Centauri

Centauri

High End Laser Power/Energy Meter

User Manual

Ophir Optronics Solutions Ltd.

www.ophiropt.com/photonics

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1 Introduction

The Ophir Centauri is a microprocessor-based laser power/energy meter with single and dual channel options that provides a broad range of measurements, displays, and data handling options. It operates with thermal, pyroelectric, and photodiode sensors. Smart connector technology enables sensor configuration and calibration information to be stored in an EEROM in the sensor connector plug, and when the sensor is attached, Centauri automatically identifies the sensor type, calibration, and configuration. Simply connecting the sensor causes the Centauri to reconfigure and calibrate to operate with that sensor.

The Centauri's 7" full-color touchscreen enhances measurement. The Centauri can graph power or energy versus time. It displays power measurements in both digital and analog form simultaneously, including a needle-type display. It can autorange, so you do not have to set scales; or you can set the range manually. It remembers what mode you were using before you turned it off, and returns to that mode when turned on. You can zoom in on the present reading, or subtract background. You can zero the Centauri at the touch of a button.

Centauri is capable of logging data in its internal memory, or onto a USB flash drive for transfer to a PC for analysis via an application like Ophir's StarLab. It is also capable of real-time reporting of data via USB to Ophir's StarLab application for display and processing of the information. The OTG USB port can be used to connect Centauri directly to StarLab. Centauri also has RS232 and Ethernet capabilities for real-time data reporting to a PC. Centauri also has the infrastructure for field upgrade of the embedded software (firmware) when required.

The Centauri has advanced circuitry and digital signal processing for excellent sensitivity, signal to noise ratio, accuracy, and response time. It has special circuitry to reject electromagnetic interference.

The Centauri has the ability for field upgrade of the embedded software (firmware) when required.

1.1 This Document

This document covers everything you need to know to use the Centauri for all your laser measurement needs. It includes a Quick Reference (Chapter 2) to enable you to perform basic measurements immediately, without reading the whole manual.

1.2 Related Documentation

Ophir takes pride in the wealth of laser measurement information we provide including FAQ's, catalogs, spec sheets, and more. Go to https://www.ophiropt.com/laser--measurement.

1.3 Support

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

2 Quick Reference

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

2.1 Getting Started

The Centauri is equipped with a 7" full-color touch screen. Sensor parameters can be updated with a few taps on the screen.

When turned on for the first time, a one-time only language selection screen appears.
Languages presently supported are:
English, French, Spanish, Italian, German, Russian, Japanese, Chinese and Korean

Select the language of your choice. Henceforth, the language selection can be changed from either the User Interface Settings, or from the top of the main settings menu.

The Channel Options menu, reached by tapping the three-dot icon ( ), enables access to additional features. See Channel Options Menu.

The Settings menu can be accessed by tapping the cog icon ( ). See Using the Settings Menu.

For each of the display types, a Full Screen option can be enabled and disabled by tapping the full screen icon ( ) at the top of the screen.

To connect a single sensor to the Centauri meter:

- Insert the 15 pin D type connector of the measuring sensor cable into the socket marked "Sensor Input" on the Channel A section of the upper panel of the meter.

To switch the Centauri on:

- Briefly press the Power button on the top of the meter and wait a few seconds for the measurement screen to appear.

To switch the Centauri off:

- Press the power button for a few seconds until it turns off.

To set general meter settings:

1. Disconnect the sensor.

   The **Settings** screen is displayed.

2. Tap **Instrument Settings**.
3. The **Instrument Settings** screen is displayed. On this screen, set the following:
   - **Line Frequency**: Set to 50Hz or 60Hz, depending on the electrical power grid in your area.
   - **Date/Time**: Tap the current date to update the date. In the dialog, roll the month/date/year to the desired date. Tap **OK** to exit. Tap the current time to update time. In the dialog, roll the hour and minutes to set time according to the 24-hour clock. Tap **OK** to exit.

The Centauri automatically saves the current settings for its next power-up.

To zero the meter:

1. Disconnect the sensor.
2. Make sure the meter is not in an electrically noisy environment and is undisturbed.
3. Tap **Instrument Settings**.
4. From the Instrument Settings screen, tap **Zero** at the top of the screen.

   The Zeroing Instrument dialog is displayed.
5. Tap **Start**. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” appears.
6. Tap **Save** to save Zero values and tap **Exit**.

2.2 Thermal Sensors

2.2.1 Using Centauri with Thermal Sensors

1. Plug in the thermal sensor. Centauri reconfigures itself to work with the attached sensor.

   The sensor’s measurement parameters are displayed on the main screen.
2. Tap the parameters to select any new values.

   Centauri saves the changes automatically for its next power-up.

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

2.2.2 Using Centauri to Measure Laser Power

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

2.2.3 Using Centauri to Measure Single Shot Energy

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

2.3 Photodiode Sensors

2.3.1 Using Centauri with Photodiode Sensors

1. Plug in the photodiode sensor. Centauri reconfigures itself to work with the attached sensor.

   The sensor's measurement parameters are displayed on the main screen.

2. Tap the parameters to select any new values.

   Centauri saves the changes automatically for its next power-up.

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

2.3.2 Setting the Measurement Parameters

1. Set **Range** to the appropriate manual range, **AUTO**. Note that when selecting a manual range, the correct range is the lowest one that is larger than the expected maximum power of the laser.
2. Set **Laser** to the appropriate laser wavelength. If the wavelength you want is not among the wavelength listed, select one and tap the edit icon that is next to it to display the **Modify Laser** dialog. Using the keyboard displayed, type in the wavelength you want. Tap **Apply**.
3. Set **Filter** to **IN** or **OUT** as physically configured on the sensor.
4. Set **Average** to the period to average power over, or set to **NONE** to disable.

2.3.3 Measuring Average Power or Exposure

To measure average power:

1. **Set Measuring Mode** to **Power**.
2. Set measurement parameters as described above.

To measure exposure:

1. Set **Measuring Mode** to **Exposure**.
2. Set measurement parameters as described above.
3. Set **Stop Mode** (on bottom of the screen) to **Manual** or **Timeout**.
4. To start or stop power exposure, tap the **start/stop** icon at the bottom of the screen.
5. Accumulated energy exposure is displayed on the screen, as well as the elapsed time.

2.3.4 Measuring with Fast Power

The Fast Power measuring mode measures at a rate of 10 kHz. It is used to measure laser modulation, and may also be necessary for flicker measurement of LED light sources. The data is measured very fast, and can only be properly used in conjunction with logging and analysis.

To measure laser modulation:

1. Set **Measuring Mode** to **Fast Power**.
2. Set measurement parameters as described above.

3. Start logging to record the laser modulation.

2.3.5 Measuring with Low Frequency Power

To measure average power:

1. **Set Measuring Mode** to **Low Freq Power**.
2. Set measurement parameters as described above.
3. Set Pulse Frequency by tapping the arrow and then entering a Pulse Frequency between 5 and 100 Hz.
4. Click **Apply** to exit.

2.4 Pyroelectric or Photodiode Energy Sensors

2.4.1 Using Centauri with Energy Sensors

1. Plug in the pyroelectric/photodiode energy sensor. Centauri reconfigures itself to work with the attached sensor.

   The sensor's measurement parameters are shown on the main measurement screen.

2. Tap the parameters to select any new values.

   Centauri saves the changes automatically for its next power-up.

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

2.4.2 Zeroing the Meter with the Sensor

For the most accurate calibration, zero the energy sensor with the Centauri it is being used with.

1. Make sure the sensor is in a quiet environment and not subject to pulsed radiation.
2. Tap the settings icon on the top of the screen.
3. The **Settings** screen is displayed.
4. Tap **Instrument Settings**.
5. On the **Instrument Settings** screen, tap **Zero** on the top line.
6. In the **Zeroing Instrument** dialog tap **Start**. Zeroing takes about 30 seconds. Wait until "Zeroing completed successfully" is displayed.
7. Tap **Save** to save the zero values. Tap **Exit**.

2.4.3 Setting the Measurement Parameters

1. Set **Range** to the lowest one that is larger than the expected maximum pulse energy of the laser.
2. Set **Laser** to the appropriate laser setting. If this sensor is a metallic type and if the wavelength you want is not among those listed, select one and tap the edit icon next to it to

display the **Modify Laser** dialog. Using the keyboard displayed, key in the wavelength you want. Tap **Apply**.

3. Set **Pulse Width** to the shortest time that is longer than the expected pulse length.

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

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

2.4.4 Measuring Energy, Average Power, or Exposure

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

To measure energy:

1. Set **Measuring Mode** to **Energy**.
2. Set measurement parameters as described above.

   Energy is displayed on the screen along with the laser’s frequency.

To measure average power:

1. Set **Measuring Mode** to **Power**.
2. Set measurement parameters as described above.

   Average power is displayed as a function of “Energy x Frequency” on the screen, along with the laser’s frequency.

To measure energy exposure:

1. Set **Measuring Mode** to **Exposure**.
2. Set measurement parameters as described above.
3. Along the bottom of the screen, set Stop Mode to **Manual**, **Timeout**, or **Pulses**.
4. To start or stop energy exposure, tap the **start/stop** icon at the bottom of the screen.

   Accumulated energy exposure is displayed on the screen, along with the elapsed time and number of pulses measured.

2.5 Graphical Displays

To present measurements on a graduated scale (bargraph):

1. In **Power** or **Energy** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. In the **Display Type** dialog, select **Bar**.

   The main measurement display screen displays the relevant bargraph.
3. To expand the bargraph scale ±5x of the present reading, slide **Zoom** on the bottom of the screen. Slide **Zoom** back to return the bargraph to full scale.
4. To subtract the background and set the current reading to zero, slide **Offset** along the bottom of the screen. Slide **Offset** again to cancel.

To simulate an analog needle:

1. In **Power** or **Energy** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. In the **Display Type** dialog, select **Needle**.

   The main sensor measurement screen displays the relevant needle graph.
3. To expand the needle graph ±5x of the present reading, slide **Zoom** along the bottom of the screen. Slide **Zoom** back to return the needle range to full scale.
4. To subtract the background and set the current reading to zero, slide **Offset** along the bottom of the screen. Slide **Offset** again to cancel.
5. Slide **Persistence** to keep older measurements on the screen and to display the **Min** and **Max** values measured. Slide **Persistence** back to cancel.

To graph laser output over time:

This is especially useful to fine-tune the laser power.

1. In **Power** or **Energy** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. In the **Display Type** dialog, select **Line**.

   The main sensor measurement screen displays the relevant line graph.
3. Zoom and un-zoom the display by stretching and pinching the graph with two fingers, either top to bottom or side to side.
4. Pan the display by moving your finger up and down on the graph.
5. Double-tap the graph to reset the zoom and pan.
6. Tap Autoscale Y Axis along the bottom of the screen to scale the axis between the minimum and maximum readings.
7. Tap **Reset** at the top of the screen to clear the Min/Max tracking and to restart the graph.

To graph laser output in pulse chart form:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. Select **Pulse**.

   The main sensor measurement screen displays the relevant pulse graph.

3. Zoom and un-zoom the display by stretching and pinching the graph with two fingers, either top to bottom or side to side.
4. Pan the display by moving your finger up and down on the graph.
5. Double-tap the graph to reset the zoom and pan.
6. Tap **Autoscale Y Axis** along the bottom of the screen to scale the axis between the minimum and maximum readings.
7. Tap **Reset** at the top of the screen to clear the **Min/Max** tracking and restart the graph. (For more details, see Reset).

To set pass/fail tracking:

1. In **Power** or **Energy** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. In the **Display Type** dialog, select **Pass/Fail**.

   The main sensor measurement screen displays the relevant Pass/Fail graph.
3. Tap **Upper** and **Lower** to set tolerance limits. If the reading is out of range, an appropriate warning is displayed on the screen.

To display real-time statistics:

1. In **Power** or **Energy** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. In the **Display Type** dialog, select **Statistics**.

   The main sensor measurement screen displays the relevant statistics graph.
3. Displayed are Maximum, Minimum, Average, Standard Deviation, Total Readings, and Number Overrange.
4. To subtract background and set the current reading to zero, slide **Offset** at the bottom of the screen. Slide **Offset** back to cancel.
5. Tap **Reset** at the top of the screen to clear the statistics.

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

1. Set **Measuring Mode** to **Track**, tap the **Channel Options menu** icon and then tap **Display Type**.
2. Select **Position**.
3. The main sensor measurement screen displays the relevant Position graph.
4. Slide **Center** button to center the laser beam.
5. Slide **Offset** button to subtract the background noise from the measurement and reset the value to zero.

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

1. Set **Measuring Mode** to **Track**, tap the **Channel Options menu** icon and then tap **Display Type**.
2. Select **Stability**.
3. The main sensor measurement screen displays the relevant Stability graph.
4. Tap **1 sec** on the bottom of the screen to change the time interval (to 3, 10, 30 seconds or 1 minute).

2.6 Functions

To apply a fixed offset to measurements:

This sets the value to subtract from subsequent measurements.

1. Tap the **Channel Options menu** icon and then tap **Functions**.
2. On the **Functions** screen, tap the edit icon for **Fixed Offset**.
3. In the **Set Fixed Offset** dialog, either type in a fixed offset or select the present measurement as a fixed offset. Tap **Apply**.

To apply a scale factor to measurements:

This sets the value by which to multiply subsequent measurements.

This is useful when working with beam splitters.

1. Tap the **Channel Options menu** icon and then tap **Functions**.
2. On the **Functions** screen, tap the edit icon for **Scale Factor**.
3. In the **Set Scale Factor** dialog, type in a scale factor and tap **Apply**.

To normalize against a reference measurement:

Define a baseline against which to compare subsequent measurements.

1. Tap the **Channel Options menu** icon and then tap **Functions**.
2. On the Functions screen, tap the edit icon for **Normalize**.
3. In the **Set Normalize** dialog, either type in a baseline value or select the present measurement as a baseline value. Tap **Apply**.

To display as power/energy density:

1. Tap **Channel Options menu** icon and tap **Functions**.
2. On the **Functions** screen, tap the edit icon for **Density**.
3. In the **Set Density Parameters** dialog, select the beam shape and then enter the size. Tap **Apply**.

Measurements are shown as W/cm^2.

2.7 Logging Measurement Data

You can log measurement data to a file in the meter's internal memory, or on an external storage device connected to the meter's USB port for upload to a PC for analysis. You can also take control of the Centauri on a PC from the StarLab application, and use StarLab to log and analyze data on the PC. For details, see Measurement Logging .

3 Using the Centauri Meter

This section describes the Centauri meter, hardware functions, firmware upgrade, interfaces, and general operation.

Topics include:

- Centauri Hardware Components and Interfaces
- Zero Adjustment
- Offset
- Using the Settings Menu
- Configuring Measurements
- Using StarLab

3.1 Centauri Meter

Figure 3-1 below displays the Centauri meter, displaying the measurement screen with a sensor and a USB flash drive attached.

Figure 3-1 Centauri Meter

The Centauri is equipped with:

- Large 7 " full-color touch display
- Upper panel with the following sockets: 12VDC, power button, an RS232, USB, OTG USB, and TRIG IN ports, and channels for two separate sensors including for each channel a sensor input, and ANLG and TTL outputs.

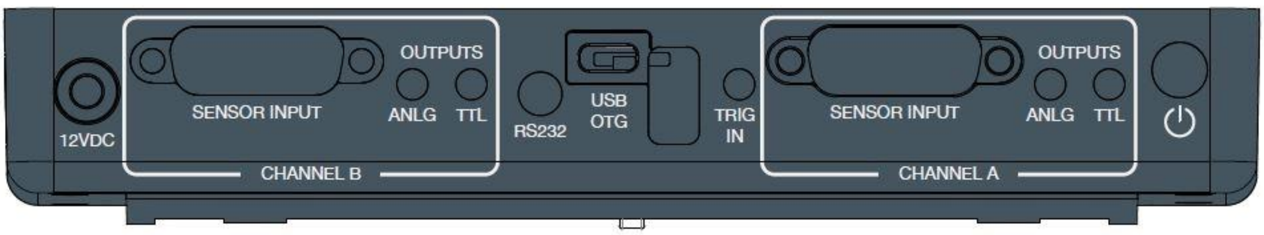


Figure 3-2 Centauri Upper Panel

The right side of the Centauri meter has a pinhole for access to a micro-switch for field firmware upgrade, and Ethernet and WiFi antenna sockets (for future use).

Figure 3-3 Right side of Centauri Meter

3.2 Centauri Hardware Components and Interfaces

This section describes the Centauri hardware components and interfaces.

Topics include:

- Sensor Input
- On-Off Switch
- Centauri Touchscreen User Interface
- Charger Input
- Analog Output
- RS232
- TTL Output
- External Trigger/TRIG IN
- USB
- OTG USB
- USB Flash Drive
- WiFi Antenna Socket
- Ethernet Socket
- Ethernet **connectivity is available from meter firmware version 5.0 and up.**

The side panel Ethernet socket enables connecting the meter to a PC, for use with an application such as StarLab. Connecting to StarLab enables full remote control of the Centauri. When the connection is made with the PC application, the Centauri touch screen is locked to prevent conflict with the PC application, and “Touch Response Locked” is displayed at the top of the Centauri screen.

- Loudspeaker
- Field Upgrade of the Centauri Firmware
- Calibration Reminders

3.2.1 Sensor Input

The Sensor Input, located on either side of the Centauri upper panel, is the socket used to connect the 15-pin D-type connector of the measuring sensor cable to the meter, as shown in Figure 3-4 below.

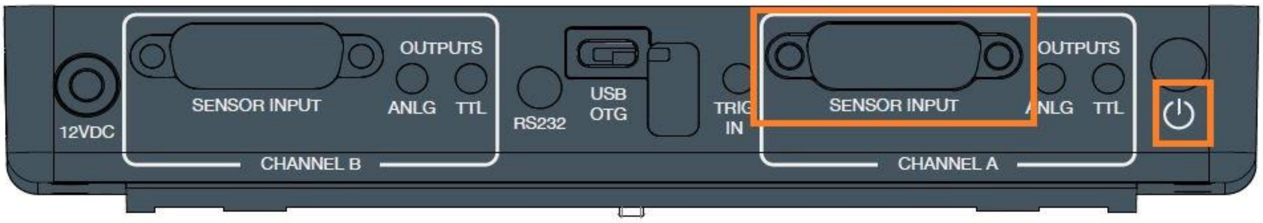


Figure 3-4 Centauri Upper Panel View Channel A sensor input and power button highlighted

To connect a sensor to the Centauri meter:

- Insert the 15 pin D type connector of the measuring sensor cable into one of the sockets marked **Sensor Input** on the upper panel of the Centauri meter. If the second channel is not enabled, be sure to insert the cable into Channel A, which is the channel on the left as you face the touchscreen.

  The measurement screen is displayed for that sensor, allowing parameter and display configuration.

  If your device has the second channel enabled, you can use either or both of the sockets at the top of the meter. When two sensors are connected, the measurement screen is split, and displays data and allows configuration for both channels.

3.2.2 On-Off Switch

This section describes how to switch the Centauri on and off.

To switch the Centauri on:

- Briefly press the power button on the top of the meter and wait a few seconds for the measurement display screen to appear. See Figure 3-4 above.

The unit switches on after logos appear.

(When turned on for the first time, a one-time only language selection screen appears.)

If no sensor is connected, the **Settings** menu is displayed, providing access to various configuration screens and the log history.

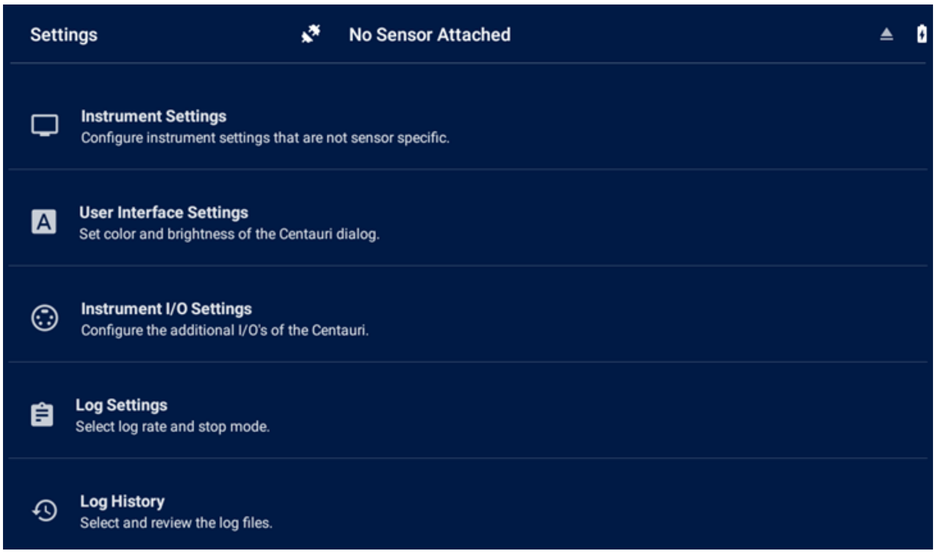


Figure 3-5 Settings Menu

For information on using this screen, see Using the Settings Menu.

If a sensor is connected, the measurement screen for the sensor is displayed, with the settings last used for the sensor. For example:

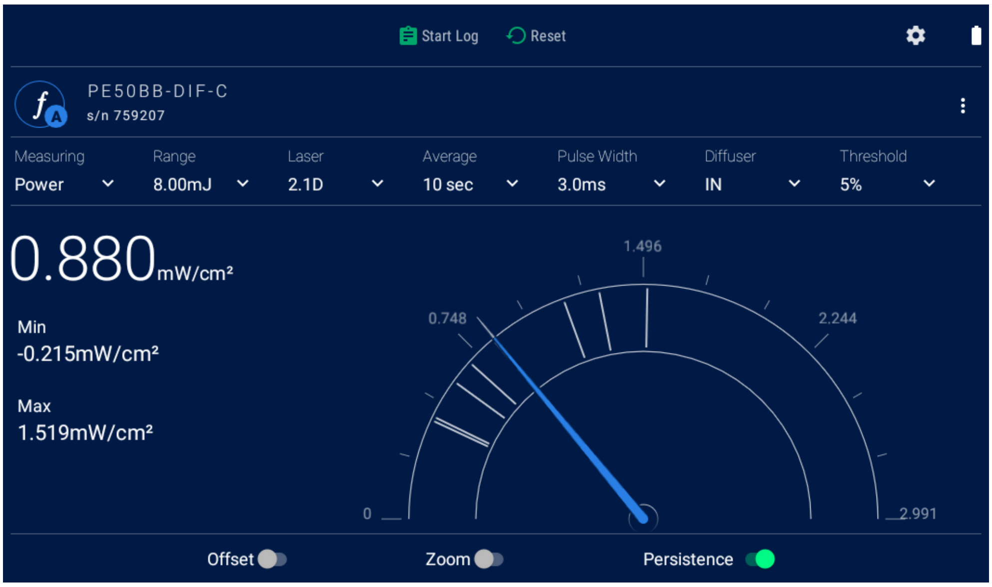


Figure 3-6 Needle Display

The Quick Reference contains useful information on setting up measurements. Refer also to Configuration Menus within the Measurement Screens and individual sensor sections Thermal Sensors, BeamTrack Sensors, Photodiode Sensors, and Pyroelectric and Photodiode Energy Sensors for more information on configuring measurements with specific sensors.

To switch the Centauri off:

➢ Press the power button for a few seconds until the meter turns off.

3.2.3 Centauri Touchscreen User Interface

The Centauri has an intuitive 7-inch full-color touchscreen display designed to provide easy reading of laser measurements, quick access to configuration parameters, and the capability to be set up for more advanced work.

Figure 3-7 below displays the layout of a typical Centauri measurement screen.

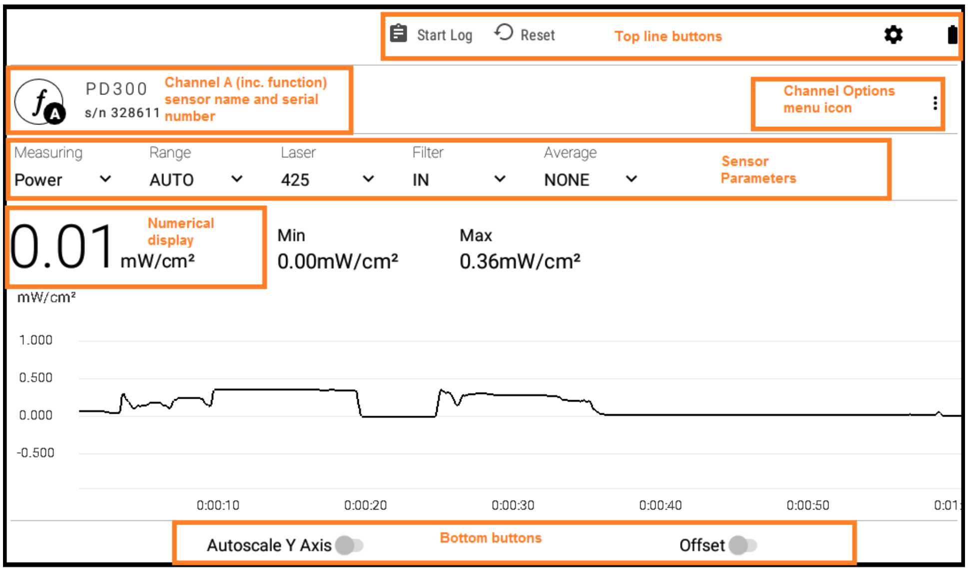


Figure 3-7 Centauri Measurement Screen Layout

When a sensor is attached to the Centauri, the measurement screen is displayed, and the touchscreen contains the following areas:

- The top line contains icons to access log recording, reset, the Settings menu and a battery power indicator.
- The second line contains the sensor name and serial number, and an indication (ƒ) if one or more functions are configured. On the right side of this line is the Channel Options menu icon.
- The third line contains the measurement parameters, enabling you to select the Measuring Mode, and configure mode and sensor-dependent parameters such as Range, Laser wavelength, and Threshold. These parameters are sensor-specific and are saved in the sensor's memory for its next use.
- The main area in the center is the measurement display area, which varies per the selected display type (for example, large numeric readout with real-time statistics, or in this case, a line graph).
- Across the bottom of the screen are buttons to further configure the graphical display and measurement intervals and times.

