Dosage mode. Note, that the ranges displayed are always in terms of W/cm². This is because the sensor always measures irradiance. It is the StarLite meter that integrates the result into dosage.

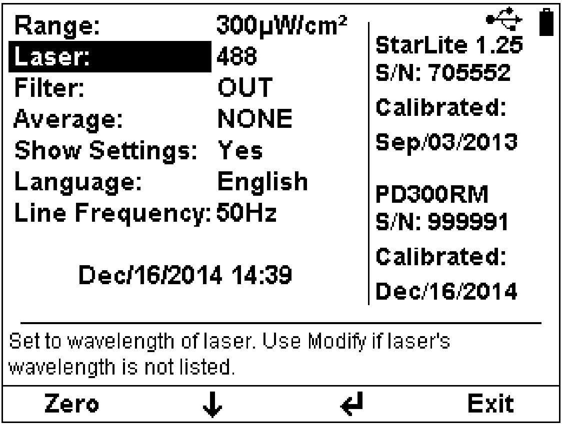


Figure 7-4 PD300RM Setup Screen

7.2.4. Offset

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

- Enter Irradiance mode and go to the second set of softkeys by pressing the Right Arrow key.
- 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.
- Return to the first set of softkeys by pressing the Left Arrow key.
- Use the Mode key to select Dosage.
- The Offset stored in the Irradiance screen will be subtracted in order to provide accurate Dosage measurements.

Chapter 8. Circuit Description

The StarLite 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.

8.1. Analog Module

8.1.1. 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 etc.) in the StarLite. 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.

8.1.2. Fast Analog Input:

In addition to the above basic analog circuit, the StarLite 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.

8.1.3. Analog Output:

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

8.2. 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-situ by StarLite support software. The Processor Board is responsible for reading the keypad, driving the LCD display that displays measurement information received from the Analog Module, and communicating with the PC (when the USB option has been enabled).

8.2.1. 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.

8.2.2. EMI Protection:

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

Chapter 9. Calibration, Maintenance and Troubleshooting

9.1. Calibration of Thermopile Sensors

9.1.1. Absorber types and Method of Calibration of Ophir Power Meters

9.1.1.1. Types of Ophir Laser Absorbers

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

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/cm^2, without changing calibration. The absorption of this coating is above 85% for most of its range, as shown in graph 1 below.

EX (excimer) absorber

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

LP1 (long pulse) absorber

This absorber has a very high damage threshold for long pulse (ms) or continuous lasers and is therefore offered for use with high power and energy lasers. It is calibrated for the spectral range 250 – 2200nm with some sensors also being calibrated for 2940nm.

2. Volume absorbers:

P (pulse) type absorber

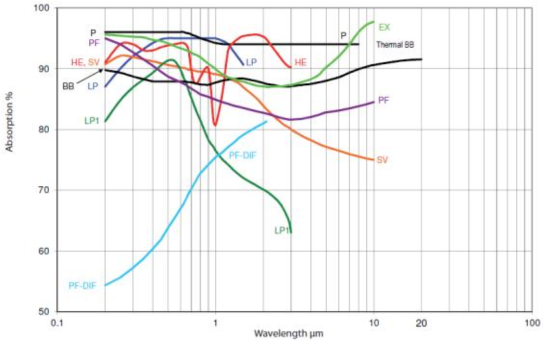
The models with the P suffix, for use with pulsed lasers, have a special absorbing glass with an absorbance of 95 ±2% over the operating range. Since the surface is a glass, its reflectivity does not change even if damaged or melted locally.

HE (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.



Graph 1

Absorption vs. Wavelength of Various Thermal Sensor Absorbers

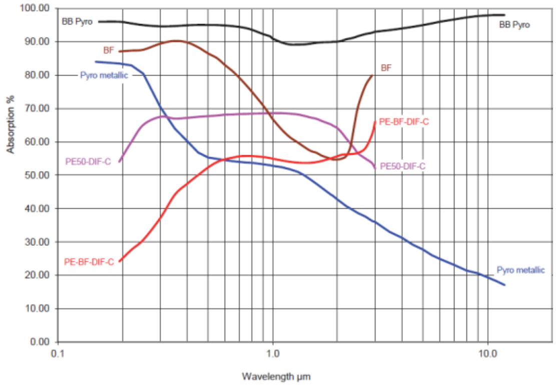
Ophir power/energy meters with the Broadband, P or PF type absorbers are individually calibrated by laser at several wavelengths against a NIST calibrated standard meter. The meter can be switched to give the exact calibration at the various wavelengths (532, 1064, and, where applicable, CO2). Since 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.

9.1.2. Linearity and Accuracy of Ophir Thermal Sensors

9.1.2.1. Linearity

The linearity of most Ophir thermal detectors is specified to be 1% over the specified power range of each particular instrument and is tested by Ophir from time to time. 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.



Graph 2.