3.2.4 Charger Input

The Centauri can be operated either on the internal battery or from an AC source with the 15W charger plugged in. Plug the charger into the jack labeled **12VDC** on the upper panel (see Figure 3-8). Full charge takes about seven hours when the meter is switched off. The charger automatically stops charging when the battery is full.

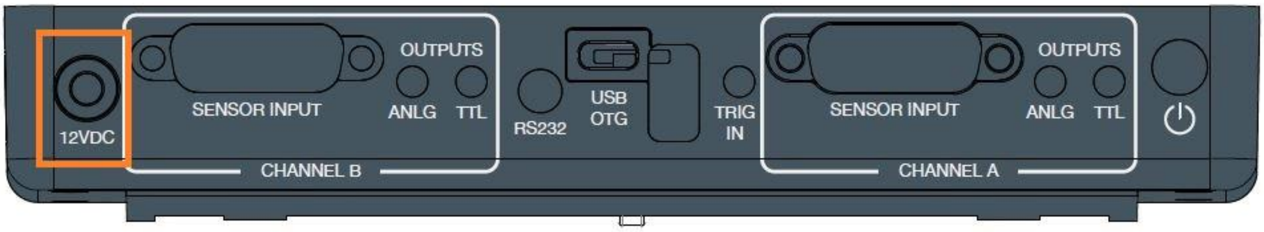


Figure 3-8 Centauri Upper View with 12VDC input highlighted

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

Note: Battery charge is depleted faster if a flash drive is left plugged into the Centauri meter**.**

The battery charge is indicated by the ▮ icon on the meter interface. When the battery is low, the icon turns red (if the interface is configured with a full-color color scheme), and the charger should be plugged in. If the loudspeaker is enabled, the Centauri beeps once every 30 seconds when the battery is at 15% or lower. Though the meter charges while turned on, it charges faster when turned off.

If the charger is plugged in, the icon might turn yellow. See Low Power Mode.

3.2.5 Analog Output

The Centauri provides an analog voltage output via the 2.5mm mono jack socket on the rear panel marked **ANLG**.

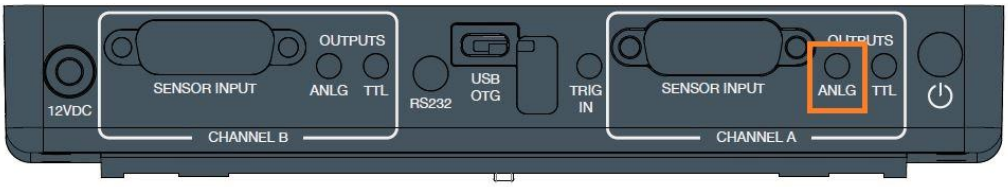
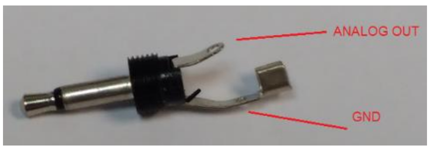


Figure 3-9 Centauri Upper View with the analog socket highlighted

The meter is supplied with a phono plug that connects to this socket.



Here is a picture of the phono plug with the cover removed, showing the polarity of signal on the inner connector, and the ground on the outer connector (shield).

The analog output is useful for driving chart recorders and other analog devices. The voltage is proportional to the reading on the display and scaled such that full scale equals 1, 2, 5, or 10 volts as configured.

To set the analog output voltage:

1. From the sensor measurement screen, tap the **Channel Options menu** icon and then **H/W Settings**.

   The **Channel Hardware Settings** screen is displayed.

2. At the end of the **Analog Output>Max Out** line, tap the arrow and then tap the relevant voltage setting: (**1V**, **2V**, **5V**, **10V**).

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

The Analog Output is available in two forms, either the processed result (digital)—the analog voltage representation of laser power, or the unprocessed sensor input (raw). The raw output provides a faster response.

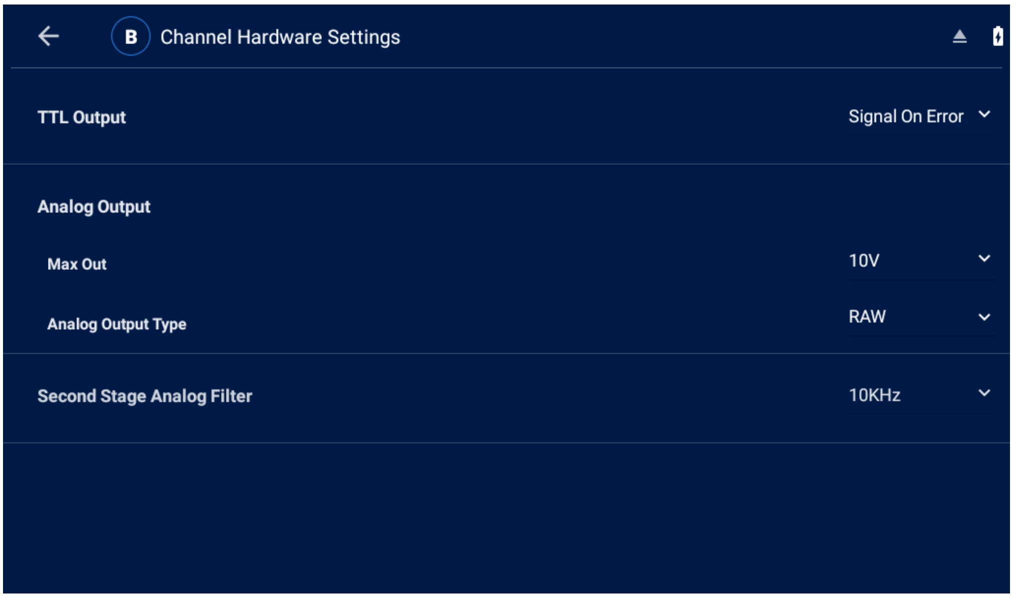


Figure 3-10 Channel Hardware Settings Screen

Analog Output: Digital

The digital output is the analog voltage representation of the measured (processed) laser power as displayed on the Centauri screen.

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

For photodiode sensors in Fast Power mode, the analog output is updated 10,000 times per second.

For pyroelectric sensors, the analog output is updated at up to 15 times per second with the latest pulse energy.

Analog Output: Raw

The Raw analog output is continuous: it is output as it comes in, and therefore not updated as the digital output is. The analog input from the sensor is routed directly to the analog output voltage, with little conditioning of the signal. However, if you select the second stage analog filter, it is applied to the raw analog output.

To set the analog output type

1. From the sensor measurement screen, tap the **Channel Options menu** icon and then **H/W Settings**.

   The **Channel Hardware Settings** screen is displayed.

2. From the **Analog Output Type** line, tap the arrow and then tap the relevant setting: (**Digital/Raw**). Digital refers to the analog voltage representation of laser power.

Second Stage Analog Filter

The Second Stage Analog Filter allows you to apply an additional analog filter to the measurement to quiet noise that might end up being confused with the actual signal.

To set the second stage analog filter

1. From the sensor measurement screen, tap the **Channel Options menu** icon and then **H/W Settings**.

   The **Channel Hardware Settings** screen is displayed.

2. From the **Second Stage Analog Filter** line, tap the arrow and then tap the relevant frequency setting: (**None, 250 KHz, 50KHz, 10KHz, 1KHz, 100Hz, 5Hz, 0.5Hz**).

3.2.6 RS232

The Centauri is equipped for RS232 communications. It is supplied with a custom RS232 cable.

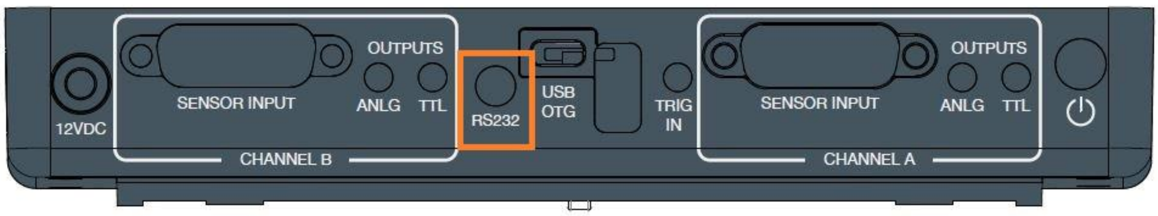


Figure 3-11 Centauri Upper View with RS232 input highlighted

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

To set the RS232 baud rate for RS232 PC communication:

1. From the **Settings** screen, tap **Instrument I/O Settings**.

   The **Instrument I/O Settings** screen is displayed.

2. Tap the end of the **RS232 Baud Rate** line to display the options (**115200**, **57600**, **38400**, **19200**).
3. Tap to select one.

3.2.7 TTL Output

Each channel is equipped with a binary output for signaling the status of the present measurement to the outside world. This is useful for situations such as interlocking to shut down a laser that gets out of range. TTL is a standard binary electrical signal of 0 v (off) or 5 v (on).

Figure 3-12 Centauri Upper View with TTL Output highlighted

The TTL Output can be set to one of the following states: Disable (Low), On (High), Signal On Error and Pass/Fail Limits. These states are defined as described below:

- Disabled Low) – The TTL Output is set to output a 0.
- On (High) – The TTL Output is 5 volts.
- Signal on Error – The TTL output is set to High (1) when the measurement process reports an error. An error is defined as one of the following:
- A to D circuit Saturation
- Sensor Saturated
- More than 10% over-range
- Any of the error states when performing Single Shot Energy

Frequency over-range, negative measurements, and too low dBm low are not defined as error states.

When the error state is no longer true, the TTL Out is cleared to Low (0).

- Pass/Fail Limits - This state is used in conjunction with the Pass/Fail graph. If the measurement is above the upper limit or below the lower limit, then the TTL Output is set to High. If the measurement is within the limits, then the TTL Output is set to Low.

To configure TTL Output

1. From the sensor measurement screen, tap the **Channel Options menu** icon and then **H/W Settings**.

   The **Channel Hardware Settings** screen is displayed.

2. Tap the value on the **TTL Output** line, and select Disable (Low), On (High), Signal On Error, or Pass/Fail Limits.

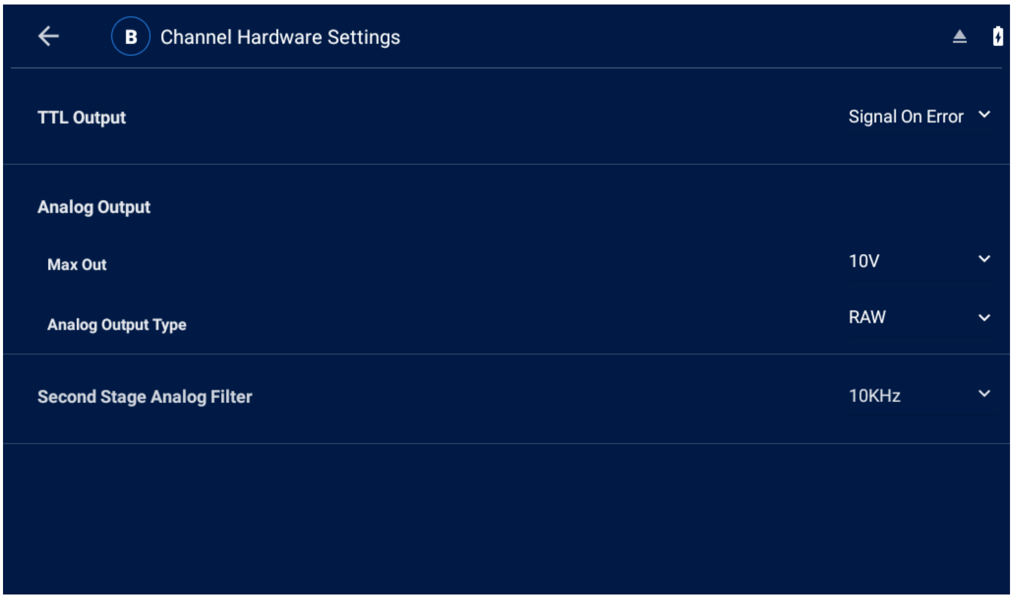


Figure 3-13 Channel Hardware Settings Screen

3.2.8 External Trigger

The Centauri includes an External Trigger phono connector.

There is one TRIG IN input that affects both channels.

Figure 3-14 Centauri Upper View with TRIG IN highlighted

A signal can be connected from the sync output of a laser or laser-system to the TRIG IN connector. It can be used to detect and log missing pulses, or to lock out and ignore specific pulses or groups of pulses that are not of interest.

The TRIG IN input is used for the External Trigger feature.

The External Trigger can be set to one of five states:

- Disabled: the meter ignores any signaling on the external trigger and proceeds normally. This is the meter's default state.
- Trigger on High Level: The meter processes any measurements made while the external trigger is high and ignores all measurements made when low. This trigger mode applies to all sensor types.
- Trigger on Low Level: The meter processes any measurements made while the external trigger is low and ignores all measurements made when high. This trigger mode applies to all sensor types.
- Trigger on Rising Edge:

  This trigger mode applies to PyroC sensors only.

  In this mode, the Centauri measures pulses that happen within a user-defined window of time after the External Trigger goes to high. After that period of time, the level of the Trigger input is ignored until it goes low and is therefore re-armed to trigger a new measurement window. The user defined window can be up to 50mS.

  In this mode, it is possible to measure missing pulses. A missing pulse is defined as a trigger happening, where the sensor does not report a pulse.
- Trigger on Falling Edge:

  This trigger mode applies to PyroC sensors only.

  In this mode, the Centauri measures pulses that happen within a user-defined window of time after the External Trigger goes to low. After that period of time, the level of the Trigger input is ignored until it goes high and is therefore re-armed to trigger a new measurement window. The user defined window can be up to 50mS.

  In this mode, it is possible to measure missing pulses. A missing pulse is defined as a trigger happening yet the sensor does not report a pulse.

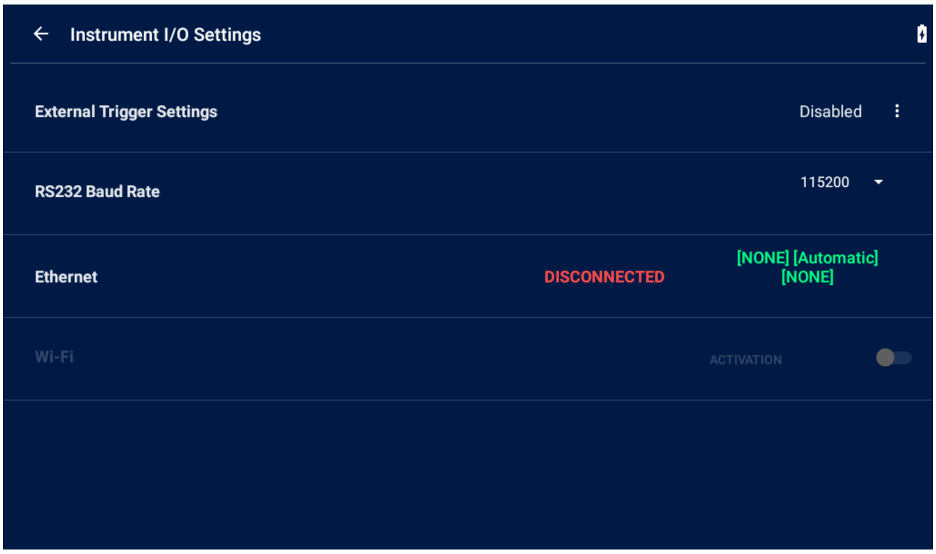


Figure 3-15 Instrument I/O Settings Screen

To set the external trigger level:

1. From the **Settings** screen, tap **Instrument I/O Settings**.
2. On the **External Trigger Level** line, tap the 3-dot menu icon

   The External Trigger Settings dialog is displayed.
3. Tap the down arrow of the Mode area to display the mode options: Disable, Rising Edge, Falling Edge, High, Low.

   For rising edge and falling edge modes, set the Window Time within which to take measurements by tapping the current number, using the keypad displayed to enter a value, and then tap Apply.
4. You can adjust Channel A/Channel B buttons (whether the feature is enabled for either channel or both channels), if available – for High and Low modes.
5. Click Apply to save and exit.

Table 1-1 External Trigger Input Modes

Input Mode	Description
Rising Edge	• The device is sensitive to a trigger on the RISING EDGE of the input. • The trigger is valid for a pulse arriving during a window of time *after* the active (rising) edge • The inactive (falling) edge of the signal is ignored. • Missing Pulses are recorded when an External Trigger edge is received, but no pulse arrives within the Window Time before or after the active edge. • Pulses are ignored if they arrive outside the Window Time, before or after the active edge. • If more than one pulse arrives within the Window Time, only the first pulse is measured.
Falling Edge	• The device is sensitive to a trigger on the FALLING EDGE of the input. • The trigger is valid for a pulse arriving during a window of time *after* the active (falling) edge • The inactive (rising) edge of the signal is ignored. • Missing Pulses are recorded when an External Trigger edge is received, but no pulse arrives within the Window Time before or after the active edge. • Pulses are ignored if they arrive outside the Window Time, before or after the active edge. • If more than one pulse arrives within the Window Time, only the first pulse is measured.
High Level	• Pulses are recorded only when the input signal is at a HIGH LEVEL. • Any pulse arriving while the signal is high is counted. Any pulse arriving while the signal is low is ignored. • No Missing Pulses are recorded in this mode.
Low Level	• Pulses are recorded only when the input signal is at a LOW LEVEL. • Any pulse arriving while the signal is low is counted. Any pulse arriving while the signal is high is ignored. • No Missing Pulses are recorded in this mode.

3.2.9 USB

The USB input enables connection of an external storage device. The storage device is required for performing field upgrade, and can be used for transferring logs to a PC for analysis.

Figure 3-16 Centauri Upper View with USB highlighted

When removing the external storage device from Centauri, first tap the triangle icon on the upper right-hand side of the screen. See *Figure 3-17*

Figure 3-17 Centauri Screen with USB release icon highlighted

3.2.10 OTG USB

The OTG USB input enables connecting the meter to a PC, for use with an application such as StarLab. Connecting to StarLab enables full remote control of the Centauri. When the connection is made, the PC screen becomes the Centauri full-featured display, and the Centauri touch screen is locked to prevent conflict. (“Touch Response Locked”)

Figure 3-18 Centauri Upper View with OTG highlighted

3.2.11 USB Flash Drive

A USB flash drive is required for performing field upgrade, and can be used for storing data logs for transfer to a PC for analysis using an application such as StarLab.

3.2.12 WiFi Antenna Socket

For future use

3.2.13 Ethernet Socket

Ethernet connectivity is available from meter firmware version 5.0 and up.

The side panel Ethernet socket enables connecting the meter to a PC, for use with an application such as StarLab. Connecting to StarLab enables full remote control of the Centauri. When the connection is made with the PC application, the Centauri touch screen is locked to prevent conflict with the PC application, and “Touch Response Locked” is displayed at the top of the Centauri screen.

3.2.14 Loudspeaker

The loudspeaker allows the Centauri to sound audio warnings. Perforations for the speaker are located in the center of the back panel. The volume and types of warnings are configured on the User Interface Settings page.

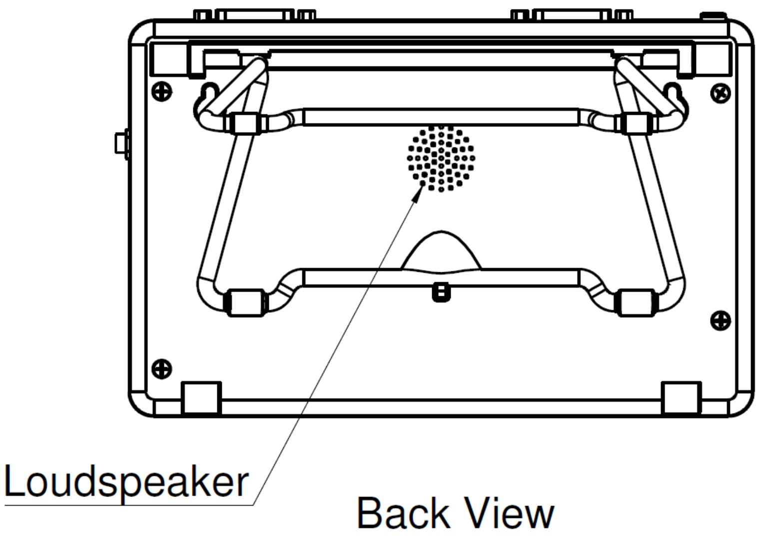


Figure 3-19 Centauri Back Panel with speaker perforations highlighted

If enabled, the loudspeaker sounds a beep for audio warnings in the following cases:

- When the measurement exceeds the selected range.
- Measurements on a Pass/Fail graph are too high or too low.
- Key click on screen touch.
- When the battery level is 15% or lower, the Centauri beeps once every 30 seconds. The low battery audio warning can be stopped either by plugging in the charger or by tapping the battery icon.

3.2.15 Field Upgrade of the Centauri Firmware

Centauri has the necessary infrastructure for performing field upgrade of the embedded software.

To update the Centauri firmware:

1. Download the latest Centauri firmware upgrade package from the Ophir website: https://www.ophiropt.com/laser--measurement/laser-power-energy-meters/products/laser-power-meters/centauri
2. The upgrade package is contained as a folder within a ZIP file. Extract from the ZIP file the folder (called 'centauri_upgrade') and copy this folder to the main directory (the root) of a USB flash drive.

   Note: The USB flash drive must not be larger than 32GB, and formatted as FAT32
3. Insert the flash drive into the USB port that is found on the upper panel of the meter (see Figure 3-20).

Figure 3-20 Upper panel of Centauri Meter with USB input highlighted

4. Insert a pin in the pinhole (see Figure 3-21) to access the micro-switch.
5. Turn on the Centauri while simultaneously pressing through the pinhole for a few seconds.
6. The upgrade procedure starts, with a progress bar displayed on the screen.
7. When the procedure is completed, the Centauri restarts with the new firmware version.

Figure 3-21 Right side of Centauri Meter with pinhole highlighted

3.2.16 Calibration Reminders

All Ophir equipment is factory-calibrated according to NIST-traceable standards. Due to the drifting nature of electronic components, equipment should be returned to a service center for recalibration on a periodic basis. Centauri provides an indication when recalibration is due:

- If the meter is due for calibration, a message to that effect is displayed upon start up.

- If a sensor is due for calibration, a message to that effect is displayed when it is connected, along with its channel name, model number, serial number, and calibration due date.

3.3 Zero Adjustment

This section provides a complete overview of zeroing related with the Centauri.

To zero the meter

1. Disconnect the sensor.
2. Make sure the meter is not in an electrically noisy environment and is undisturbed. Let the Centauri run for at least 10 minutes before performing zero adjustment.
3. Tap **Instrument Settings.**
4. From the **Instrument Settings** screen, tap **Zero** at the top of the screen.

   The **Zeroing Instrument** dialog is displayed.
5. Tap **Start**. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” appears.
6. Tap **Save** to save the Zero values, and then tap **Exit**.

Pyroelectric Sensors

When zeroing the meter for use with a pyroelectric sensor being used for the first time, after zeroing the meter alone, it is important to zero the meter with the new pyroelectric sensor attached.

After zeroing the pyroelectric sensor, you do not have to zero it again when it is used with the same meter. If you zeroed the pyroelectric sensor with a different meter, you should zero it again.

Zeroing the meter with the sensor attached

For the most accurate calibration, you can also zero the sensor against the Centauri it is being used with.

1. Make sure the sensor is in a quiet environment and not subject to laser radiation, light * or heat**.
2. Tap the **Settings** icon at the top of the screen. The **Settings** screen is displayed.
3. Tap **Instrument Settings**.
4. On the Instrument Settings screen, tap **Zero** at the top of the screen.
5. In the **Zeroing Instrument** dialog, tap **Start**. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” is displayed.
6. Tap **Save** to save the zero values. Tap **Exit**.

*When zeroing with **photodiode sensors**, turn the laser off, and cover the sensor.

When zeroing with **thermal sensors, turn the laser off, and let the sensor cool down until thermally stable.

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

3.4 Offset

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

3.4.1 For Thermal and Photodiode Sensors Measuring Power

The PD300 and PD300-3W sensors have automatic background. The Offset function can be used to subtract the residual background signal that remains, if desired. The same holds true when the ambient environment has a thermal background, such that Centauri shows a non-zero power reading even when there is no laser: you can subtract the background using the Offset function. For example, the Centauri display reads 0.1mW when the laser is blocked and 20.5 mW with laser power applied. In this case, the true power is 20.5 - 0.1 = 20.4 mW. To subtract the background, slide **Offset** while the laser is blocked. The Centauri then reads zero (0.0), and the 0.1 mW background is subtracted from all subsequent readings. The laser power reading is thus 20.4 mW.

1. Set the **Measuring Mode** to **Power**.
2. Block the laser/light source under measurement and slide **Offset** to activate the offset feature.

   When active, the **Offset** button is green, and the offset value that is being subtracted is shown to the right of the large numeric display.

Figure 3-22 Photodiode Bargraph showing stored offset

To deactivate, slide **Offset** back. If the **Offset** is engaged, and you wish to subtract a new value of the background, slide **Offset** back and forth. The first slide cancels the old value, and the second activates a new value.

If you have trouble reading very low values, the meter's internal zero should be reset. See Zero Adjustment.

3.4.2 For Photodiode Sensors Measuring Exposure

Background noise that affects power measurement affects exposure too. To overcome this, perform the following:

- Set the Measuring Mode to Exposure.

The Offset stored in the previous step is subtracted in order to provide accurate Exposure measurements.

3.4.3 For Thermal Sensors Measuring Single-Shot Energy and for Energy Sensors

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

3.4.4 Measuring Loss Using the dB Offset Function

Since dBm is a logarithmic measurement, the ratio between two measurements is the difference between the dBm measurements. For instance, say 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 enables you to measure this easily.

To measure loss using the dB Offset function:

1. When measuring the reference value, tap **dB Offset**.
2. Now make your second measurement and the value of the difference in dB = ratio in numerical units is 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, tap **Offset** and subtract the zero offset. Then follow steps 1 and 2 above. The zero offset subtracted when **Offset** was tapped is saved in the dBm scale and you can now use the dB Offset setting to measure the true ratio without zero offset problems.

3.5 Using the Settings Menu

This section describes settings that can be configured by drilling down through the **Settings** menu. From the **Settings** menu, you can configure various instrument, interface, and I/O settings. You can also configure logging, and access the log files.

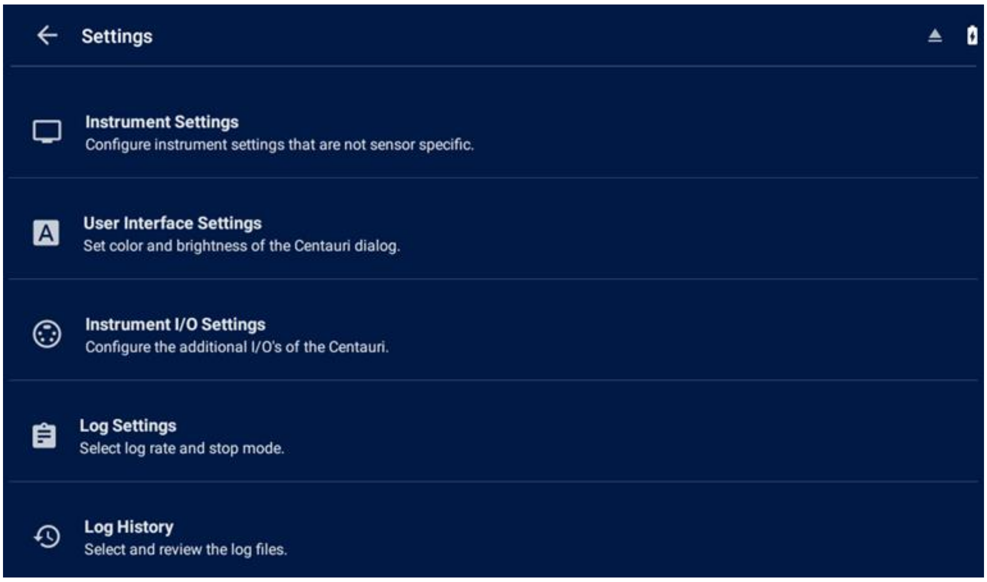


Figure 3-23 Centauri Settings Menu

From the **Settings** menu, you can reach the following screens:

- Instrument Settings
- User Interface Settings
- Instrument I/O Settings
- Log Settings

- Log History: Accessing Logged Data

Sub-topics in this section include:

- Zeroing
- Dual Channel Activation
- Real-Time Clock
- Line Frequency
- Color Scheme
- Brightness Control
- Audio Warnings
- External Trigger
- RS232 Baud Rate
- Log Settings
- Log History

When no sensor is connected, the Centauri **Settings** menu is displayed upon power-up.

Reach the **Settings** menu from measurement screens by tapping the settings/cog icon ( ) .

Return to where you were before this menu by tapping the back arrow on the top line.

3.5.1 Instrument Settings

This screen displays the meter's serial number, firmware version, last calibration date and the next calibration date, as well as whether or not the meter is enabled for dual-channel use.

From this screen, you can zero the unit, set the date and time, and the line frequency.

The Centauri automatically saves all current settings for the next time the meter is turned on.

Figure 3-24 Instrument Settings Screen

Zeroing

All adjustments of the Centauri, including zeroing internal circuits, are performed from the software. This ensures simple and accurate re-alignment. It is recommended to re-zero the Centauri every two months for best performance.

To zero the meter:

1. Disconnect the sensor.
2. Run the meter for at least 30 seconds.
3. Make sure the meter is not in an electrically noisy environment and is not subject to pulsed radiation.
4. From the **Instrument Settings** screen, tap **Zero** at the top of the screen.

   The Zeroing Instrument dialog is displayed.
5. Tap **Start**. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” appears.
6. Tap **Save** to save Zero values.
7. Tap **Exit**.

Dual Channel Activation

The Centauri has the capability to handle two sensors at a time, enabling review and comparison. If you would like to work with two sensors at a time, acquire an Activation code from your dealer.

To activate the dual channel capability:

1. On the Second Channel line of the Instrument Settings screen, tap **Activation**.

   The **Set Second Channel Activation** dialog is displayed.
2. Enter the code and tap **Apply**.
3. See Dual-Channel Features

Real-Time Clock

The Centauri is equipped with a real time clock which enables display of the date and time. This clock allows the Centauri to query the sensor attached and notify you if the sensor is due for calibration. You can change the date and time.

To set the date

1. On the **Instrument Settings** screen, tap the date on the **Date/Time** line.

   A dialog is displayed.
2. In the dialog, roll the month/date/year to the desired date.
3. Tap **OK** to exit.

To set the time

1. On the **Instrument Settings** screen, tap the time on the **Date/Time** line.

   A dialog is displayed.
2. In the dialog, roll the hour and minutes to set the time according to the 24-hour clock.
3. Tap **OK** to exit.

Line Frequency

Set the line frequency to 50Hz or 60Hz, depending on the electrical power grid in your area.

To set the line frequency

1. On the **Instrument Settings** screen, tap the Line Frequency arrow to display the options: 50Hz or 60Hz.
2. Tap the option appropriate for the electrical power grid in your area.

3.5.2 User Interface Settings

This screen enables setting the color scheme and brightness of the Centauri display, the interface language, configuration of audio warnings, and low power mode.

Color Scheme

You can configure the Centauri to full-color or monochrome functionality. Choose a full-color option to make use of special color enhancements. Choose a monochrome scheme when using protective goggles that filter out visible wavelengths.

Full Color

To set the screen color scheme to full color:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Color Scheme** line, tap the current color scheme and then tap one of the following color schemes.

- **Dark Background** 

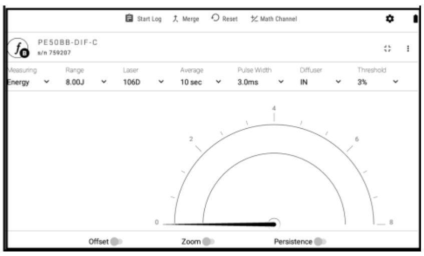
- **Light Background** 

Monochrome

Monochrome schemes are for use with lasers that demand use of protective glasses that filter out colors in the visible part of the wavelength spectrum. Color-enhanced features are not functional in the monochrome screens.

To set the screen color scheme to monochrome:

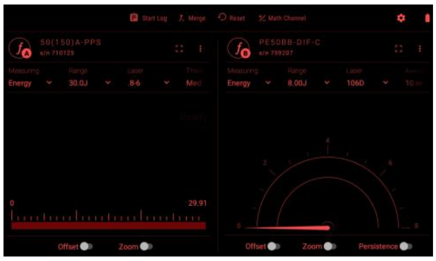
1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Color Scheme** line, tap the current color scheme and then tap to select one of the following color schemes:

- **Black on White**: Black text on white background 

- **Blue on Black**: Sky blue text on black background

- **Green on Black**: Green text on black background

- **Red on Black**: Red text on black background



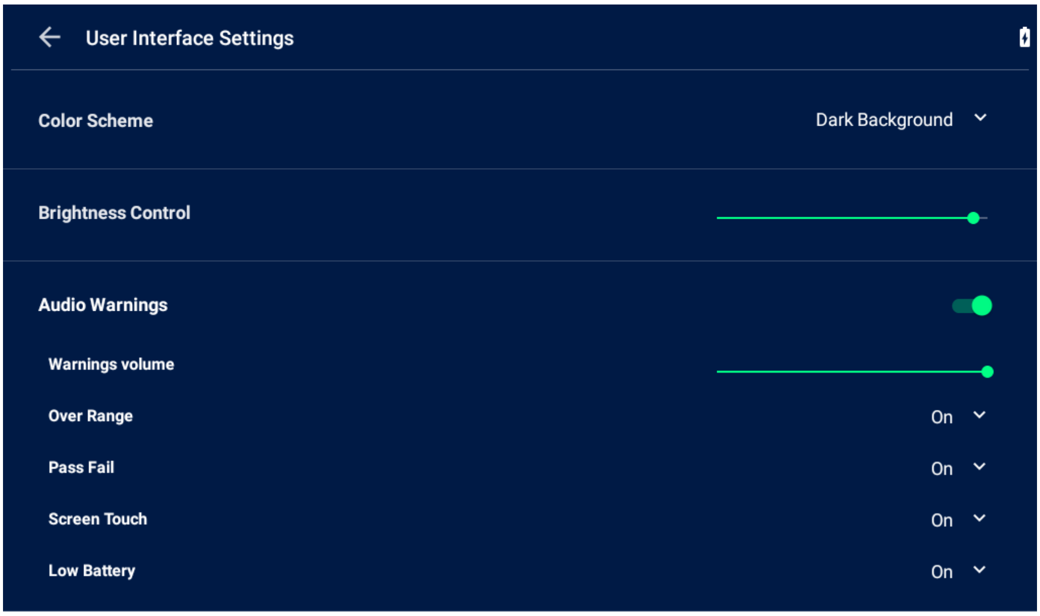


Figure 3-25 User Interface Settings Screen

Brightness Control

To adjust the display brightness:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Brightness Control** line, move the slider control to the right to increase brightness, or to the left to reduce screen brightness.

Audio Warnings

To enable or disable audio warnings

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Audio Warnings** line, slide the button to the right to enable, or to the left to disable these features.

To adjust warning volume

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the Warnings Volume line, move the slider control to the right to increase the volume, or to the left to reduce warning volume.

To enable a warning sound on over range:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Over Range** line, tap to turn the warning sound on or off.

   Sound is a ticking beep.

   If enabled, the meter beeps once per second when the reading is over range.

To enable a warning sound on when pass fail conditions are violated:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Pass Fail** line, tap to turn the warning sound on or off.

   If measurement is too high, a continuous high beep sounds.

   If measurement is too low, a lower longer continuous beep sounds.

To enable sound on screen touch:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Screen Touch** line, tap to turn the warning sound on or off.

   If enabled, there is a barely audible sound when the screen is touched.

To enable warning sound on low battery:

1. From the **Settings** screen, tap **User Interface Settings**.
2. On the Low Battery line, tap to turn the warning sound on or off.

   When the battery level is 15% or lower, the Centauri beeps once every 30 seconds. The low battery audio warning can be stopped either by plugging in the charger or by tapping the battery icon.

Low Power Mode

Should the battery overheat when the charger is connected, charging is suspended, and the Centauri continues to run on AC alone. This mode is intended to assist with resuming charging.

In Low Power Mode, 30 minutes after battery charging is suspended due to heat, the meter screen goes dim, and after two hours, dark and measuring stops until the battery cools down and charging is resumed. When the battery icon turns yellow it indicates that charging of the battery is presently suspended due to the battery being too hot.

To enable Low Power Mode

➢ Slide button to the right to enable, back to the left to disable.

Figure 3-26 Battery Charge Icon in Low Power Mode highlighted

Language

The language selection can changed from either the User Interface Settings, or from the top of the main settings menu.

Languages presently supported are:

English, French, Spanish, Italian, German, Russian, Japanese, Chinese and Korean

Battery Save Settings

Dim backlight after no touch for a set time.

Sleep after 5 minutes in passive screen.

For future use

3.5.3 Instrument I/O Settings

You can configure additional I/O ports for Centauri from the Instrument I/O Settings screen

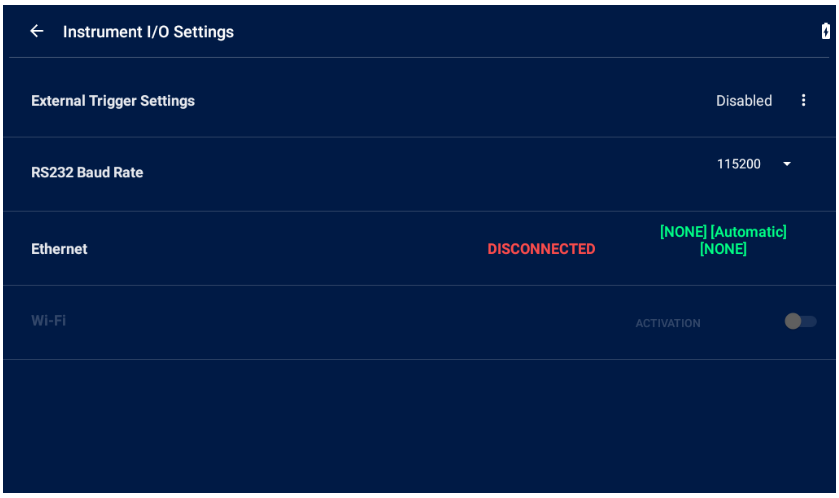


Figure 3-27 Instrument I/O Settings Screen

External Trigger Settings

You can configure the external trigger settings from this screen. For further information, see External Trigger.

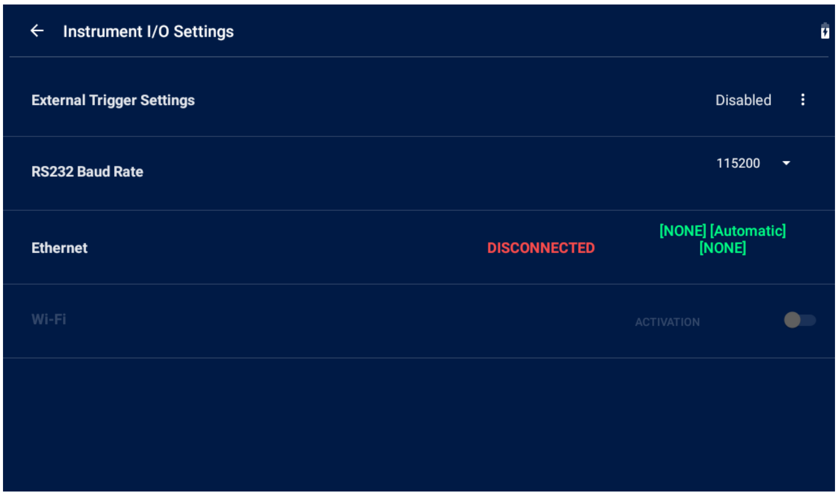
RS232 Baud Rate

You can set the baud rate for PC communication through the Centauri COM port. For further information see RS232.

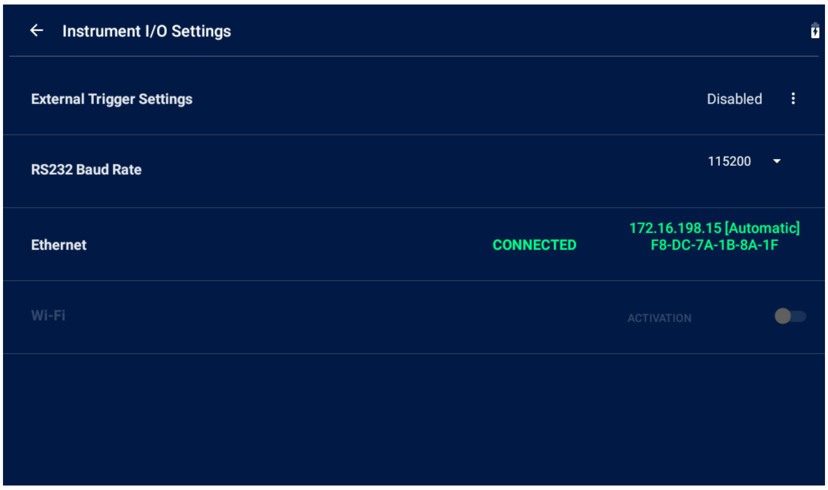
Ethernet Connectivity

You can setup Ethernet configuration for communication through the Ethernet port.
Ethernet connectivity is available from meter firmware version 5.0 and up.

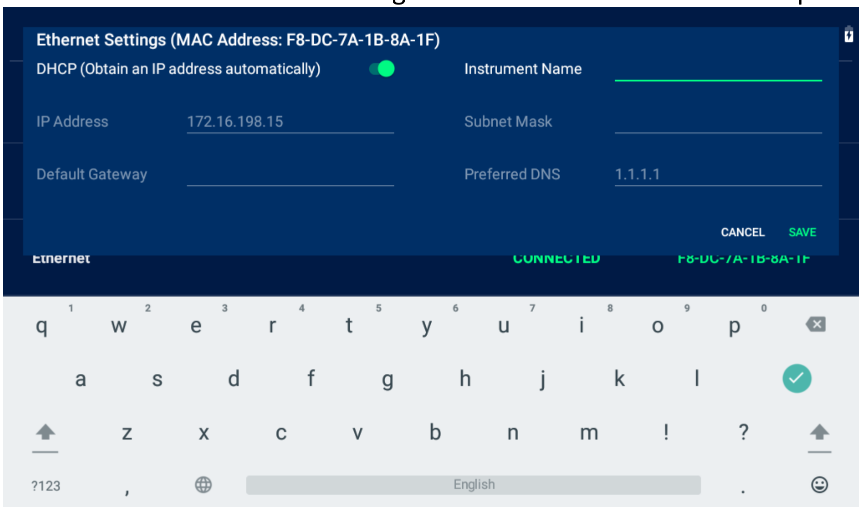
When the meter is not connected via Ethernet, 'Disconnected' will appear in red.



When the meter is connected via Ethernet, 'Connected' will appear in green, and the IP address and device MAC address will appear.

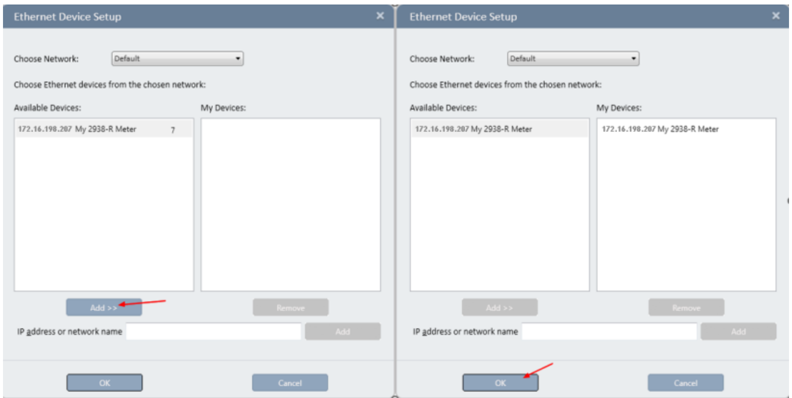


Press the green text at the end of row showing the Ethernet status in order to open the 'Ethernet.



The IP Address and additional fields can be entered either manually, or received from a connected network automatically via DHCP.

Text entered in the 'Instrument Name' field can assist in identifying the meter, as shown in the example below when connecting the meter via Ethernet with the StarLab PC application.



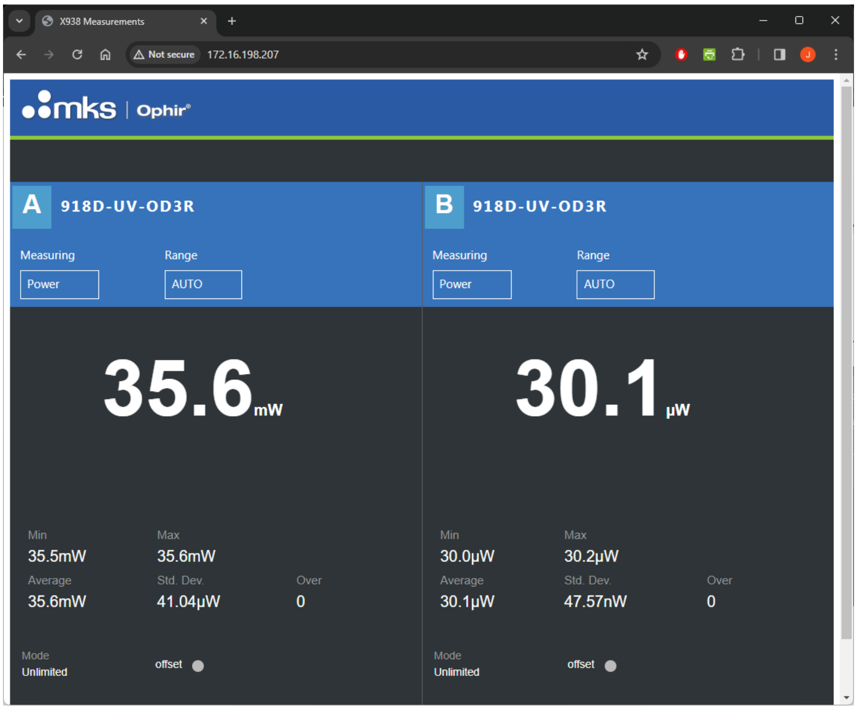
Note for SW integrators - The Centauri can communicate via Ethernet using TCP/IP and HTTP protocols.

When using TCP/IP protocol, communication is via port: 12321

There is also a Webserver available when entering the IP address into a web browser.

The Webserver displays measurements, but does not allow modifying any settings

The Webserver only displays the Statistics 'Display Type' from the meter.



WiFi

For future use.

3.5.4 Log Settings

This screen is described in Chapter 12.1 Log Settings.

3.5.5 Log History

This screen is described in Chapter 12.5 Log History: Accessing Logged Data

3.6 Configuring Measurements

The Quick Reference contains a quick introduction to using the Centauri for measurements. This section provides a summary of all the menus used for configuring measurements.

If there is a sensor connected to the meter, its measurement screen is displayed.

Figure 3-28 Photodiode sensor measurement screen with sensor parameters highlighted

The measurement screen comprises the following:

- On the top line are the Start Log and Reset buttons, the Settings menu icon, and battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function is configured, and the Channel Options menu icon.
- On the third line are the sensor parameter settings. The sensor parameters, including Measuring Mode, Range, Laser, Filter, Average, are configured with a tap on the parameter, and then the value is selected from the drop down list.
- Large numeric display.
- Offset and zoom buttons on bottom of screen.

In addition:

- There are several additional menus described below in this section that enable configuring displays, functions, and hardware settings.
- Menus directly related to dual-channel operation are described in Dual-Channel Features.
- The general **Settings** menu can be accessed from this screen by tapping the cog icon  . This menu is described in Using the Settings Menu.

Further information on configuring measurements is provided in the individual sensor sections:

- Thermal Sensors
- BeamTrack Sensors
- Photodiode Sensors
- Pyroelectric and Photodiode Energy Sensors

3.6.1 Configuration Menus within the Measurement Screens

Within the measurement screens are menus that provide further options: the Channel Options menu, and the Channel Hardware Settings screen.

The **Channel Options menu**, reached by tapping the three-dot icon ( ), enables configuration of display type, functions, and hardware settings. It also enables zero adjustments directly from the measurment screen.

Channel Options Menu

From the measurement screen, tap the **Channel Options** menu icon. The options displayed are:

- Display Type
- Functions
- Zero
- H/W Settings
- Sensor Info

Display Type

Tapping **Display Type** produces the Display Type dialog, with a menu of available graphs for the sensor in question and its configuration. For more information, see

Graphical Displays.

Functions

Tapping **Functions** produces the Functions menu, with a list of functions that can be configured for the sensor. For more information, see Functions.