Absorption vs. Wavelength of Various Pyroelectric Sensor Absorbers

9.1.2.2. Method of Calibration

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

9.1.2.3. 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

9.2. Calibration of Photodiode type 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 StarLite, the StarLite has a built in calibration adjustment for wavelength which is described in the next paragraph.

9.2.1. Method of Factory Calibration

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

The spectral sensitivity curve of the detector as well as the spectral transmission curve of the filters is fed into the 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 StarLite, the correction factor for that wavelength is applied.

9.2.2. Accuracy of Calibration

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

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

Table 3

Maximum Error as a Function of Wavelength and Filter

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

Note:

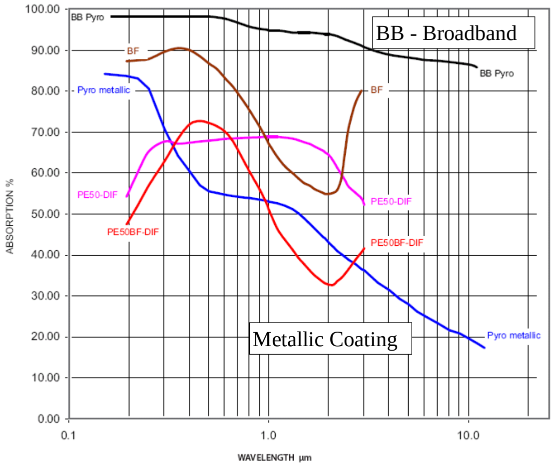
More exact specifications will be found in the latest Ophir Laser Measurement Instruments Catalog.

9.3. Calibration of Pyroelectric type Sensors

9.3.1. Two main types of absorber surface are used in Ophir pyroelectric measuring sensors

1. **Metallic Type:** The type with no suffix in the name have a partially reflective multilayer metallic coating which absorbs approximately 50% and whose absorption graph is shown in Graph 3 below. The metallic coating permits very high repetition rates, up to 25000Hz as well as relatively high damage threshold.
2. **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 $0.8J/cm^2$ for short pulses and $2J/cm^2$ for long pulses without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Graph 3 below. This coating is available for the PE50, PE25, and PE10 sensors. For even higher damage thresholds, there are the –DIF diffuser series with a diffuser in front of the absorber.
3. **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.

Absorption(%) vs. Wavelength (nm)



Graph 3.

Absorption of Ophir Pyroelectric Absorbers

9.3.2. Calibration

The sensitivity of the various Ophir pyroelectric sensors can vary from one to another as well as with wavelengths. Therefore, Ophir pyroelectric detectors are individually calibrated against NIST traceable standards. In addition, 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 thermal power meter. The average energy is set to the average power of the standard power meter divided by the laser frequency. The metallic PE25 and PE50 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 StarLite, the correction factor for that wavelength is applied.

The PD10 & 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.

9.3.3. Accuracy of Calibration

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

The non-linearity is approximately 2%, and the error due to wavelength is given in table 4 below.

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

9.4. Error Messages

The StarLite 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 StarLite 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.

9.5. Troubleshooting

9.5.1. StarLite 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 StarLite turned off for 5 hours. If the StarLite still doesn't work with battery, then the Lithium Ion battery is probably dead. Replace battery (see section 9.6.1.2).

9.5.2. Thermal Sensors, Energy Measurements

Problem	Cause/Remedy
Instrument triggers on background noise or sometimes fails to catch large pulse.	Increase threshold level; See Section 4.4.4.3
Instrument does not show ready for a long while after a reading is made.	Increase threshold level; See Section 4.4.4.3
Non-reproducible results when measuring very small energy pulses; or no response to pulses at low energy.	Decrease threshold level: See Section 4.4.4.3

9.5.3. Thermal Sensors, Power

Problem	Cause/Remedy
Instrument shows zero reading in both power and energy modes.	Check connections between the sensor and the instrument. (See section 9.6.1.1). 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.	Have the sensor disc replaced.
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 section 3.5.5. If the offset persists, try zeroing with the sensor connected as well, as described in the same section.

9.5.4. 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 cable away from bench. 2. Move sensor/display further away from EMI.

9.6. Maintenance

9.6.1. Maintenance of Thermal Sensors

9.6.1.1. Tracing the Signal from the Sensor to StarLite

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 the sensor specification table.
3. Using a multimeter set to current, unplug the sensor from the StarLite and check that this current appears between pin 1 and 9 of the D type plug.