Zero

Tapping **Zero** produces the Zeroing instrument dialog. For more information, see Zero Adjustment.

H/W Settings

Tapping **H/W Settings** produces the Channel Hardware Settings Screen, described below.

Sensor Info

Tapping **Sensor Info** produces the Sensor Info window, which displays the following information about the sensor: model number, serial number, date of last calibration, and date of next calibration. Tap anywhere on the screen to return to the main sensor measurement screen.

The calibration dates are updated in the factory.

Channel Hardware Settings Screen

The **Channel Hardware Settings** menu is accessed from the **Channel Options** menu on the measurement page, and enables configuration of the TTL Output, Analog Output, and, Second Stage Analog Filter features.

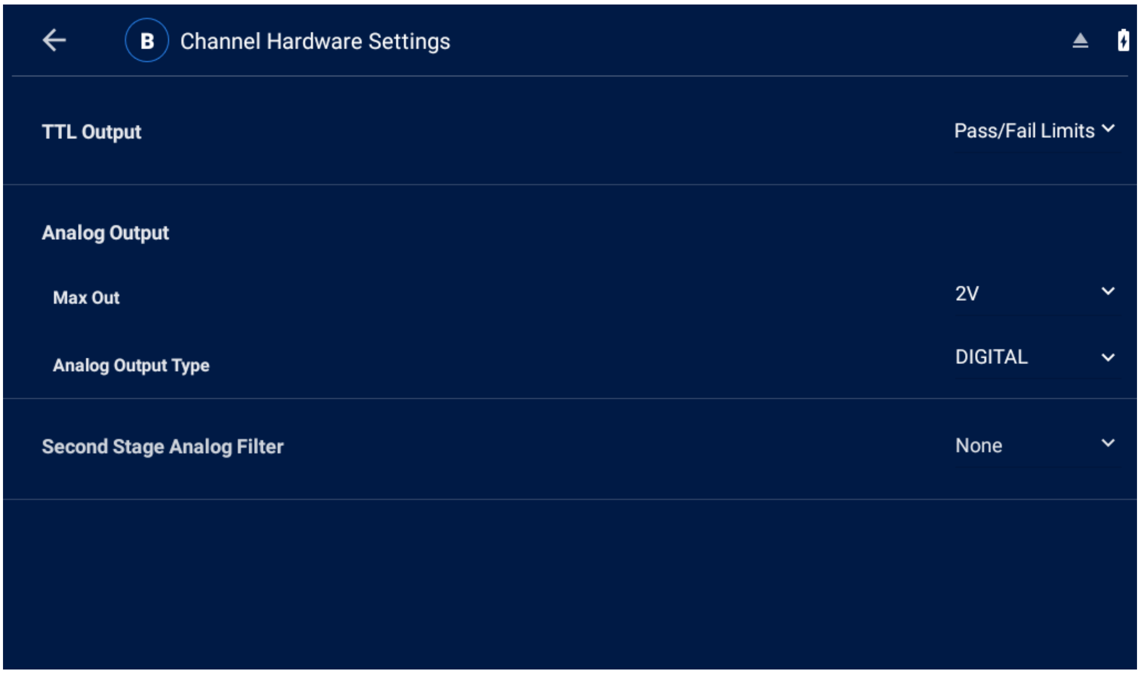


Figure 3-29 Channel Hardware Settings Screen

TTL Output

Each channel is equipped with a binary output for signaling the status of the present measurement to the outside world. This is beneficial for situations such as interlocking to shut down a laser that gets out of range.

For more information and configuration, see TTL Output.

Analog Output

The Centauri provides an analog voltage output via the 2.5mm mono jack socket on the rear panel marked ANLG (see Figure 3-9). For information and configuration, see Analog Output.

Analog Output Type

You can select whether the source of the Analog Output is the processed result (Digital) --- the analog voltage representation of laser power or the unprocessed sensor input (Raw).

For further information and configuration, see Analog Output.

Second Stage Analog Filter

You can apply an additional analog filter to the Raw measurement in order to quiet noise that could be confused with the signal itself. For further information and configuration see Analog Output.

3.7 Using StarLab

You can connect Centauri to StarLab for complete remote control from a PC. While Centauri is connected to StarLab in this way, the PC acts as a full-featured display, and Centauri is locked; the notice “Touch Response Locked” is displayed on the screen.

To connect Centauri to StarLab

- Either connect a USB cable from the PC to the OTG USB input on Centauri.
- Alternatively, connect a network cable to the Ethernet socket on the Centauri.

4 Points to Consider

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

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

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

5 Thermal Sensors

For a list of the available thermal sensor models that can be used with Centauri, see **Sensor Specifications**.

Warning: Before using a thermal sensor for power or energy measurement, check that your laser power, energy, and energy density do not exceed the sensor ratings. See **Sensor Specifications**.

If the sensor is a water-cooled type, ensure that the cooling water is flowing at an adequate rate (see Table 5-1 below). Also, note that the reflectance from the absorber could be as much as 10%, and with CO2 lasers, the reflected beam can be quite specular, so it is advisable to provide a beam stop for the reflected beam with the highest power lasers.

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

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

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

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

Most thermal sensors have somewhat different absorption at different wavelengths. To compensate for this, each sensor is calibrated by the laser at several wavelengths. When you choose the correct laser setting, the correction factor for that wavelength is automatically introduced. Note that the laser setting selected is displayed on the third line of the display.

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

The Centauri can be set to various settings while operating, and it automatically saves the settings for the next power-up. This way the Centauri is in the desired configuration when turned on the next time.

On power-up, the Centauri meter checks its own memory, and that of the sensor, to configure on the measurement configuration. For example, if during the last session, the sensor was used to measure power, displayed in a bargraph, with autoranging with a YAG laser and averaging for 10 seconds, this is the setup used the next time the system is powered up. These settings can all be easily changed, as described in the following sections.

Topics include:

- Operation of Centauri with Thermal Absorber Sensors
- Measuring Laser Power with Thermal Sensors
- Measuring Laser Energy with Thermal Sensors
- Measuring Laser Pulsed Power with Thermal Sensors

5.1 Operation of Centauri with Thermal Absorber Sensors

To use Centauri with thermal sensors:

1. Connect the thermal sensor to the Centauri meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the upper panel of the meter. Centauri reconfigures itself to work with the attached sensor.

   The sensor’s measurement parameters are shown on the measurement screen.

1. Tap the current value of the parameter you want to change, and then tap the relevant value.
2. Repeat for all parameters to be changed.

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

Warning: When operating the laser, do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in Sensor Specifications, as there is a risk of damaging the absorber.

5.2 Measuring Laser Power with Thermal Sensors

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

Power measurements can be displayed in main measurement screen in Bargraph, Needle, Line, Pulse Chart, Pass/Fail, or Statistics graphical formats (by tapping the **Channel Options** menu icon, and then **Display Type**, and then selecting a display type). Measurement parameters are updated in the measurement screen. A sample is shown in Figure 5-2 below at the end of this procedure.

To measure laser power using thermal sensors:

1. Set **Measuring Mode** to **Power**.

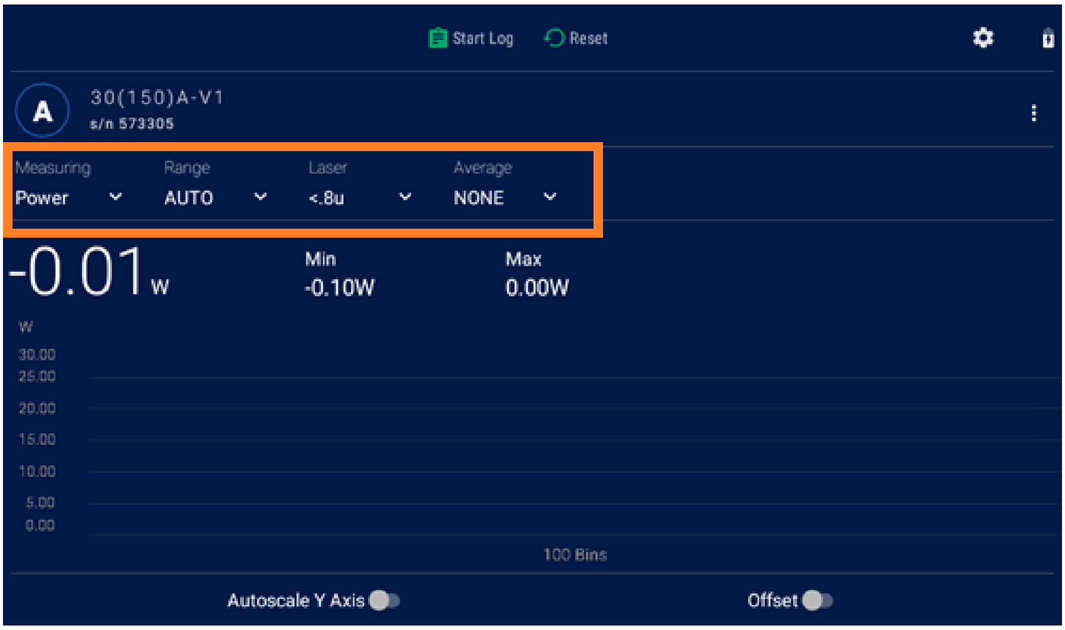


Figure 5-1 Setting the Sensor Parameters

2. Set **Range** to **AUTO** or to one of the manual ranges, as follows:
   - **AUTO**: Select autoranging when the laser power is unknown or varies widely. In autorange, you do not have to change ranges. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. The ranges are ordered by factors of 1, 10, 100, and so on. When the reading falls below 9% of full scale, the range changes to one range lower. This change only occurs after a few seconds delay, which provides overlap (hysteresis) to keep the Centauri from flipping back and forth when reading close to the end of the scale.
   - **Manual range**: The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autoranging, since it changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.
3. Set **Laser** to the appropriate laser wavelength.
4. Set **Average** to the period you wish to average power over or set to **NONE** to disable. This feature is especially useful for lasers with unsteady output. (The **Average** can also be configured in the Functions screen.) The Power is measured 15 times per second.

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

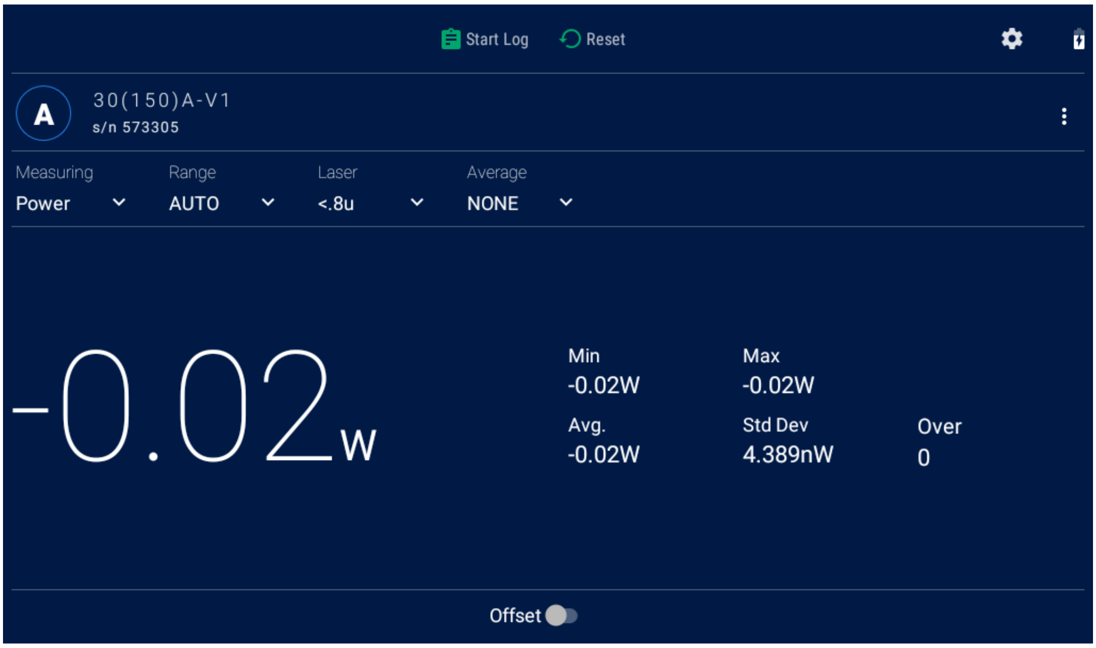


Figure 5-2 Thermal Power Statistics Display

5.3 Measuring Laser Energy with Thermal Sensors

In addition to power, thermal sensors can be used to measure single shot energy, where they integrate the power flowing through the disc over time and thus measure energy. Since it typically takes several seconds for the disc to heat up and cool down, these thermal sensors can only measure one pulse every few 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 can be since the measurement is of the heat flowing through the disc as a result of the pulse.

Energy measurements can be displayed in Bargraph, Needle, Line, Pulse Chart, Pass/Fail, or Statistics graphical formats (by tapping the **Channel Options** menu icon and then **Display Type**).

To measure single shot energy when using thermal sensors:

1. Set **Measuring Mode** to **Energy**.
2. Set **Range** to the appropriate manual range. (In **Energy** mode, there is no autoranging.) The correct range is the lowest one that is larger than the expected maximum pulse energy of the laser.
3. Set **Laser** to the appropriate laser wavelength.
4. Set **Threshold** to change the energy threshold to **LOW**, **MED**, or **HIGH** to set the hardware threshold in the sensor to screen out noise that would otherwise be seen as energy pulses. (This screens out false triggers.) The factory setting of the energy threshold is **Med** for medium. If the unit triggers on noise, set the threshold to **High**. If you are measuring small energies and the unit does not trigger, set the threshold to **Low**.

   If the Centauri is used in a noisy environment or where there is a high level of background thermal radiation, the meter 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 meter 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, as this causes degradation in the accuracy of energy measurements of pulses below about four times the threshold level.

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

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

Figure 5-3 Thermal Energy Needle Graph

5.3.1 Measuring Pulses of Very Low Energy

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

- A continuous train of pulses can 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

- A train of a known number of pulses can be fired, and the total energy measured in Energy mode. This train should not exceed 5 seconds in 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 generally give improved accuracy, but care should be taken not to exceed maximum power ratings.

5.3.2 Measuring Energy of Rapidly Repeating Pulses

With a typical thermal sensor, Centauri only measures individual pulses every five 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 Centauri and just have to be plugged in to be used.

5.4 Measuring Laser Pulsed Power with Thermal Sensors

Thermal energy sensors are capable of measuring pulsed power in order to display instantaneous power of a laser pulse. Power can be calculated from energy if you know the length of the pulse.

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

To measure laser pulsed power using thermal sensors:

1. Set **Measuring Mode** to **Pulsed Power**.
2. Set **Range** to the appropriate manual range. (In **Energy** mode, there is no autoranging.) The correct range is the lowest one that is larger than the expected maximum pulse energy of the laser.
3. Set **Laser** to the appropriate laser setting.
4. Set **Pulse Width** to the correct pulse length. (The range is **0.1** to **10** seconds in increments of 0.1. The default is 1.0 seconds.) When finished, tap **Apply**.
5. Set **Threshold** to change the energy threshold to **Low**, **Med**, or **High** to set the hardware threshold in the sensor to screen out noise that would otherwise be seen as energy pulses. (This screens out false triggers.) The factory setting of the energy threshold is **Med** for medium. If the unit triggers on noise, set the threshold to **High**. If you are measuring small energies and the unit does not trigger, set the threshold to **Low**.

   If the Centauri is used in a noisy environment or where there is a high level of background thermal radiation, the meter 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 meter is designed not to respond to pulses below some preset minimum size. This "Minimum Energy Threshold" is typically set to 0.3% of the full scale of the selected range. If this level is found to be too sensitive for your particular environment, you can change it. The threshold should not, however, be raised higher than necessary, as this causes degradation in the accuracy of energy measurements of pulses below about 4 times the threshold level.

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

Figure 5-4 Thermal Pulsed Power

Note: It is possible to record log files of Pulsed Power measurements.

5.4.1 Pulsed Power Limitations

Function Limitations

Functions are discussed in Functions.

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

When measuring pulsed power, Average is disabled.

6 BeamTrack Sensors

For a list of the available BeamTrack sensor models that can be used with Centauri, see **Sensor Specifications**.

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

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

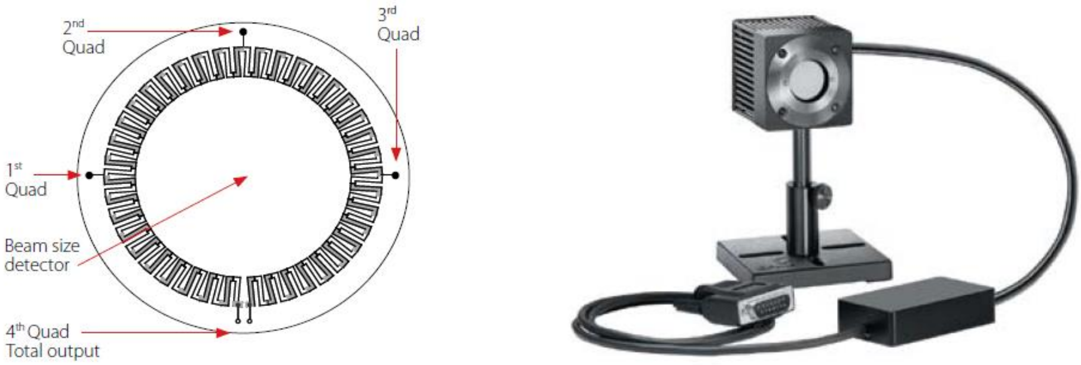


Figure 6-1 BeamTrack Sensor

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

Topics include:

- Setting Measurement Parameters
- Tracking Laser Beam Position and Size
- Tracking Stability - Laser Beam Position Over Time

6.1 Setting Measurement Parameters

Measurements can be displayed in Position (for BeamTrack Sensors) or Stability graphical formats (by tapping the **Channel Options** menu icon**,** then the **Display Type**). Updating measurement parameters is performed in the main measurement screen. A sample is shown in Figure 6-2 below at the end of this procedure.

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

1. Connect the relevant BeamTrack sensor to the Centauri.
2. Set **Measuring Mode** to **Track**.
3. Set **Range** to **AUTO** or to one of the manual ranges, as follows:
   - **AUTO**: Select autoranging when the laser power is unknown or varies widely. In autorange, you do not have to change ranges. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. The ranges are ordered by factors of 1, 10, 100, and so on. When the reading falls below 9% of full scale, the range changes to one range lower. This change only occurs after a few seconds delay. This provides overlap (hysteresis) to keep the Centauri from flipping back and forth when reading close to the end of the scale.
   - **Manual range**: The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autorange, since it changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.
4. Set **Laser** to the appropriate laser wavelength.
5. Set **Average** to the period you wish to average power over or set to **NONE** to disable. This feature is especially useful for lasers with unsteady output.

6.2 Tracking Laser Beam Position and Size

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

1. From **Track** mode, tap the **Channel Options menu** icon and the **Display Type**.
2. Select **Position**.
3. Tap **Center** on the bottom of the screen to center the laser beam.
4. Slide the **Offset** button at the bottom of the screen to subtract the background noise from the measurement and reset the value to zero.

Figure 6-2 Position Display with BeamTrack Sensor

6.3 Tracking Stability - Laser Beam Position Over Time

To track laser beam position over time using BeamTrack sensors:

1. From **Track** mode, tap the **Channel Options menu** icon and then **Display Type**.
2. Select **Stability**.
3. Tap **1 sec** on the bottom of the screen to change the time interval (to **3**, **10**, **30 seconds** or **1 minute**).

Figure 6-3 Stability Display with BeamTrack Sensor

7 Photodiode Sensors

For a list of the available photodiode sensor models, see Sensor Specifications.

Warning: Before using the photodiode sensor for power measurement, check that your laser power, energy, and energy density do not exceed the sensor ratings. See Sensor Specifications.

When a photon source, such as a laser, is directed at one of the Photodiode sensors, 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 signals from the two detectors cancel each other out.

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 Centauri meter amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the Centauri, the noise level is very low, and the photodiode sensors with the Centauri display have a large dynamic range from nanowatts to hundreds of milliwatts.

Since many low power lasers have powers on the order of 5 to 30mW, and most photodiode detectors saturate at about 2mw, most sensors of the PD300 series are 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 SAT is displayed on the screen. Table 7-1 below gives the actual maximum power as a function of wavelength.

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

Filter Out

Wavelength	PD300/ PD300R	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wavelength	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	3mW	N.A.	800nm	12mW	0.8mW
400nm	30mW	3mW	100mW	3mW	N.A.	1-1.3µm	30mW	0.8mW
633nm	20mW	2.5mW	100mW	3mW	1W	1.4µm	30mW	0.8mW
670nm	13mW	2mW	100mW	3mW	2W	1.5µm	25mW	0.8mW
800nm	10mW	1.5mW	100mW	2.5mW	3W	1.6µm	30mW	0.8mW
900mm	10mW	1.5mW	100mW	2.5mW	3W	1.8µm	30mW	N.A.
1060nm	25mW	3mW	100mW	3mW	3W			

Filter In

Wavelength	PD300/ PD300R	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wavelength	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	300mW	N.A.	800nm	0.8mW	100mW
400nm	300mW	1W	3W	300mW	N.A.	1-1.3µm	0.8mW	30mW
633nm	300mW	1W	3W	300mW	1W	1.4µm	0.8mW	150mW
670nm	200mW	500mW	2W	300mW	2W	1.5µm	0.8mW	150mW
800nm	100mW	300mW	1.2W	150mW	3W	1.6µm	0.8mW	150mW
900mm	150mW	300mW	1.2W	150mW	3W	1.8µm	N.A.	N.A.
1060nm	250mW	500mW	2.2W	300mW	3W			

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

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

Topics include:

- Operation of Centauri with Photodiode Sensors
- Measuring Laser Power with Photodiode Sensors
- Averaging and Measuring Very Low Power Measurements
- Measuring Total Exposure

7.1 Operation of Centauri with Photodiode Sensors

To use Centauri with photodiode sensors:

1. Connect the photodiode sensor to the Centauri meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the upper panel of the Centauri meter. Centauri reconfigures itself to work with the attached sensor.

   The sensor's measurement parameters are shown on the measurement screen.
2. Tap the current value of the parameter you want to change, and then tap the relevant value.
3. Repeat for all parameters to be modified.

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

Warning: When using the laser, do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in Sensor Specifications as there is a risk of damaging the absorber.

7.2 Measuring Laser Power with Photodiode Sensors

The following procedure describes how to use photodiode sensors to measure laser power. (The power is measured 15 times per second.) You can specify the expected laser **Range**, **Laser** setting, whether the **Filter** is IN or OUT (placed on the sensor or not), and the **Average** power period.

Photodiode sensors have a different sensitivity at different wavelengths. Moreover, the filters used in the sensor have a different transmission at different wavelengths. In order to compensate, each sensor has a built-in calibration curve (with 1nm resolution) over the entire measurement range. When you choose the correct laser setting, the correction factor for that wavelength is automatically introduced.

The PD300 sensor is equipped with a built-in filter so that the photodiode can measure up to 30mW without saturating the detector. In addition, the PD300 comes with an additional removable filter for measuring up to 300mW. Other models of the PD300 series also have built-in and removable filters. The exact maximum power is reached when the reading reaches full scale or the output current from the sensor reaches 1.3mA, whichever comes first. See Table 7-1 Filter In and Filter Out for the exact maximum as a function of wavelength.

Depending on which levels of power you wish to measure, decide whether to work with the removable filter installed or not. For this purpose, the Centauri has a **Filter** setting and uses the proper correction curve depending on whether or not the filter is installed.

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

1. The measuring mode is **Power**.
2. Set **Range** to **AUTO**, or to one of the manual ranges, as follows:
   - **AUTO**: Select autoranging when the laser power is unknown or varies widely. In autorange, you do not have to change ranges. (The reading is displayed in watts.) This change only occurs after a few seconds delay. This provides overlap (hysteresis) to keep the Centauri from flipping back and forth when reading close to the end of the scale.
   - **Manual range**: The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autorange, since it

changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.

3. Set **Laser** to the appropriate laser setting. If the wavelength you want is not among the wavelengths listed, select the edit icon of the one you want to change, and key in the relevant value in the dialog.

4. Set the removable **Filter** setting to **IN** to measure higher power, when the filter is on the sensor, or to **OUT** for more accuracy and a wider wavelength range, when the filter is not assembled on the sensor. See Table 7-1 Filter In and Filter Out. Make sure to physically insert/remove the filter before continuing measurements. For sensors with built-in filter state detection, only the present state of the filter is shown to the user. It is updated when the filter state is physically changed, thereby causing the sensor to report the new filter state to the meter.

   Warning: If the PD300 is used with the **Filter IN** setting and the filter is not installed, or vice versa, the readings are **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.

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

   Figure 7-1 below shows a sample Line Graph showing laser power measurements, including range, wavelength, filter, and average values. In this display, you can Zoom by stretching the screen with two fingers, and tap Offset. (Click the above links for more details.)

Figure 7-1 Photodiode Power Line Graph

7.3 Averaging and Measuring Very Low Power Measurements

In standard Power measurement mode, the power is measured 15 times per second. If the laser power is fluctuating, the Centauri can display the average power readings with averaging periods varying from 1 second to 1 hour. When measuring very low powers, such as picowatt measurements using the PD300-IRG or PD300-UV, there is 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 tapping offset to eliminate the detector zero offset.

To measure very low powers:

1. On the measurement screen, set the **Average** value to the duration to average over.
2. Block the power source you wish to measure, wait for a few measurement periods and slide **Offset** to subtract the zero offset.
3. Unblock the power source and measure.

For a detailed description of the average function, see Average.

7.4 Measuring Total Exposure

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

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

To measure total exposure:

1. Set **Measuring Mode** to **Exposure**.
2. Set measurement parameters as described above.
3. Tap to set the Stop Mode to **Manual** or **Timeout** period on bottom of the screen.
4. Tap the **Start** icon on the bottom of the screen.

   Accumulated laser power exposure is displayed on the screen, as is elapsed time.
5. To stop exposure measurement before the configured period, tap the stop icon at the bottom of the screen.
6. To reset the reading to zero before another reading, tap **Reset** at the top of the screen.
7. To return to the main power measurement screen, set **Measuring Mode** to **Power**.

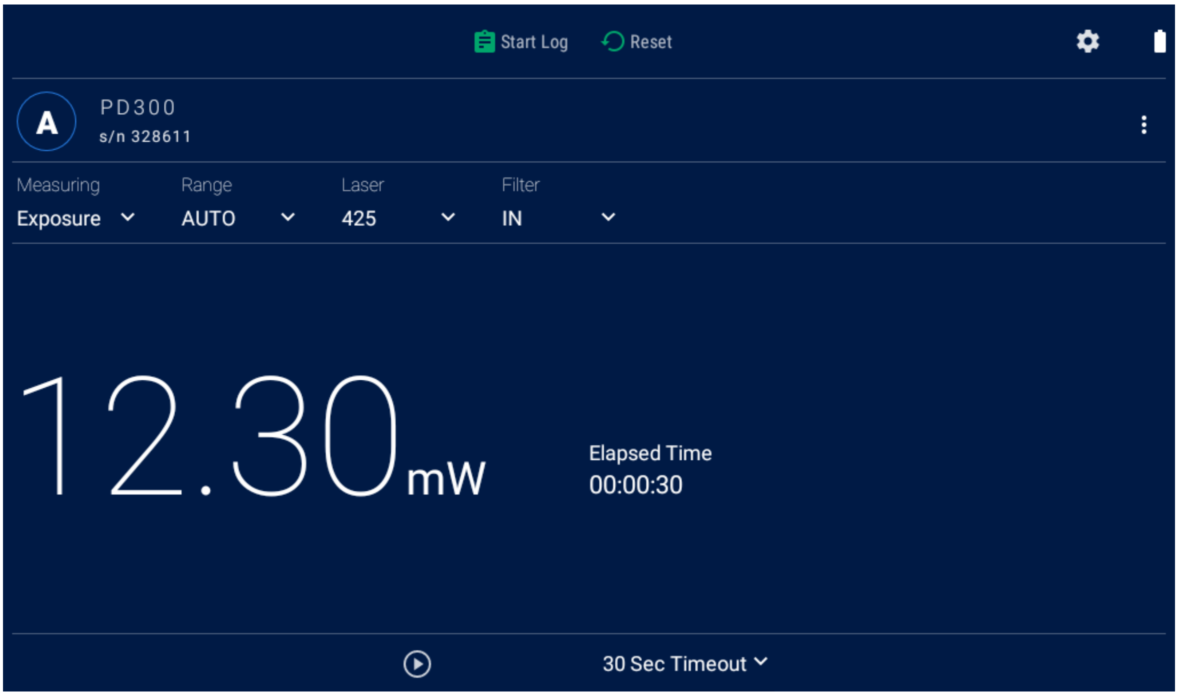


Figure 7-2 Photodiode Exposure Measurement

7.4.1 Exposure Limitations

Function Limitations

When measuring exposure, only Scale Factor is enabled.

7.5 Measuring Average Power of Low Frequency Pulsed Lasers -Low Freq Power Mode

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

Some care needs to be taken when choosing the correct frequency value. If the frequency setting is slightly different from the actual laser frequency, the power readings may show beating effects. If the frequency setting is too low, this may result in periodic positive “spikes” of power above the average power level being measured. If the frequency is too high, the spikes will be negative, below the average power level.

After setting the frequency, choose the correct power range. As a rough guide, the power range should approximately match the expected AVERAGE power to be measured. The correct range to use is usually the most sensitive range available that does not show “OVER” or “over” on the screen - meaning the average power is too high, or the peak power is saturating the electronics.

When switching to “Low Freq. Power Mode” the firmware inside the device makes several changes to the way the electronics is configured and how it measures the photodiode signals, to accommodate the low frequency pulses being measured.

Some tips when using “Low Freq. Power Mode”

Zeroing:

Pay special attention to zeroing of the sensor. Zeroing is always critical, but even more so when measuring low duty-cycle pulses. Always zero the sensor in the same environment as will be used when taking measurements. Preferably block out all background light - or at least reduce it to insignificant levels compared to the measurement being performed.

Perform zeroing in the regular way as described in the user manual. Remember to “save” the zero levels into the memory of the device when zeroing is completed.

Noise:

In some cases it may be possible to reduce noise by averaging power measurements over a longer period.

When to use the Low Freq. Power Mode:

The following steps are recommended:

1. First try selecting regular “Power” mode.
2. Choose the most sensitive scale possible that does not cause “over”
3. Observe the power measurements to determine if the data is stable or noisy
4. If the signal is very noisy, switch to Low Freq. Power Mode.
5. If the data is stable, change up by one power scale (for example, from 3uJ scale to 30uJ scale)
6. Check the average power measured is the same on successive power scales - if not, that might indicate saturation on the more sensitive power scale. In that case, switch to Low Freq. Power Mode.

For photodiode sensors with a “Filter IN” option, in some cases it may be better to use the additional filter and set the Power Meter to “Filter IN” option, thereby reducing the signal on the photodiode and forcing the firmware to choose a more sensitive internal analog range which has heavier low pass filtering. This may provide better performance for pulsed signals.

7.6 Measuring Laser Modulation – “Fast Power Mode”:

The Fast Power measuring mode measures at a rate of 10 kHz. It is used to measure laser modulation, and may also be necessary for flicker measurement of LED light sources. The data is measured very fast, and can only be properly used in conjunction with logging and analysis.

To measure laser modulation:

1. -Set **Measuring Mode** to **Fast Power**.
2. Set measurement parameters as described above for the Power measuring mode.
3. Start logging to record the laser modulation.

8 Pyroelectric and Photodiode Energy Sensors

Centauri supports the PE-C and PD-C series of energy sensors.

For a list of all the available pyroelectric and photodiode energy sensor models that can be used with Centauri, see Sensor Specifications.

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

Topics include:

8.1 Pyroelectric Sensors – Method of Operation

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

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

The Centauri 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, Centauri is also able to display average power.

8.2 Photodiode Energy Sensors – Method of Operation

The PD10-C and PD10-PJ-C operate in a similar fashion to the Pyroelectric PE-C sensors except it has a photodiode detector instead of a pyroelectric one. Because of its great sensitivity, it can operate down to about 1nJ of energy. It has complete wavelength correction over its entire measurement range of 200 - 1100nm. The PD10-IR-PJ-C is sensitive from 700nm – 1800nm and can measure energies down to 30 picoJoules.

8.3 Measuring Pulses of High Energy Density

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

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

- Ophir has sensors specifically designed for high energy density pulses. Some of these sensors can measure energy densities up to several Joules/cm^2. Contact your Ophir dealer for details.

8.4 Operation of Centauri with Pyroelectric and Photodiode Energy Sensors

On power-up, the Centauri meter checks its own memory as well as that of the sensor to determine the measurement configuration. For example, if in the last session the sensor was used to measure energy in a bargraph screen in the 200uJ range with a 1064 laser with no averaging, this is the setup used the next time the system is powered up.

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

To use Centauri with pyroelectric and photodiode energy sensors:

1. Connect the pyroelectric (or photodiode) energy sensor to the Centauri meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked Sensor Input on the rear panel of the Centauri meter. Centauri reconfigures itself to work with the attached sensor.
2. The sensor's measurement parameters are shown on the measurement screen.
3. Tap the current value of the parameter you want to change, and then tap the relevant value.
4. Repeat for all parameters to be changed.

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

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

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

Warning: When using the laser, do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in **Sensor Specifications,** as there is a risk of damaging the absorber.

8.4.1 Zeroing the Energy Sensor with the Centauri Meter

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

To zero the meter with the energy sensor:

1. Make sure the sensor is in a quiet environment and not subject to pulsed radiation.
2. Tap the **Channel Options menu** icon and select **Zero**.
3. Tap **Start**. Wait until "Zeroing completed successfully" appears.
4. Tap **Save** to save the new zero values.
5. Tap **Exit** to close the dialog.

   After you have performed zeroing, you do not need to do it again when using the sensor with the same type of meter. If you zeroed it with a different type of meter, then a different value was saved and when used with a Centauri again, you should zero it again.

8.4.2 Setting Measurement Parameters When Using Energy Sensors

To set measurement parameters using energy sensors:

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

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

2. Set **Laser** to the appropriate laser setting. If this sensor is a metallic type and if the wavelength you want is not among the wavelengths listed, tap the edit icon of the one you want to change and then type in the new value in the **Modify Laser** dialog. When finished, tap **Apply**.
3. Set **Pulse Width** to the shortest time that is longer than the expected pulse width. Select a shorter pulse width setting for higher frequency lasers. Set a longer pulse width setting for higher energy lasers.

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

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

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

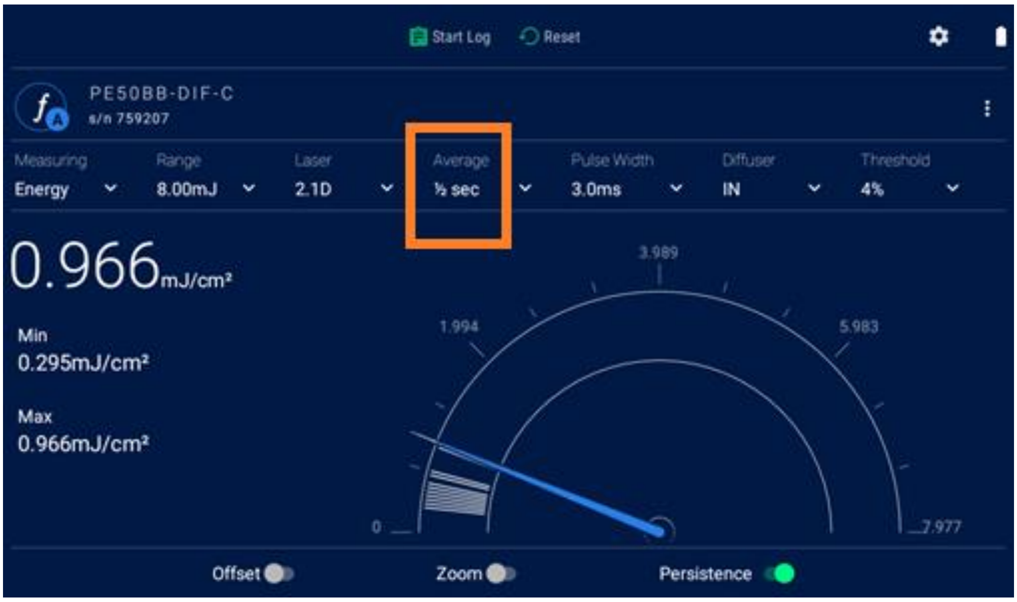


Figure 8-1 Pyroelectric Energy Needle with Average Selected

8.4.3 Energy, Average Power, or Exposure Measurement

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

The pyroelectric sensor is capable of measuring pulses up to very high repetition rates on the order of kilohertz or higher. The Centauri meter samples pulses at up to 25,000 pulses per second, depending on the sensor. However, the display can only display at rates up to 10Hz.

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

8.4.4 Measuring Laser Energy

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

To measure laser energy:

1. Set **Measuring Mode** to **Energy**.
2. Set measurement parameters as described above.

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

8.4.5 Measuring Average Power

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

Average Power = Average Energy X Frequency

where the energy and frequency of the pulses were measured by Centauri.

Note: Centauri use when measuring power is the same as when measuring energy, and is described in full in section Operation of Centauri with Pyroelectric and Photodiode Energy Sensors.

To measure average power:

1. Set **Measuring Mode** to **Power**.
2. Set measurement parameters as described above.

   Average power is displayed as a function of "Energy x Frequency" on the screen as is the laser's frequency.

Figure 8-2 Pyroelectric Power Bargraph

8.4.6 Measuring Total Energy Exposure

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

To measure total energy exposure:

1. Set **Measuring Mode** to **Exposure**.
2. Set measurement parameters as described above.
3. Set the Stop Mode to **Manual**, **Timeout** period, or **Pulses**.

   Accumulated laser energy exposure is displayed on the screen, as is elapsed time and number of pulses measured.
4. To stop exposure measurement before the chosen period, tap the round **Stop** icon on bottom of the screen.
5. To reset the reading to zero before another reading, tap **Reset** at the top of the screen.
6. To return to the main energy measurement screen, set **Measuring Mode** to **Energy**.

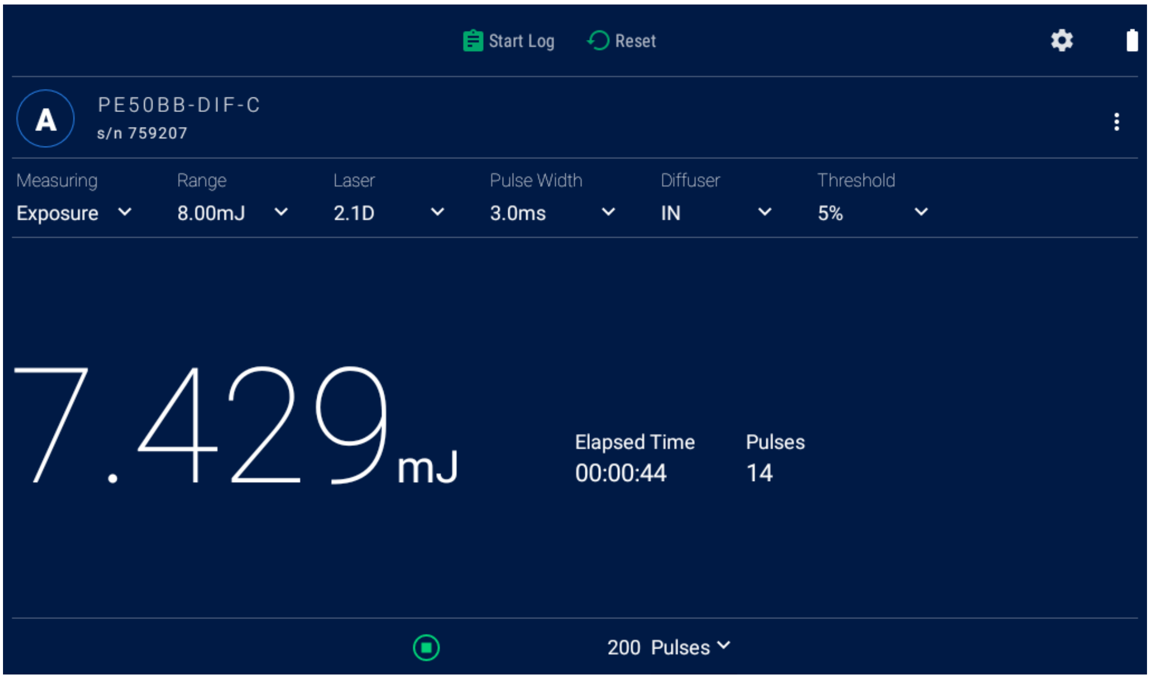


Figure 8-3 Pyroelectric Exposure Measurement

9 Graphical Displays

The Centauri has a variety of customizable graphical displays for measuring, presenting, and reading data. This section describes the graphical displays and how to use and customize them, and related functionality.

In single or split channel operation, there are six display types to choose from: Bar, Needle, Line, Pulse, Pass/Fail, Statistics.

For each of the display types, a Full Screen option can be enabled and disabled by tapping the full screen icon ( ) at the top of the screen.

When two channels are merged (see Dual-Channel Operation), the only display types suitable are the line and pulse graphs.

Topics include:

Power and **Energy** mode graphs:

- Bargraph
- Analog Needle
- Line Graph
- Pulse Chart
- Pass/Fail
- Statistics

Exposure mode graphs:

- Exposure

Track mode graphs (for BeamTrack sensors):

- Position
- Stability

9.1 Bargraph

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

Options available for this display:

- You can slide the Zoom button at the bottom of the screen to zoom in on a smaller section of the range when readings are fluctuating slightly.
- If you notice that noise has impacted the measurement, you can slide the Offset button to remove it from the measurement.

Figure 9-1 Pyroelectric Power Bargraph

The bargraph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon and the battery charge indicator.
- On the second line are the sensor's name and serial number, an indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line you can configure measurement parameters.
- A large numeric display and the bargraph are shown prominently in the middle of the screen.
- The Offset and Zoom buttons on bottom of screen.

To present measurements on a graduated scale (bargraph):

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options** menu icon and then tap **Display Type**.
2. From the **Display Type** dialog, tap to select **Bar**.

   The bargraph view is displayed.
3. To expand the bargraph scale ±5x of the present reading, slide **Zoom** on the bottom of the screen. Slide **Zoom** back to return the bargraph to full scale. For more details, see Zoom.
4. To subtract the background and set the current reading to zero, slide **Offset**. Slide **Offset** back to cancel. For more details, see Offset. See also Measuring Loss Using the dB Offset Function.

9.1.1 Measuring Modes

The **Measuring Modes** that a bargraph can be used with include:

- Power
- Energy
- Pulsed Power

9.1.2 Zoom

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

From a bargraph, slide **Zoom** to focus the bargraph on the present reading. The bargraph shows 20% of the full scale centered on the present reading. Thus, if the full scale of the bargraph is 20 Joules, and your measurement is 15 Joules, sliding **Zoom** makes the bargraph scale range between approximately 13 and 17 Joules. Sliding **Zoom** back returns the unexpanded bargraph display.

When **Zoom** is active, the Zoom button is green, and the endpoints of the bargraph indicate the range the graph is zoomed out between. See figures below.

Figure 9-2 Pyroelectric Power Bargraph

Figure 9-3 Pyroelectric Power Bargraph with Zoom

9.2 Analog Needle

The Needle graph simulates an analog display, similar to the style of an analog voltmeter or a car's speedometer. It is available when measuring power or energy. If the persistence feature is activated, all present measurements remain marked on the display, and the minimum and maximum measurements are displayed numerically on the left side of the screen.

Options available for this display:

- Slide the **Zoom** button at the bottom of the screen to zoom in on a smaller section of the range when readings are fluctuating slightly.
- If you notice that noise has impacted the measurement, you can slide the **Offset** button to remove it from the measurement.
- Slide the **Persistence** button to continue to display previous readings as well as to show the minimum and maximum measurements.

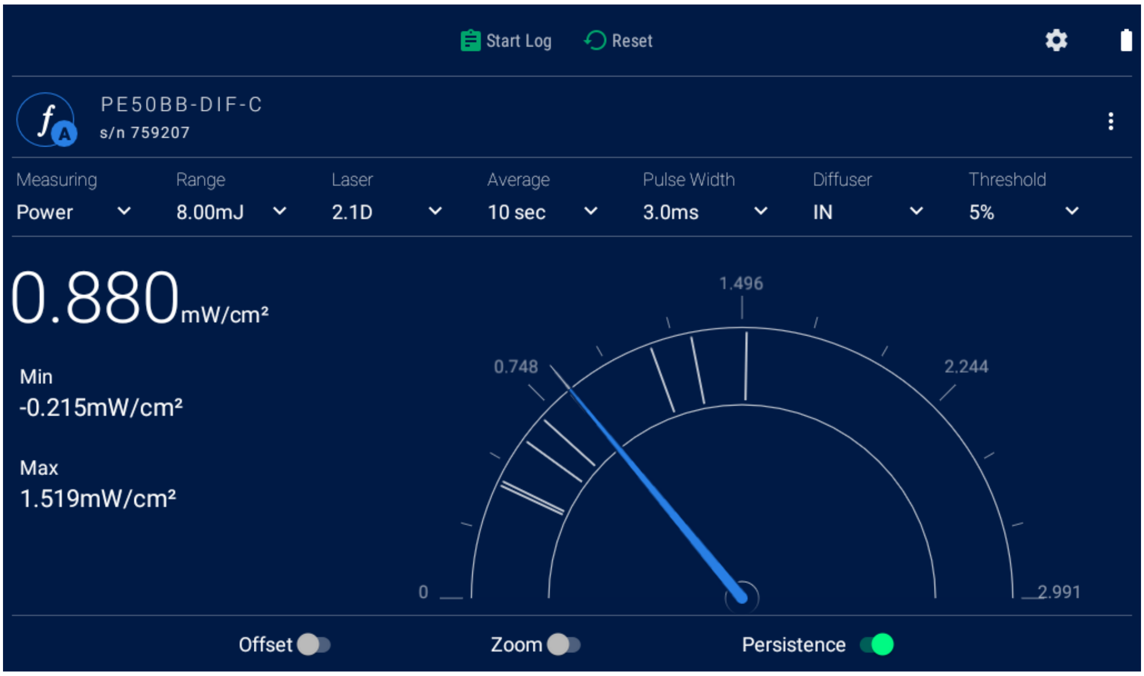


Figure 9-4 Pyroelectric Energy Needle Display

The Needle graph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, an indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- The needle graph is displayed prominently in the middle of the screen with the numerical display.
- If Persistence is activated, all readings remain marked on the needle display, and the minimum and maximum measurements are displayed numerically.
- Offset, Zoom, and Persistence buttons at the bottom of screen.

To simulate an analog needle:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. Tap to select **Needle**.

   Needle representation is displayed.
3. To expand the needle graph ±5x of the present reading, slide **Zoom**. Slide **Zoom** again to return the needle range to full scale.
4. To subtract the background and set the current reading to zero, slide **Offset**. Slide **Offset** back to cancel. For further details, see Offset.
5. Slide **Persistence** to keep older measurements marked on the graphic, and to display numerically the **Min** and **Max** values measured. Slide **Persistence** back to cancel.

9.2.1 Measuring Modes

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

- Power
- Energy
- Pulsed Power

9.2.2 Persistence

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

Tap **Persistence** to continue to display previous readings as well as to show the minimum and maximum measurements.

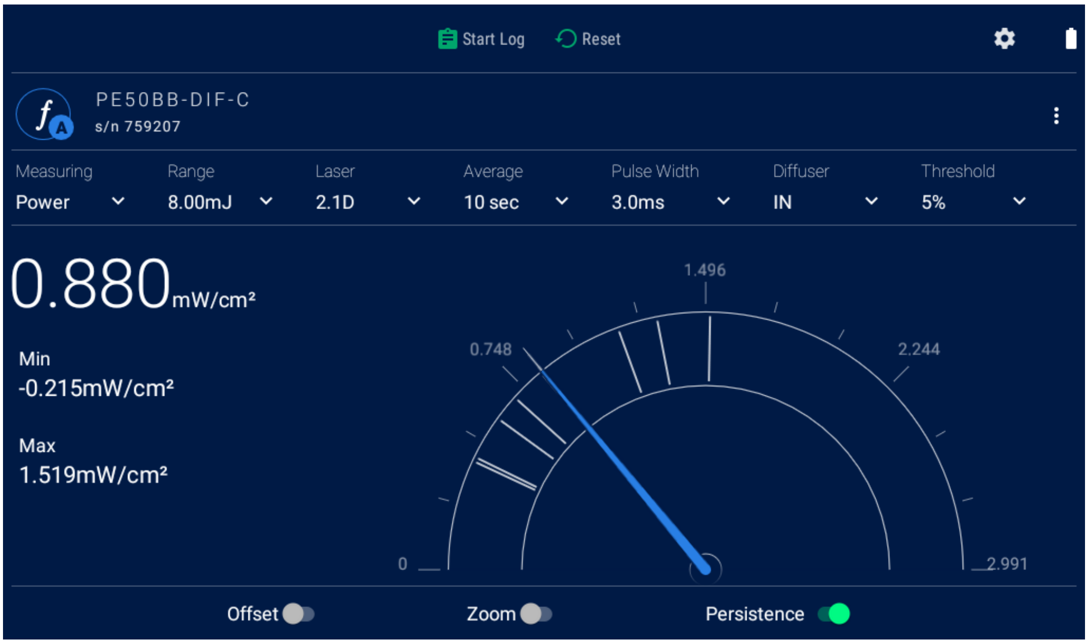


Figure 9-5 Pyroelectric Energy Needle with Persistence

9.3 Line Graph

The Line graph displays laser output as a function of time. This is useful for technicians performing laser alignment (laser tuning) who want to see a graphical representation of the results of their experimenting, and the maximum laser power attained. This graph is displayed against time, and is most applicable when there is a continuous stream of data. The Line graph can be used with any sensor that measures power or energy.