9.6.1.2. Battery Replacement

If the StarLite 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 StarLite is switched OFF. Turn the StarLite meter upside down and unscrew the 5 Phillips screws on the bottom panel of the StarLite.
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 StarLite and close the 5 screws.
5. Switch on the StarLite with NO SENSOR DETECTOR attached and set the date and time of the instrument correctly. (See section 3.5.4)

Chapter 10. StarLite Specifications

10.1. System/Meter Specifications

Input Specifications Thermal, 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	500 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 (optional)	USB
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: Thermal, Photodiode 19, Pyroelectric 16 With medium backlight: Thermal/Photodiode 17, Pyroelectric 15 With high backlight: Thermal/Photodiode 15, Pyroelectric 13

10.2. Sensor Specifications

Sensor	Max Power (WATTS)	Max Avg. Power Density at Max Power	Absorber Type
PD300/UV/IR	300mW	50W/cm²	PD
PD300-3W	3W	100W/cm²	PD
3A-IS	3W	200W/cm²	Int Sph PD
3A	3W	1000W/cm²	BB
3A-P	3W	50W/cm²	P
3A-FS	3W	200W/cm²	FS
10A	10W	28KW/cm²	BB
12A	12W	25KW/cm²	BB
12A-P	12W	50W/cm²	P
20C-SH	4(20)W	23KW/cm²	BB
30A-BB-18	30W	20KW/cm²	BB

30A-P-17	30W	50W/cm²	P
L30A-10MM	30W	20KW/cm²	BB
50A-PF-DIF-18	50W	0.5KW/cm²	PF-DIF
30(150)A-BB-18	30(150)W	12KW/cm²	BB
30(150)A-HE-17	30(150)W	500W/cm²	HE
50(150)A-BB-26	50(150)W	12KW/cm²	BB
L50(150)A-BB-35	50(150)W	12KW/cm²	BB
L50(150)A-LP1-35	50(150)W	38KW/cm²	LP1
L50(150)A-EX-35	50(150)W	2KW/cm²	EX
L40(150)A	35(150)W	12KW/cm²	BB
L40(150)A-LP1	35(150)W	38KW/cm²	LP1
F150A-BB-26	150W	12KW/cm²	BB
FL250A-BB-35	250W	10KW/cm²	BB
L250W	250W	10KW/cm²	BB
FL400A-BB-50	400W	8KW/cm²	BB
FL500A	500W	7KW/cm²	BB
1000W/1000W-LP	1000W	6/7KW/cm²	BB/LP
L1500W/L1500W-LP	1500W	5/6KW/cm²	BB/LP
5000W/5000W-LP	5000W	3/4KW/cm²	BB/LP
10K-W	10000W	10KW/cm²	BB
PD10	50mW	50W/cm²	PD
PE9	2W	30W/cm²	PE
PE10-BF-C	3W	50W/cm²	PE-BF
PE25-C	25W	20W/cm²	PE
PE25BF-C	25W	20W/cm²	PE-BF
PE25BF-DIF-C	30W	120W/cm²	PE-BF-DIF
PE50-C	25W	20W/cm²	PE
PE50-DIF-C	30W	100W/cm²	PE-DIF
PE50BF-C	25W	20W/cm²	PE-BF
PE50BF-DIF-C	30W	200W/cm²	PE-BF-DIF
PE100BF-DIF	40W	500W/cm²	PE-BF-DIF

Table 5. Max Power Specifications of Sensors

PD - Photodiode
P - P type volume absorber for short pulse lasers
PF - volume absorber for short pulses and high average powers
HE - volume absorber for high energy pulses
EX - Excimer type, volume absorber
PE - pyroelectric metallic or black absorber
BB - broadband surface absorber, high power density
LP1 - broadband surface absorber for highest power density
BF - very high damage threshold, long pulses
FS - Fused silica window close to detector for divergent beams

Note:

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

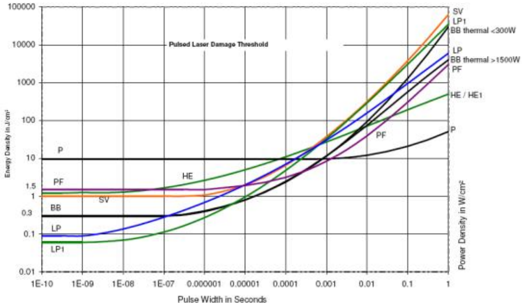
Absorber Type	Max Energy Density J/cm² Pulse Length		
	10ns	1μs	300μs
P	10	10	10
HE	3	5	15
BB	0.3	0.5	3

LP1	0.09	0.5	10
EX	0.8	0.9	7
PE, Metallic	0.2	0.5	4
PE, BB	0.5	0.5	1
PE-DIF	1	2	20
PE BB-DIF	3	3	10

Table 6

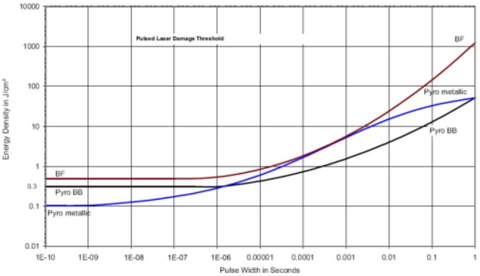
Maximum Energy Densities for Various Absorbers
(Single pulse).

Note: The CW power damage threshold in W/cm2 is found on the right hand side of the table at the 1s pulse width value.



Graph 4.

Pulsed Laser Damage Threshold for Thermal Sensors



Graph 5.

Pulsed Laser Damage Threshold for Pyroelectric Sensors

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