The line graph is mainly used for continuous measurements of CW (continuous wave) lasers with photodiode or thermal power sensors.

The line graph has the following touchscreen capabilities: you can move the graph up and down, stretch and pinch the graph with two fingers, and double-tap the graph area to reset.

Figure 9-6 Photodiode Power Line Graph

The Line graph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, an indication whether a function is configured, and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- There is a large numeric display plus Max and Min values are above the Line graph in the center of the screen.
- Autoscale Y Axis and Offset buttons on the bottom of the screen.

To graph laser output over time:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options** menu icon, and tap **Display Type**.
2. Tap to select **Line**.

   Line representation is displayed.
3. Zoom and un-zoom the display by stretching and pinching the graph with two fingers, either top to bottom or side to side.
4. Pan the display by moving your finger up and down on the graph.
5. Double-tap the graph to reset the zoom and pan.
6. Tap **Autoscale Y Axis** along the bottom of the screen to scale the axis between the minimum and maximum readings.
7. Tap **Reset** along the top of the screen to clear the **Min/Max** tracking and to restart the graph.

9.3.1 Measuring Modes

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

- Power
- Energy
- Pulsed Power

9.3.2 Autoscale Y-Axis

Adjusting the y-axis scale allows you to set the focus of the graph. If this feature is activated, the y-axis of the graph is scaled between the minimum and maximum readings only, focusing the graph closely on the actual range of the readings.

9.3.3 Reset

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

9.4 Pulse Chart

The Pulse Chart displays a graph of pulses as they occur. The readings are shown as bars with lengths proportional to the measurement. This is useful for technicians performing laser alignment (laser tuning) who want to see a graphical representation of the results of their experimenting, and the maximum laser power attained. This graph is not time-based and is most applicable when the data flow is not necessarily periodic. It is ideal when measuring low frequency lasers. The Pulse

Chart can be used with any sensor that measures power or energy. It is mainly used for pulsed lasers with pyroelectric energy sensors.

The Pulse Chart has the following touchscreen capabilities: you can move the graph up and down, stretch and pinch the graph with two fingers, and double tap the graph area to reset.

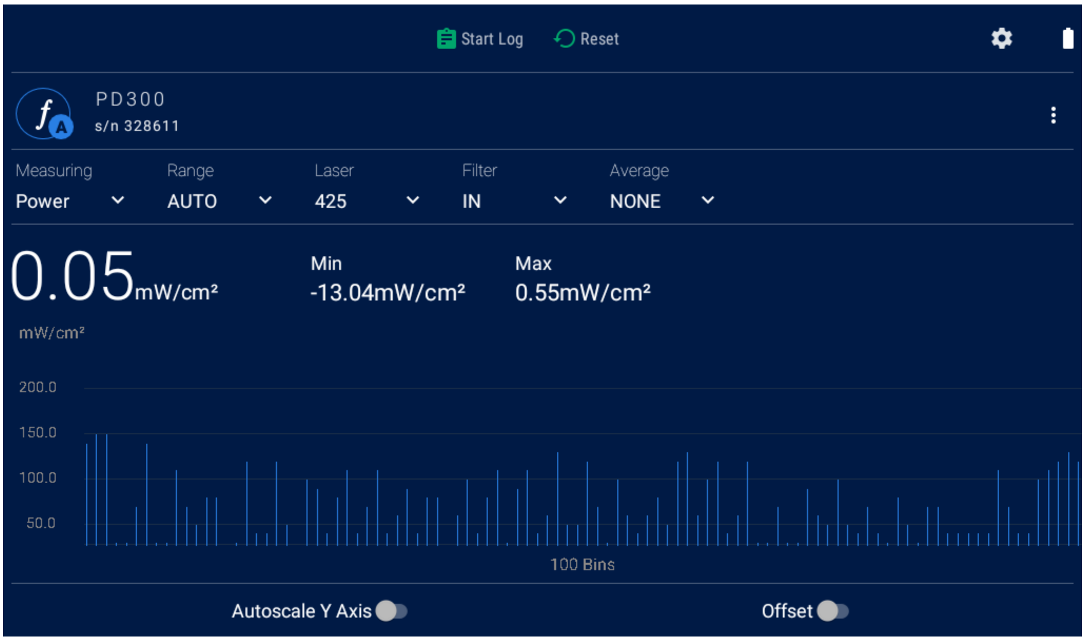


Figure 9-7 Photodiode Pulse Chart

The Pulse Chart display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function has been configured, and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Large numeric display and Max and Min values are above the Pulse Chart.
- The Pulse Chart is displayed prominently in the middle of the screen. It displays a graph of pulses as they occur. When the graph reaches the end of the screen, it continues at the last point shifting previous readings to the left and no longer showing the least recent measurement. The readings are shown as bars with length proportional to the measurement.
- Autoscale Y Axis and Offset buttons on bottom of screen.

To graph laser output in pulse chart form:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options** menu icon and tap **Display Type**.
2. From the **Display Type** dialog, tap to select **Pulse**.

   The main sensor measurement screen displays the relevant Pulse graph.
3. Zoom and un-zoom the display by stretching and pinching the graph with two fingers, either top to bottom or side to side.
4. Pan the display by moving your finger up and down on the graph.
5. Double-tap the graph to reset the zoom and pan.
6. Tap **Autoscale Y Axis** along the bottom of the screen to scale the axis between the minimum and maximum readings.
7. Tap **Reset** along the top of the screen to clear the **Min/Max** tracking and restart the graph.

9.4.1 Measuring Modes

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

- Power
- Energy
- Pulsed Power

9.5 Pass/Fail

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

If the measurement is out of range, indications of that are displayed on the screen. When the measurements are within range, the display is normal.

Figure 9-8 Pyroelectric Pass/Fail Over the Upper Limit

The Pass/Fail display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function is configured, and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- In the center of the screen is a large numeric display.
- Upper Limit and Lower Limit are in the center to the right of the large numeric display.
- Out-of-range warning: red numeric display, red arrow above limit violated.
- Offset button, and buttons for setting upper and lower limits on bottom of screen.

To set pass/fail tracking:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Options menu** icon and tap **Display Type**.
2. From the **Display Type** dialog, tap to select **Pass/Fail**.

   The Pass/Fail screen is displayed.
3. Tap **Upper** and **Lower** on the bottom of the screen to set tolerance limits. If the reading is out of range, an appropriate warning is displayed on the screen.

9.5.1 Measuring Modes

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

- Power
- Energy
- Pulsed Power

9.6 Statistics

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

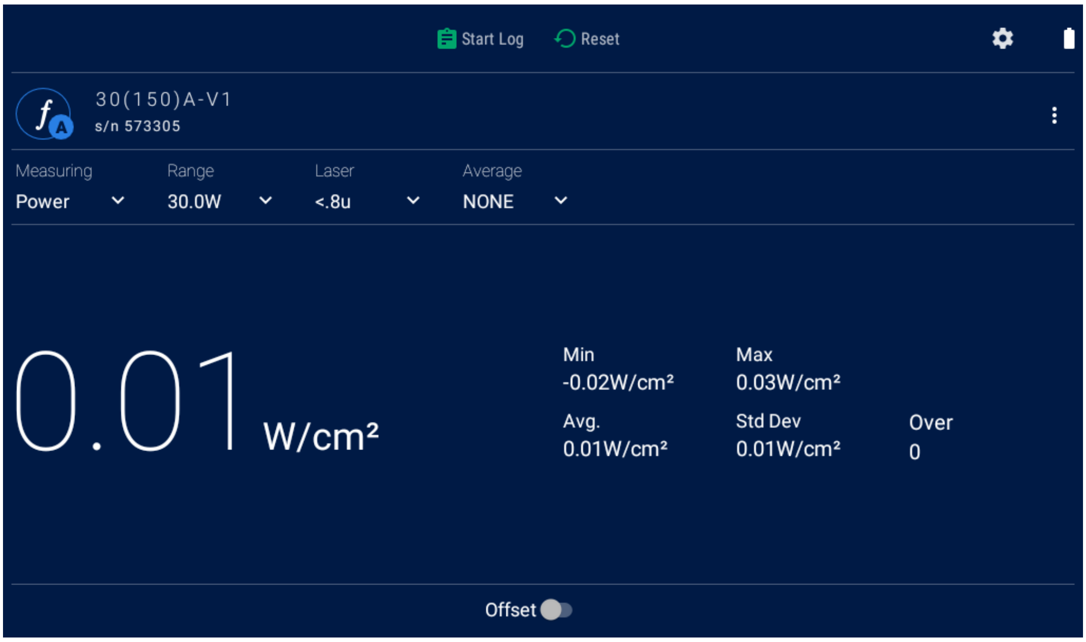


Figure 9-9 Thermal Power Sensor Statistics

The Statistics display comprises the following components:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, an indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Max, Min, Average, Standard Deviation, and Over values on the right-hand side of the main screen.
- Large numeric display.
- Offset button at the bottom of the screen.

To display real-time statistics:

1. In **Power**, **Energy**, or **Pulsed Power** mode, tap the **Channel Option menu** icon and tap **Display Type**.
2. From the **Display Type** dialog, tap to select **Statistics**.

   The statistics screen is displayed.
3. Displayed are **Maximum**, **Minimum**, **Average**, **Standard Deviation**, **Total** readings, and number **Over** range.
4. To subtract the background and set the current reading to zero, tap **Offset** on the bottom of the screen. Tap **Offset** again to cancel. For further details, see Offset.
5. Tap **Reset** on the top line to clear the statistics.

9.6.1 Measuring Modes

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

- Power
- Energy
- Pulsed Power

9.6.2 Upper/Lower Limits

You can set the upper and lower limits for measurements. The initial default upper limit is the maximum of the present range, and the initial default lower limit is 0 (until the first time both values are set to something else).

To set the upper and lower limits:

1. Tap the **Upper** or **Lower** button at the bottom of the screen. The respective **Set Upper Limit/Set Lower Limit** dialog is displayed.
2. Tap to select the digit to update, including the exponent (E+**00**).
3. Key in the digits to reach the desired value. (The limits can be set from -9999 to 9999 E -15 to E +12.) Tap **Apply**.

If the measurement is out of range, there is an indication of the violation.

9.7 Exposure (for Pyroelectric Sensors)

The Exposure display shows the sum of the total energy of a series of pulses over a given time period or number of pulses. This gives the total energy "exposure" over that time period. For example, if the laser is pulsing at 30 times/sec at 1mJ per pulse and you measure the exposure over 20 seconds, then the total exposure is 30 x 1 x 20 = 600mJ. The Exposure graph is available when measuring exposure with pyroelectric sensors.

Note: When switching measurement mode from Exposure, the graphic display is changed automatically to the previously defined graphical display.

Figure 9-10 shows a sample Pyroelectric Sensor Exposure graph, where you can configure **Mode**, **Range**, **Laser** setting, **Pulse Length**, **Diffuser**, and **Threshold** settings, as described in Setting

Measurement Parameters When Using Energy Sensors and Measuring Total Energy Exposure. See also Manual/Timeout/Pulses.

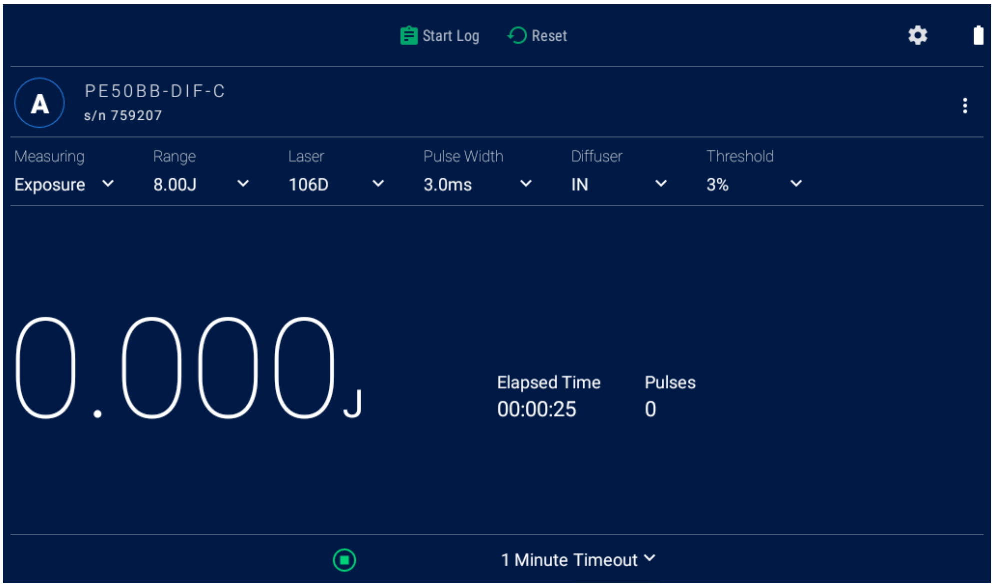


Figure 9-10 Pyroelectric Exposure Measurements

The Exposure display comprises the following components:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Total exposure (large numeric display) is displayed prominently in the center of the screen.
- Elapsed time and Pulses received to the right of the large numeric display.
- Start/Stop and Stop Mode buttons are on the bottom of the screen.

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

1. When using a pyroelectric sensor, in **Exposure** mode, the graph type is **Exposure** (no need to set it).
2. Configure the settings, as described in Measuring Total Energy Exposure.
3. Tap **start/stop icon** on the bottom of the screen to manually start or stop the exposure measurement.
4. Tap **Manual** (on the bottom) and select the mode for ending the exposure measurement (see Stop Modes: Manual/Timeout/Pulses).
5. Tap **Reset** to stop the exposure measurement and reset the total, pulse counter, and elapsed time to 0.

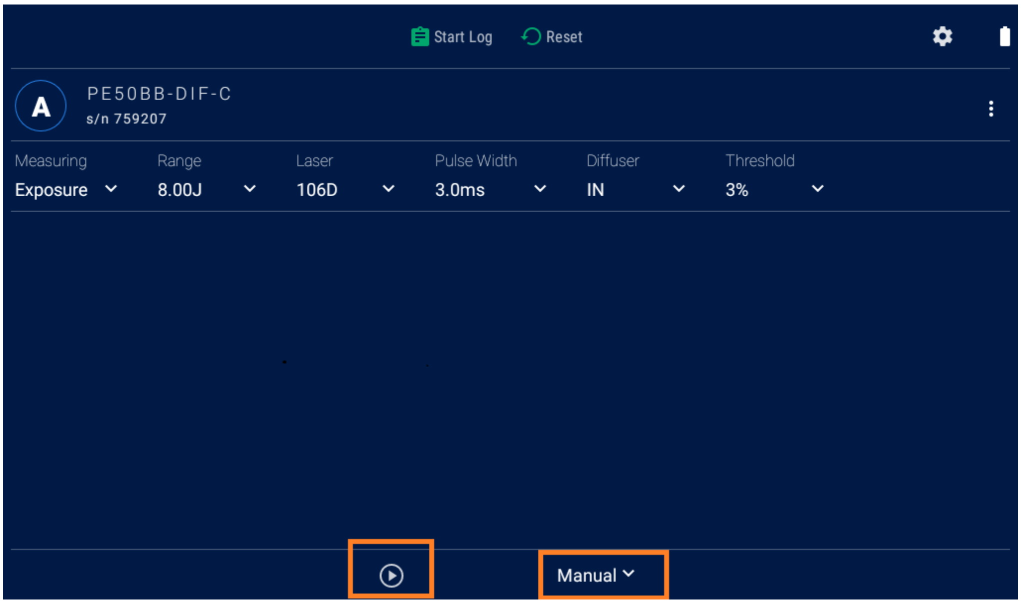


Figure 9-11 Pyrolectric Exposure Screen indicating the start/stop button and the Manual Option Selected

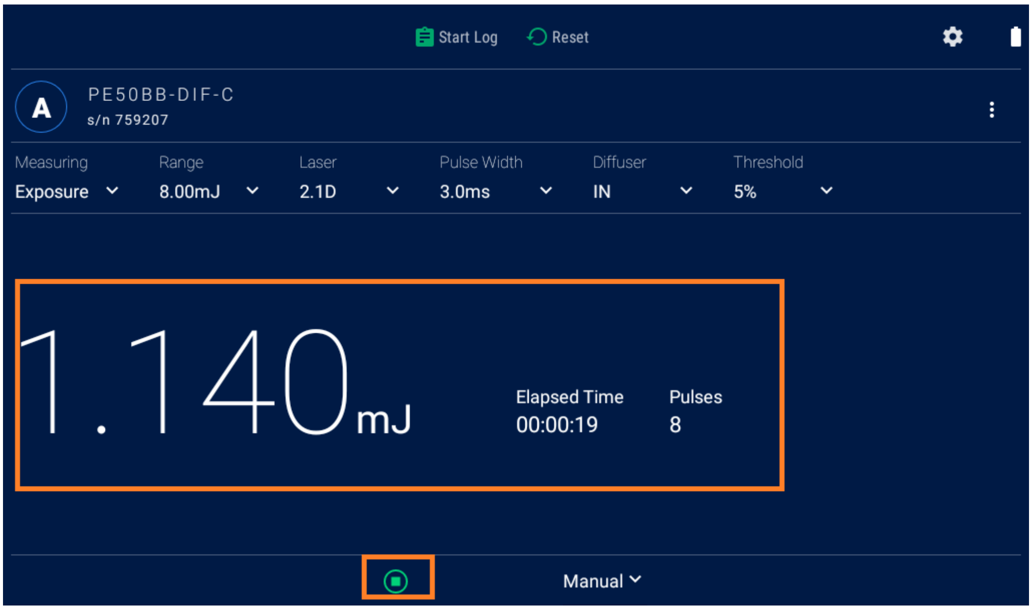


Figure 9-12 Pyrolectric Exposure Screen indicating the numerical display and the stop button

9.7.1 Measuring Modes

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

- Exposure

9.7.2 Stop Modes: Manual/Timeout/Pulses

Tap **Manual** (on the bottom right) to display the stop mode menu. Tap to select the desired stop mode:

- **Manual**: Stop the exposure measurement by tapping the **start/stop** icon.
- **Timeout**: Stops after the specified time has elapsed (as shown on the key legend). You can select: 1 second, 3 seconds, 10 seconds, 30 seconds, 1 minute, 3 minutes, 10 minutes, 30 minutes, or 1 hour. You can also tap the **start/stop** icon.
- **Pulses**: Stops after the specified number of pulses has arrived (as shown on the key legend). You can select: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, or 5000. You can also tap the **start/stop** icon.

9.8 Measuring Exposure with Photodiode Sensors

Exposure can be measured with photodiode sensors. The following are the differences between measuring exposure with pyroelectric energy sensors and photodiode sensors:

- Photodiode sensors actually measure power and sum the results into energy.
- There is no Pulses stop mode option with photodiode sensors.

9.9 Position (for BeamTrack 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 four quadrants so by measuring and comparing the output from the four sections you can determine the position of the center of the beam to a high degree of accuracy. In addition, there is a special patented beam size detector. After outputs are processed from these various detectors, the user is presented with the beam position and the beam size. Note that the beam size is calibrated only for Gaussian beams, but for other beams, relative size information is provided, indicated whether the beam is changing size.

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

Figure 9-13 below shows a sample BeamTrack sensor position graph. See also Offset.

Figure 9-13 BeamTrack Position and Size Display

The position display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line, you can configure management parameters.
- Numeric display of power, (x,y) position, and size along the left side of the screen.
- Position and size displayed graphically on the right side of the screen.
- Offset and Center buttons at the bottom of the screen.

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

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

1. From **Track** mode, tap the **Channel Options** menu icon and tap **Display Type**.
2. From the Display Type dialog, select **Position**.

   The Position graph is displayed.
3. Slide **Center** to center the laser beam and set the present spot position as (0, 0). Later position measurements are displayed relative to the new origin. Due to physical limitations of the BeamTrack sensors, size measurement remains available at or near the true origin only.

   When activated, the crosshairs move to the center of the spot, and the graph limits are no longer displayed.

4. Slide the **Offset** button to subtract the background noise from the power measurement.

9.9.1 Measuring Modes

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

- Track

9.10 Stability (for BeamTrack Sensors)

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

Figure 9-14 below shows a sample BeamTrack sensor stability graph.

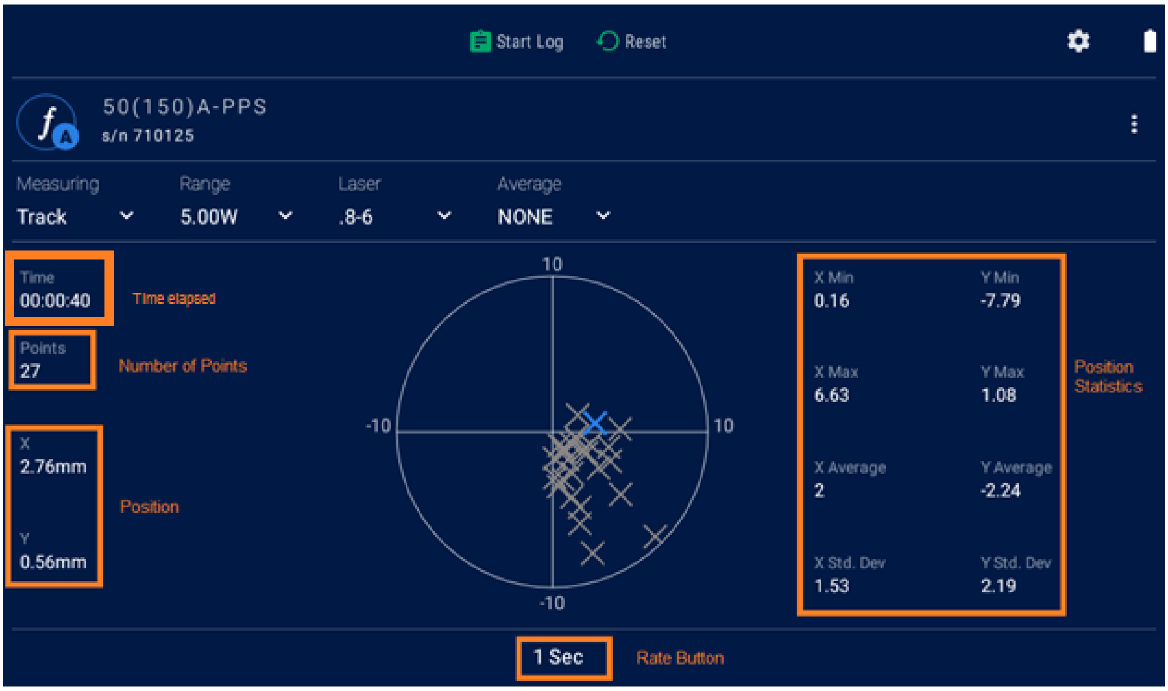


Figure 9-14 BeamTrack Stability Display

The **Stability** display comprises the following sections:

- On the top line are the Start Log and Reset buttons, the Settings icon, and the battery charge indicator.
- On the second line are the sensor's name and serial number, indication whether a function is configured (ƒ), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Time on the left side is the time elapsed since the start of this stability measurement session.
- Points refers to the number of position readings taken so far in this measurement session.
- Numeric display of (x,y) position on the left side of the screen.
- Position and size displayed graphically in the center of the screen.

- Min, Max, Average, Standard Deviation for the (x,y) position on the right side of the screen.
- Rate button on the bottom of the screen.

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

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

1. From **Track** mode, tap the **Channel Options menu** icon and then tap **Display Type**.
2. From the **Display Type** dialog, tap to select **Stability**.

   The main sensor measurement screen displays the relevant Stability graph.
3. Tap the rate button on the bottom of the screen to set the rate of data collection (Options include: **1**, **3**, **10**, **30 seconds** or **1 minute**).
4. Tap **Reset** to reset the time scale, the graph, and the statistics displayed.

9.10.1 Measuring Modes

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

- Track

10 Functions

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

Topics include:

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

10.1 Display on Main Measurement Screen

If any functions are enabled, then the letter "**ƒ**" is displayed next to the sensor information. In the graphic below from a dual-channel system, Channel A has a function configured, while Channel B does not.

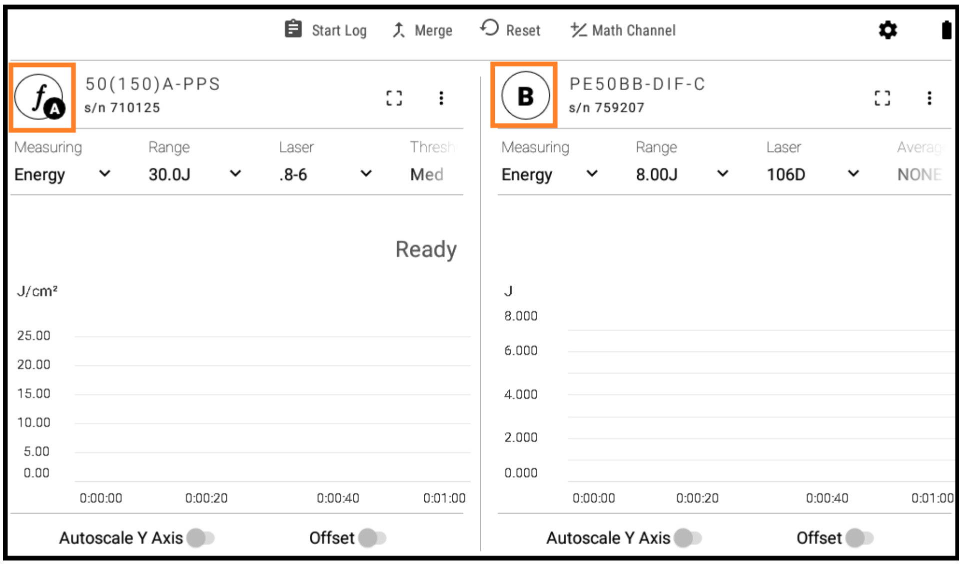


Figure 10-1 Function Indicated for Channel A

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

10.2 Functions Screen

On the Functions screen, you can set up different post processing parameters in order to display the measurement in the way most fitting for your application. These function settings can be set individually, and they can be combined, for example, to see the power density of a laser beam after it has gone through a beam splitter.

The Functions screen is accessed by tapping the **Channel Options** menu icon from the channel measurement screen, and then tapping **Functions**.

Figure 10-2 Functions Screen

The Functions screen comprises the following:

- The top line contains a return arrow, Channel A/B indication (always Channel A for single channel systems), and a Clear All icon to remove all functions from the channel.
- List of functions and their current settings, with arrow or edit icon to enable re-setting the function.
- The bottom line displays the original measurement unaffected by functions >> adjusted measurement of all configured functions.

This section describes the available functions:

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

10.3 Average

This function calculates a moving average, and is applicable only to numerical results. You can set a time period over which to average measurements. This feature is especially useful for lasers with unsteady output. (The time period can also be set directly in the channel measurement screen.)

To set a time period for averaging power readings:

1. From the measurement screen, tap the **Channel Options menu** icon and tap **Functions**.

   The **Functions** configuration screen is displayed.

2. On the **Average** line, tap the current value and select an option to set the **Average** to the period you wish to average power over, or set to **NONE** to disable. (This can also be set in the channel measurement screen.)

10.4 Fixed Offset

You can define a constant value to be subtracted from subsequent power/energy readings.

Note: This value can be positive or negative.

To apply a fixed offset to measurements:

1. From the measurement screen, tap the **Channel Options menu** icon and tap **Functions**.

   The **Functions** configuration screen is displayed.

2. On the **Fixed Offset** line, tap the current value.

   The **Set Fixed Offset** dialog is displayed

3. Set the value to subtract from all subsequent measurements, either typing in a new value, or setting it to the present measurement.
4. Tap **Apply** to save and exit dialog.

10.5 Scale Factor

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

To apply a scale factor to measurements:

1. From the measurement screen, tap the **Channel Options menu** icon and tap **Functions**.

   The **Functions** configuration screen is displayed.

2. On the **Scale Factor** line, tap the current value.

   The **Set Scale Factor** dialog is displayed.

3. Type in the value by which to multiply subsequent measurements. The scale factor can be between 0.00001 and 9999, only positive.
4. Tap **Apply** to save and exit.

10.6 Normalize

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

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

To normalize against a baseline value:

1. From the measurement screen, tap the **Channel Options menu** icon and tap **Functions**.

   The **Functions** screen is displayed.

2. On the **Normalize** line, tap the current value/edit icon.

   The **Set Normalize** dialog is displayed.

3. Type in the baseline value by which to normalize all subsequent measurements, or set the present measurement to be the baseline value. This value must be positive.

4. Tap **Apply** to set the value and exit.

   When **Normalize** is applied, measurements are displayed dimensionless; that is to say, without the W or J symbols. They are shown as the result of the present measurement/reference value.

10.7 Density

The Centauri gives you the option to measure in units of power density and energy density, instead of power and energy. You input the beam size and the meter then calculates and displays the power or energy density in units of W/cm² or J/cm².

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

To display as power/energy density:

1. From the channel measurement screen, tap the **Channel Options menu** icon and tap **Functions**.

   The **Functions** screen is displayed.

2. On the **Density** line, tap the edit icon.

   The **Set Density Parameter** dialog is displayed.

3. Select the beam shape (**Disabled**, **Circle, Rectangle**). Selecting **Rectangle** enables the **Height** and **Width** parameters for modifying the spot height. Selecting **Circle** enables the **Diameter** parameter for modifying the spot diameter.

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

   The measurements are shown in units of W/ cm² on the graphical display on the measurement screen.

5. Tap **Apply** to exit the dialog.

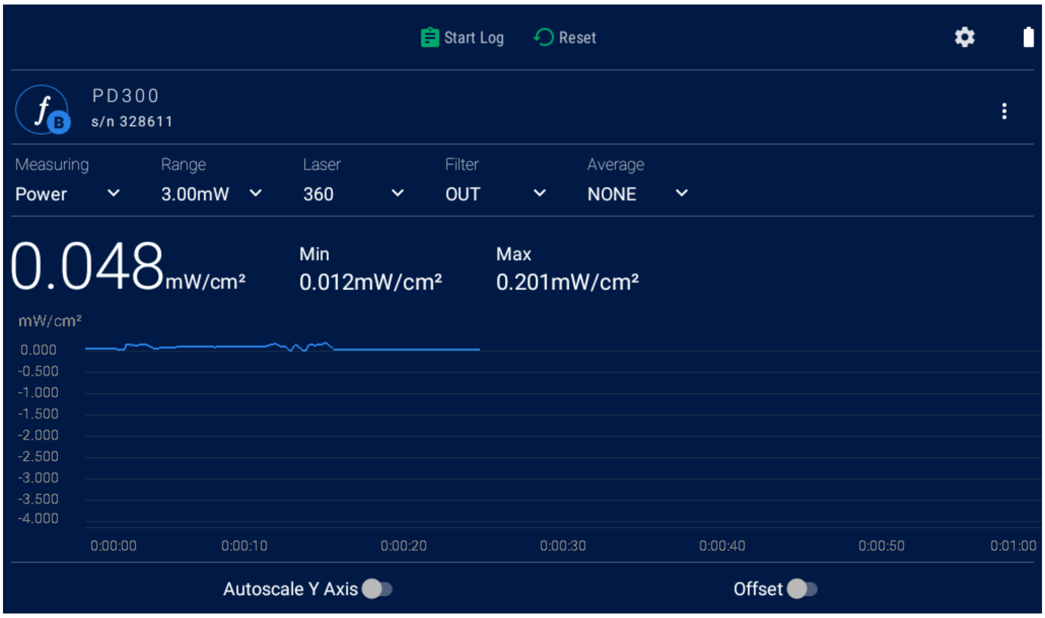


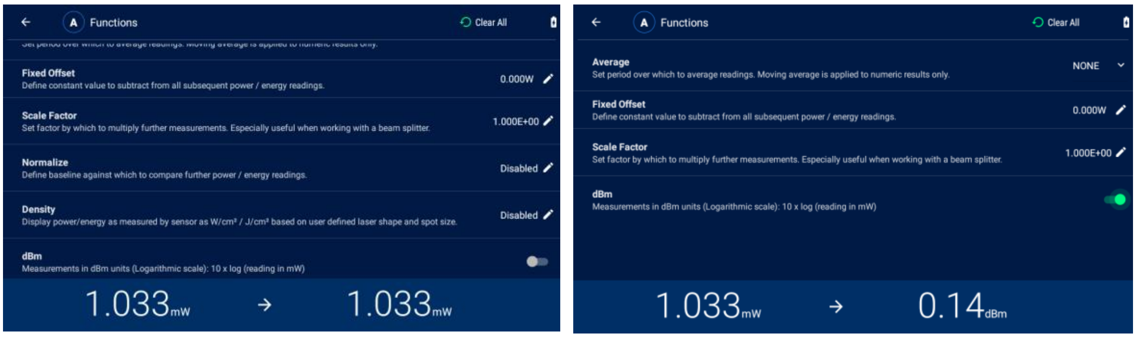
Figure 10-3 Measurement of Power Density in mW/cm²

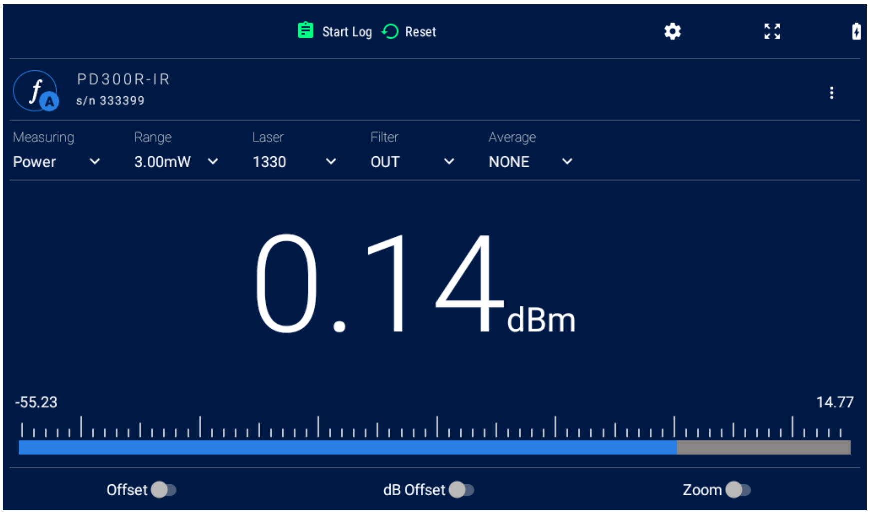
10.1 dBm

Provides measurements in dBm units (logarithmic scale)

dBm units are defined as: 10 x log (reading in mW)

Note: Normalize and Density functions are disable when dBm is set.





10.2 Function Limitations

- For thermal sensors in single-shot energy mode, Average is disabled.
- For BeamTrack sensors in Track mode, the functions apply to the power measurement only.
- For sensors in Exposure mode, Average, Normalize, and Density are disabled.
- If Normalize is active, then Density is disabled. If Density is active, then Normalize is disabled.
- If the dBm is active, then Normalize and Density are disabled.

11 Dual-Channel Features

If you purchased or upgraded to a dual-channel Centauri, you have the opportunity to compare two channels numerically and graphically. There are two pin connectors at the top of the meter, and sensors can be connected to either or both of them.

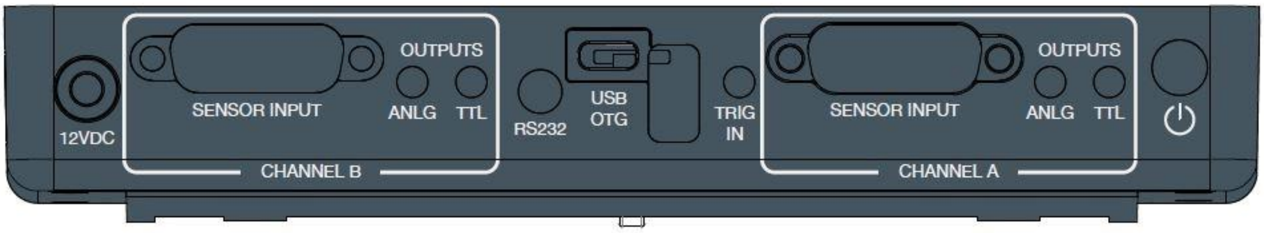


Figure 11-1 Centauri Upper Panel

Notice that the touchscreen is facing upwards in Figure 11-2; which is actually a view from the back. When you face the touchscreen, Channel A is on your left.

Q. I purchased a Single Channel Centauri, yet it has an additional sensor input socket labeled Channel B. How do I get this second input to work so that I can attach, measure, and compare with two sensors simultaneously?	A. The single-channel Centauri already contains the hardware necessary to support dual channel functionality. You can field upgrade a single-channel Centauri to a dual-channel Centauri by purchasing a dual-channel activation code, ordering P/N XXXXXX. You enter the code number received in the Instrument Settings to enable the second channel. See Dual Channel Activation.

11.1 Dual-Channel Operation

When two sensors are attached to the Centauri, the measurement screen is divided in two, displaying measurement screens for both sensors. You can configure the sensor parameters for each channel in the usual way, and use the Channel Options menu for zeroing and further configuring, including any of the Display Options.

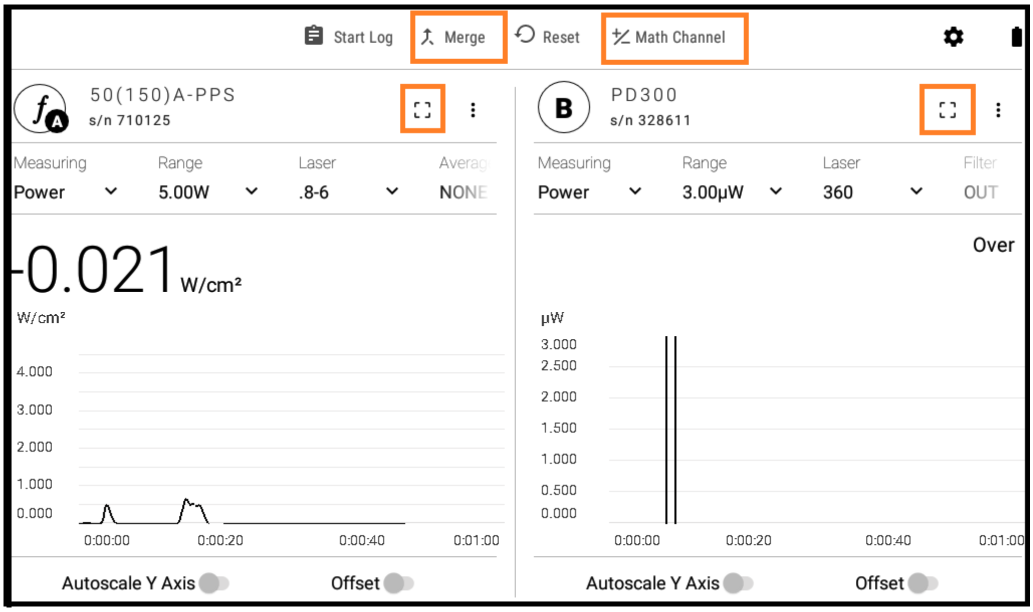


Figure 11-3 Dual Channel Operation in Split Mode

Special buttons at the top of the screen: Merge/Split, and Math Channel, enable use of the dual-channel features.

In Split mode, each channel is shown separately and completely. Full screen/reduce screen icons allow you to focus on one channel and toggle back to viewing both channels.

Figure 11-4 Dual Channel Operation with focus on Channel A (which has a function configured)

Figure 11-5 Dual Channel Operation with focus on Channel B

When you tap Merge, both channels are displayed in either line or pulse graphs on the same axes. The x-axis is the same for both channels. The y-axis setting is on the left and the right respectively for each channel.

Figure 11-6 A and B Merged

When two channels are merged, the only suitable display types are: Line, and Pulse. If both Measuring Modes are Power, a line graph is displayed by default. If both Measuring Modes are Energy, a Pulse chart is displayed by default. If there is one channel of each type, you are asked which type of display should be used.

Note that when either of the channels is set to the Track measurement mode, a merged display of the graphs is not possible.

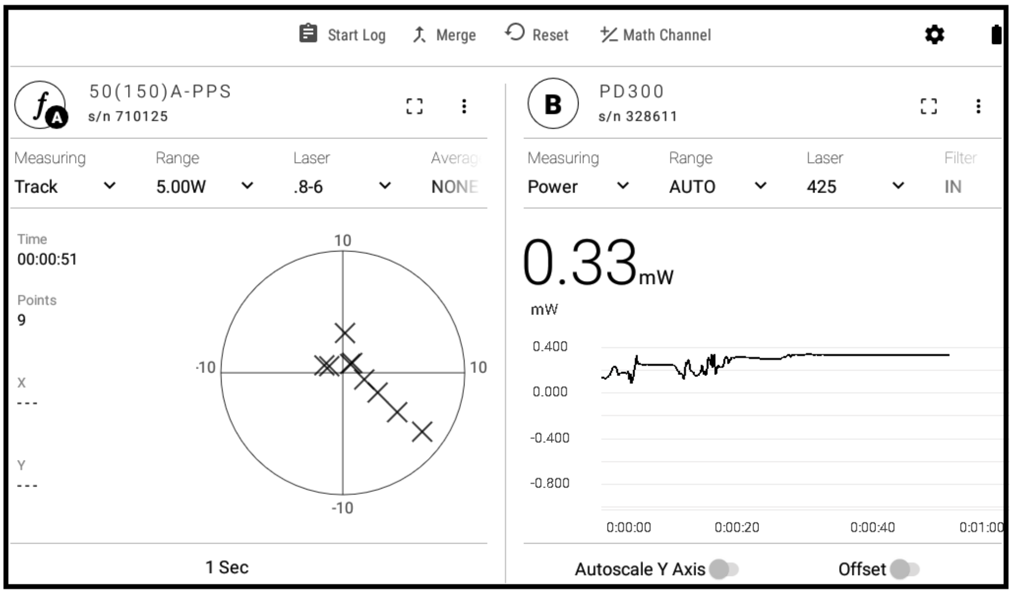


Figure 11-7 Track Graph in split display with Line Graph

Tapping **Split** returns separate graphs for each channel.

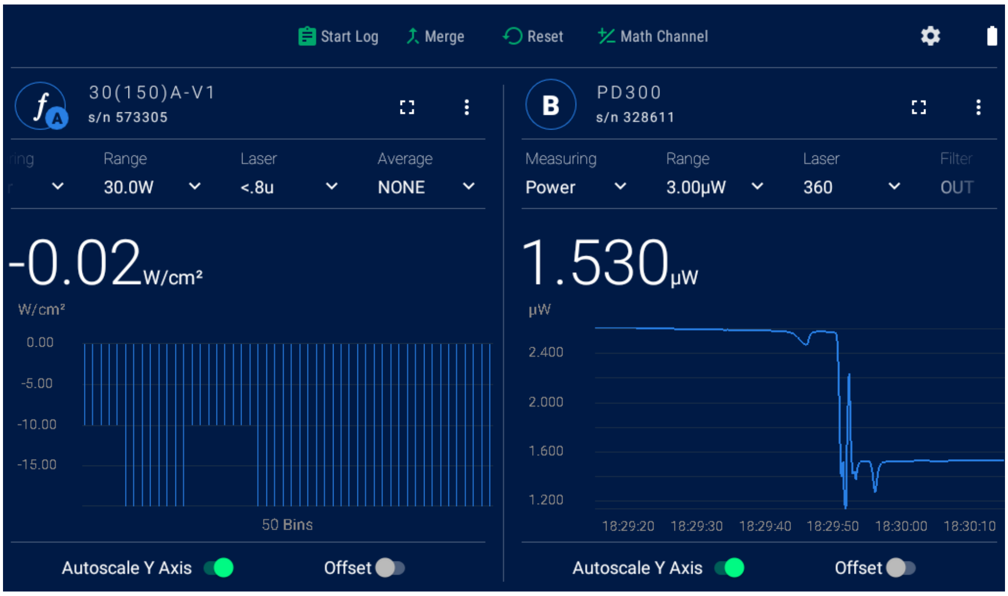


Figure 11-8 Split Screen A Pulse Graph B Line Graph

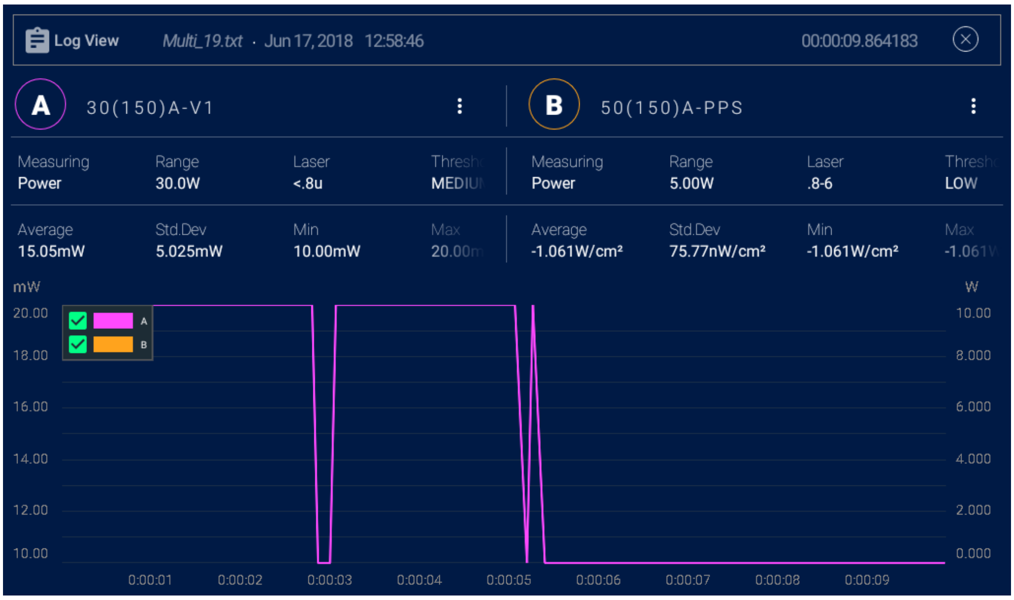


Figure 11-9 Split Screen A Pulse Graph B Line Graph

Figure 11-10 shows the Log View for a split measuring screen. See Display Log as graph.

11.2 Math Channel

The dual-channel Centauri enables comparison of the measurements of the two channels. The results can be displayed numerically and graphically, and logged. The Math Channel displays the comparison. The comparison operation options are:

- A/B
- B/A
- A-B
- B-A
- A+B
- A*B

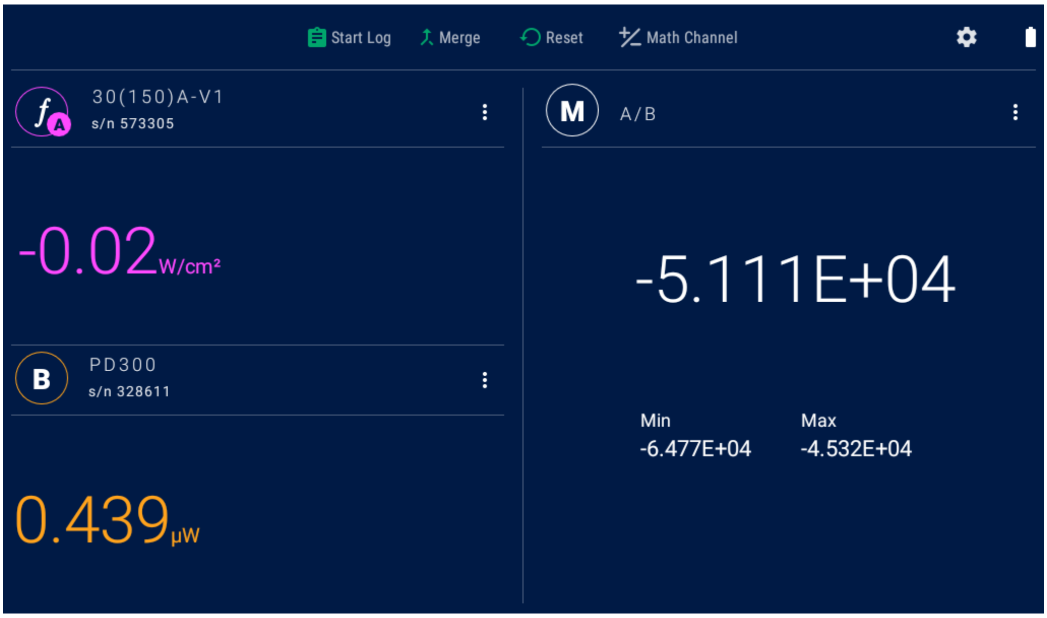


Figure 11-11 Math Channel in Operation (split display)

When two sensors are connected to the Centauri, the Math Channel icon is displayed on the upper activity bar. When tapped, the screen changes, displaying three reduced measurement screen sections. On the left side, are reduced measurement screens for the sensors, and on the right side, the Math Function screen.

The sensor sections display icons A and B, function indication (ƒ) if any, sensor model, serial number, and a large numerical display of the measurement.

The Channel Options menu icon on the A or B channel line provides access to a display of the Sensor Settings, and allows application of the offset set for the channel.

The M icon line displays the operation used to compare the measurements of each sensor. The result of this operation is displayed in the large numeric display in the center right of the screen. The Channel Options menu icon on that line enables setting the operation used to compare the measurements of the two sensors. The M main screen displays the result of the comparison operation and the Min/Max values.

To display sensor settings in the Math Channel

1. Tap the **Channel Options menu** icon next to the sensor name.
2. Tap to select **Sensor Settings**.

   The sensor's configuration settings such as: Measuring Mode, Range, Laser, Average (depending on the sensor type) are displayed vin the **Sensor Settings** dialog.
3. Tap **OK** to exit.

To apply an offset to the channel measurement

1. Tap the **Channel Options menu** icon next to the sensor name.
2. Slide the **Offset** button.

   The offset is applied to the on-screen measurement.

To set the operation used for comparing the sensor measurements

1. Tap the **Channel Options** menu icon on the M line.
2. Tap **Set Operation**.

   The **Set Operation** dialog is displayed.
3. In the dialog, tap each of the three fields to select A or B and the operator between them, to set any of the following operations: A/B, B/A, A-B, B-A, A+B, A*B.
4. Tap **OK** to save and exit.

Figure 11-12 Merged Math Channel Display

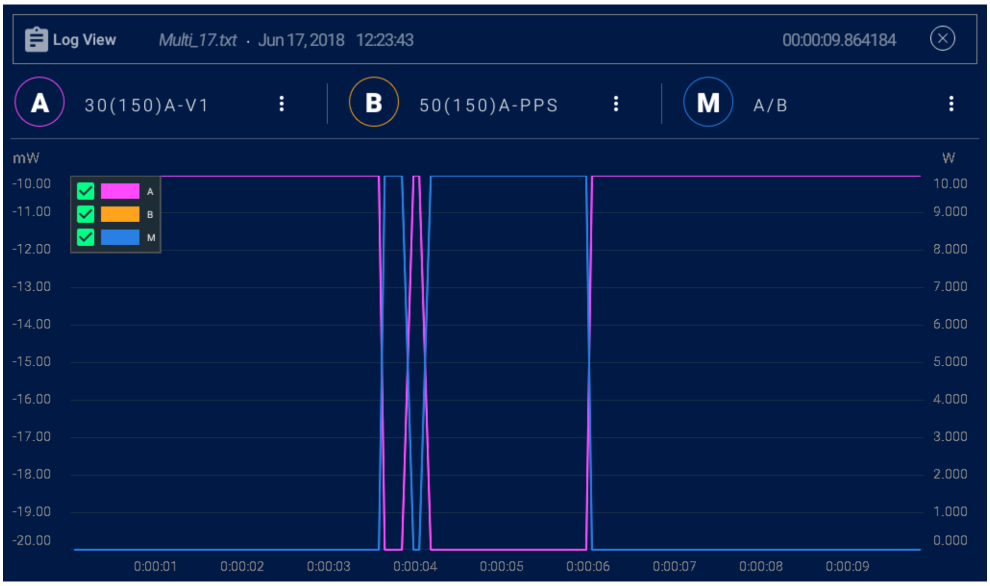


Figure 11-13 Log View of a Merged Math Channel

Figure 11-14 contains the Log View of a merged math channel. See Display Log as graph.

12 Measurement Logging

In addition to displaying measurement results graphically on the screen, you may need to gather a larger amount of data and analyze it in a more thorough fashion. Centauri provides the ability to store the data and review it with Ophir's StarLab application, Excel, or other application that suits your needs.

This section describes how to log laser measurement data to a file, which can be stored in the meter's internal memory, or on an external storage device for later upload to a PC.

Topics include:

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

12.1 Log Settings

The Log Settings screen is reached via the Settings screen.

To set the log storage location:

➢ In the Log Settings screen, on the Store to… line, tap USB flash drive/Internal storage, as required.

12.2 Setting Logging Parameters for the Various Stop Modes

You configure the **Stop Mode** parameters to set logging to stop either after a predetermined period of time, number of measurements, or manually from the **Log Settings** screen, reached from the **Settings** menu.

To set the logging parameters for the various Stop modes:

1. In the **Log Settings** screen, on the **Stop Mode** line, tap an option (click the links below for more details):
   - **Manual**: to stop logging manually.
   - **After Time Out**: to stop logging after a predetermined period of time.
   - **After Readings**: to stop logging after a specified number of measurements.

   The available parameters vary per selected **Stop Mode** option.
2. Proceed to configure the selected **Stop Mode** parameters, as described in the following sections.

12.2.1 Manual Mode

In this Stop Mode, logging does not terminate based on a predefined condition. Rather, it continues until the user taps the **Stop** icon.

To set the Stop Mode to Manual:

1. In the **Log Settings** screen, set the **Stop Mode** to **Manual**.

   Several parameters are displayed.

2. For each parameter, set the relevant options, as required:

   - **Sample Rate:** Enables you to control the number of readings that are added to the log. Options include:

     One out of 1

     One out of 3

     One out of 10

     One out of 30

     One out of 100

     One out of 300

     One out of 1000

   - **Store By:** Set logging to store the average of several readings or only one of the group. (If Sample Rate is set to One out of 1, then this parameter is disabled and grayed out.) Options include:

     Sample: Logs only the last reading that was measured. (Reduces log file size by storing only one of several measurements.)

     Average: Stores the average of all of the readings measured since the previous data was added to the log.

12.2.2 After Time Out

In this Stop Mode, logging continues until the **Stop** icon is tapped, or until the user-defined log duration is elapsed.

To set the Stop Mode to After Time:

1. In the **Log Settings** screen, set the **Stop Mode** to **After Time Out**.

   Several parameters are displayed.

2. For each parameter, set the relevant options, as required:

   - **Duration:** User defined period of time. After this time passes, logging stops automatically. The default duration is 1 minute (00:01:00). Tap the current value to display a dialog to set the duration, in hours:minutes:seconds. Click **OK** to save and exit.

   - **Interval:** Time between storing readings (i.e. before a new measurement is added to the log file). The default interval is 00:00:00. (i.e. log each reading) Tap the current value to display a dialog to set the interval, in hours:minutes:seconds. Click **OK** to save and exit.

   - **Store By:** Set logging to store the average of several readings or only one of the group. (If **Interval** is set to 00:00:00, then this parameter is disabled and grayed out.) Options include:

     Sample: Logs only the last reading measured.

     Average: Stores the average of all of the readings since the previous datum was added to the log.

12.2.3 After Readings

In this **Stop Mode**, logging continues until the **Stop** icon is tapped or until the user-defined number of readings is measured.

To set the Stop Mode to After Readings:

1. In the **Log Setup** screen, set the **Stop Mode** to **After Readings**.

   Several parameters are displayed.

2. For each parameter, set the relevant options, as required:

   - **Log Size:** Number of readings that you want to store in the log file, after which logging stops automatically. Tap the current number to display the Set Number of Readings until Stop dialog. Type in the number and tap **Apply** to save and exit.
   - **Sample Rate.** Enables you to control the number of readings to be added to the log. Tap the current value to display the following options:

     One out of 1

     One out of 3

     One out of 10

     One out of 30

     One out of 100

     One out of 300

     One out of 1000

     Tap to select a value and exit.
   - **Store by:** Set logging to store the average of several readings or only one of the group. (If **Sample Rate** is set to **One out of 1**, then this parameter is disabled and grayed out.) Options include:

     Sample: Logs only the last reading that was measured. (Reduces log file size by storing only one of several measurements.)

     Average: Stores the average of all of the readings measured since the previous datum was added to the log.

12.3 Start Logging

Activate logging by tapping the **Start Log** icon in the Log Settings screen, or from the measurement screen.

To start logging:

1. In the **Log Settings** screen tap **Start Log**. The measurement screen displays the display type that was previously selected in the **Display Type** menu, and the following additional parameters at the top of the screen:

   File Name: File name consists of the sensor serial number_number of times logging was performed for this specific sensor on this drive. For example, 328611_00.txt. If there are already log files for this sensor, the appended _00 counter is auto-incremented to the next available value. If two sensors are being logged, the name of the file is Multi_number of times multiple sensors were logged on this drive.txt.

- **Readings**: Number of measurements logged to the file since the start of the present log session.
- **Stop condition display:**
  - If stop mode is Manual, there is a display of time elapsed since starting the present log session.
  - If stop mode is After Time, there is a countdown clock until the time is up.
  - If stop mode is After Readings, there is a counter of the percentage logged.
- **Stop Icon**: You can tap this icon at any time to stop the logging.

2. While logging is active, you can tap the **Stop** icon to stop the logging manually. This stops the logging immediately and saves the data.
3. When logging is completed, the display stops updating and a Log Summary appears. The following is displayed in a message box in the display area, for each sensor:
   - Log file name
   - Time logging stopped
   - Total number of readings
   - Minimum value
   - Maximum value
   - Average value
   - Standard Deviation
   - Overrange
   - Link to the Log View Screen (Review Logged Data)
4. Below the Log Summary is a **Review Log Data** button. Tap the Review Log Data button to display the Log View screen. See Display Log as graph.
5. If **Start Log** is tapped, the logging counters are reset, the display is cleared and activated.

Note: Centauri does not provide the user with the capability to add notes to a log file.

12.4 Stop Logging

You can manually stop the logging. At that point, the Log Summary screen is displayed for each channel, containing the number of Readings, Min, Max, Average, standard deviation, and overrange.

If you tap **Review Logged Data** on the summary screen, the **Log View** screen is displayed. See Display Log as graph.

You can also review the entire log in **Log History**, reached from the **Settings** menu.

12.5 Log History: Accessing Logged Data

You can access a list of log files to view information about a specific log file from the Log History screen.

To access log files:

1. Tap **Log History** in the **Settings** screen.

   The **Log History** screen is displayed.

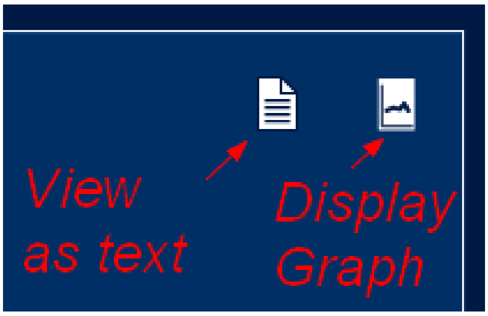
2. Select the location of the desired log files: **USB** or **Internal Storage**.
3. A list of files is displayed, with file name format serial number_xx.txt.
4. Select a file by **highlighting it with a tap**. The statistical summary of that log appears on the right.

Figure 12-1 List of Log Files saved on an external storage device

To display logged data:

There are now two options to display the logged data, via the two icons on the right of the screen.

5. Tap the View as Text icon to view the log file as text. See View Log as Text.
6. Tap the Display Graph icon to display the log file as a graph. See Display Log Graph



12.5.1 View Log as Text

You can view logged measurement data in text form.

Tap the 'View as text' icon for a particular log file, and it will be displayed.

You can scroll through the file by panning up and down

The top of the file (header) contains general information about the settings and equipment models, and log summary information.

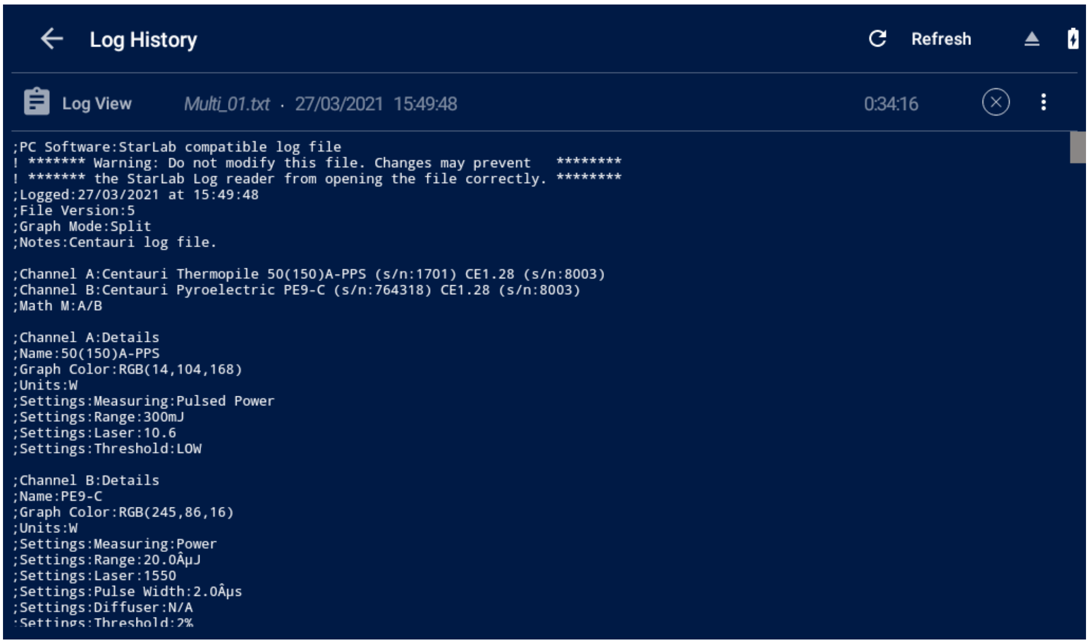


Figure 12-2 Top of text view

Further down the page is the list of logged measurements.

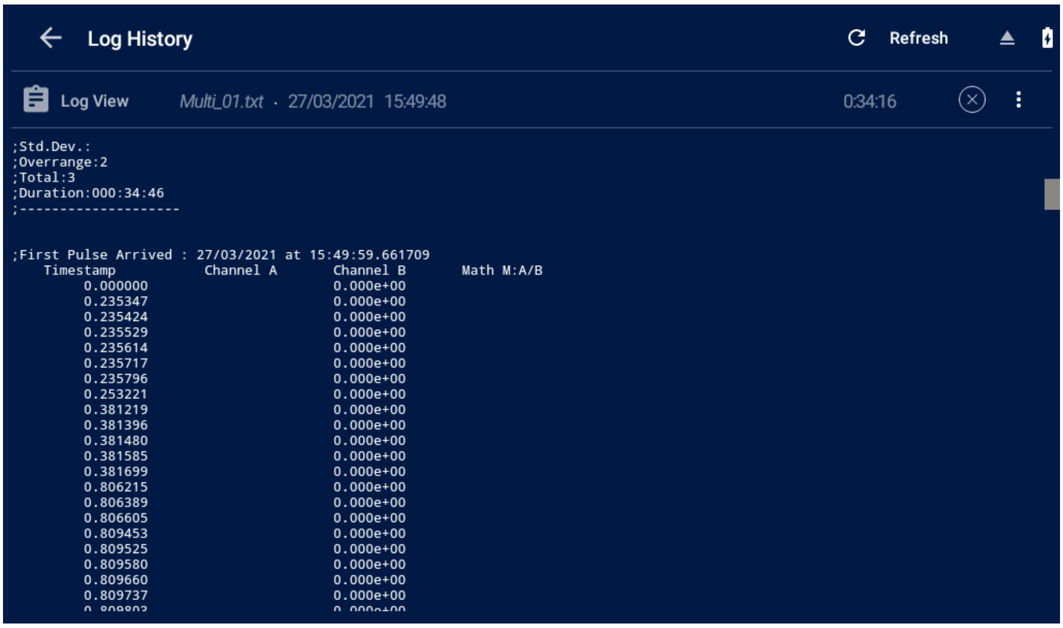


Figure 12-3 Further down in text view

12.5.2 Display Log as graph

You can view logged measurement data as a graph.

Tap the ‘Display Graph” icon for a particular log file, and it will be displayed.

Figure 12-4 Log View Screen with close screen icon highlighted

- The top line displays the name of the file, the date, time, logging time elapsed, a button to close the screen, an icon to allow proper removal of the USB flash drive, and a battery charging indication.

- The second line displays the sensor information
- The third line displays the measurement parameters that were set during the time of the logging.
- The fourth line displays averaging information, standard deviation, min/max values, overrange, total pulses.
- The readings over time are displayed in a graph.
- You can stretch and pinch the graph in either direction with two fingers and move it up and down to pan the display.
- Tap the close icon in the upper right-hand corner of the screen to close this view.

12.5.3 Delete, Copy & Move Log Files

From the Log History screen, you can Delete Copy & Move log files via icons as shown below:

1. Copy – This option is only available for log files in internal storage, enabling you to copy the files to an external storage device for transfer to a PC. After selecting the check box for the file, tap **Copy** to copy the file to a connected flash drive. The name of the new file on the flash drive is displayed in a message on the screen.
2. Move – This option is only available for log files in internal storage, enabling you to move the files to an external storage device for transfer to a PC. After selecting the check box for the file, tap **Move** to move the file to a connected flash drive. The name of the new file on the flash drive is displayed in a message on the screen.
3. Delete – After selecting the check box for the file, tap **Delete** to delete the file from the log history.

12.6 How the Various Types of Average Affect Logged Data

- The **Average** feature selected in the **Functions** screen is a moving average. If enabled, there are two columns in the log file; the first is unprocessed measurements (without any functions applied) and the second includes the moving window average (and any other configured functions).
- If **Store by** is set to **Average** in logging, it applies to each column separately; in the second column it is applied after any functions (including moving window average).
- The statistics in the log file are based on the actual measurements written to the log file, the second column if there are two columns.

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

12.7 Viewing the Log File on Your Computer

In addition to reviewing the logged data on Centauri, you can transfer the data for review at your workstation. You can also view the files directly on StarLab if they were logged through it on the PC.

To view the log file on your computer:

1. If the log files you wish to view were logged to the meter's internal memory, transfer them to a USB flash drive by using the Copy option on the Log History menu. See Delete, Copy & Move Log .
2. Remove the flash drive from the Centauri and attach it to your PC.
3. Start the StarLab application and select the **Logging Menu**.
4. Select **Open Log File**, and select the Log file from the flash drive.

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

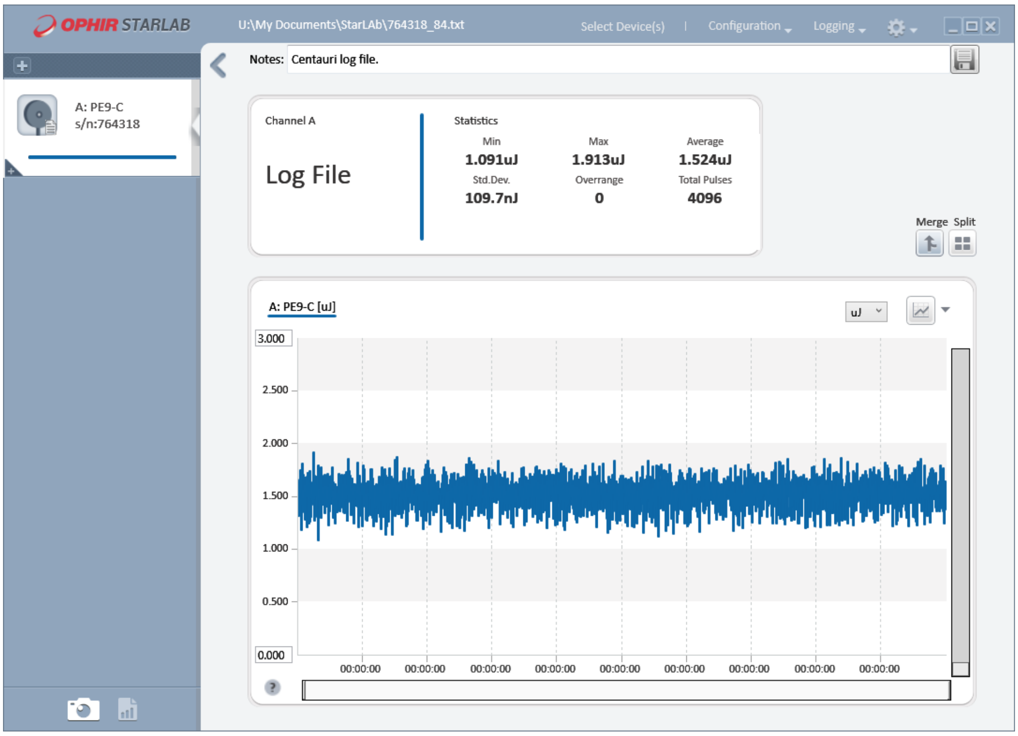


Figure 12-5 Log File in StarLab

13 Circuit Description

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

Topics include:

- Analog Module
- Processor Board

13.1 Analog Module

13.1.1 Analog Circuit

The signal from the detector sensor enters the analog circuit and passes through EMI protection components to a differential trans-impedance preamplifier. From there it is further amplified by a programmable gain voltage amplifier and passes to an Analog-to-Digital (A/D) converter. All calibration data for the analog circuit is stored in a memory chip on the main board. There are no mechanical adjustable components (trimmers, and so on) in the Centauri. 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 thermal sensors, the data is then processed by a sophisticated digital filter that speeds up the effective response time of the sensor and rejects noise.

13.1.2 Fast Analog Input

In addition to the above basic analog circuit, the Centauri contains a second fast analog input. This supports certain Ophir sensors that read energy pulses at higher rates than can be supported by the basic analog circuit, but provides less overall accuracy than the above circuit. The fast analog input consists of an EMI filtered voltage input that is passed to a first stage of mild voltage attenuation. This is then passed to a fast A/D converter. Calibration data is stored on the same memory chip mentioned above. The Analog Module's on board digital processor receives data from the fast A/D converter and translates it into a measurement that can be processed as necessary.

13.1.3 Analog Output

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

13.2 Processor Board

The processor board is built around a VAR-SOM-MX6Q application processor. The digital circuit includes an upgradeable FLASH chip that can be programmed in.

13.2.1 Power Supply

The power supply provides the internal DC supply voltages for both the processor board and the analog module. It also contains the battery charging circuit and the supply for the LCD touchscreen. The power supply circuits consist of high efficiency switch-mode designs.

13.2.2 EMI Protection

The digital processor circuit and the whole Centauri meter are protected by an 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 meter. The meter meets the requirements of the European Community with respect to electromagnetic compatibility and has the “CE” mark.

14 Error Messages and Troubleshooting

14.1 Error Messages

The Centauri 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 charge indicator turns red (only when in a full color user interface scheme, not in a monochrome interface). At this stage, the Centauri should be connected to the charger. It operates normally and charges while connected to the charger. When the battery level is 15% or lower, the Centauri beeps once every ~~five~~ 30 seconds. The low battery audio warning can be stopped either by plugging in the charger or tapping the battery icon.
- 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.

- If enabled, the loudspeaker sounds a beep for audio warnings.

14.2 Troubleshooting

14.2.1 Centauri Meter

Table 14-1 Centauri Meter

Problem	Cause/Remedy
Meter does not operate after being completely discharged and connected to charger.	Verify that charger is providing 12V.
Meter operates with charger but not with battery alone.	Battery is low. Recharge overnight with the Centauri turned off for about 7 hours. If the Centauri still does not work with the battery, then the lithium ion battery is probably dead. Replace the battery (see Battery Replacement).

14.2.2 Thermal Sensors, Energy Measurements

Table 14-2 Thermal Sensors, Energy Measurements

Problem	Cause/Remedy
Meter triggers on background noise or sometimes fails to catch large pulse.	Increase threshold level. See Set Threshold.

Meter does not display Ready for a long while after a reading is made.	Increase threshold level. See Set Threshold.
Non-reproducible results when measuring very small energy pulses; or no response to pulses at low energy.	Decrease threshold level. See Set Threshold.

14.2.3 Thermal Sensors, Power

Table 14-3 Thermal Sensors, Power

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

14.2.4 Pyroelectric Sensors

Table 14-4 Pyroelectric Sensors

Problem	Cause/Remedy
Meter reads incorrectly or erratically, especially on sensitive scale.	Possible electromagnetic interference from pulsing laser is causing misreading and/or false triggering
Meter triggers without being exposed to laser pulses.	Possible vibration via the table causing false triggering. Try mounting the sensor to the stand by using the insulated plastic rod provided with the meter, and not a metal rod. This should help dampen vibrations.
Meter shows a frequency which is too high.	1. Try keeping the cable away from the bench. 2. Move the sensor/display further away from EMI.

14.3 Maintenance

14.3.1 Maintenance of Thermal Sensors

To trace the signal from the thermal sensor to Centauri:

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

14.3.2 Battery Replacement

If the Centauri battery becomes old and defective and does not hold a charge, a replacement can be ordered from your agent (Ophir P/N 7E14009). We recommend that the new battery be installed at one of our service centers.

15 Centauri Specifications

15.1 Meter Specifications

Table 15-1 System/Meter Specifications

Thermal Sensor Input	
Input Ranges	8nA - 25mA full scale in 20 ranges
A to D Sampling rate	15Hz
A to D resolution	23 bits plus sign
Electrical accuracy (up to 1.5mA)	±0.25% ± 20pA new; ±0.5% ±50pA after 1 year
Electrical accuracy (above 1.5mA)	±0.5%
Electrical input noise level	500nV + 0.0015% of input range @3Hz.
Dynamic range	10 decades
Photodiode Sensor Input Slow Mode	
Input Ranges	8nA - 25mA full scale in 20 ranges
A to D Sampling rate	15Hz
A to D resolution	23 bits plus sign
Electrical accuracy (up to 1.5mA)	±0.25% ± 20pA new; ±0.5% ±50pA after 1 year
Electrical accuracy (above 1.5mA)	±0.5%
Electrical input noise level	0.1pA + 0.0015% of input range @3Hz.
Dynamic range	10 decades
Photodiode Sensor Input Fast Mode	
Input Ranges	8nA - 25mA full scale in 20 ranges
A to D Sampling rate	10kHz (10kHz dual)
A to D resolution	12 bits
Electrical accuracy (up to 1.5mA)	±0.25% ± 20pA new; ±0.5% ±50pA after 1 year
Electrical accuracy (above 1.5mA)	±0.5%
Electrical input noise level	1pA + 0.015% of input range @3Hz.

User Adjustable Analog Filters	2nd stage analog filter can be set to BW: None, 0.5Hz, 5Hz, 100Hz, 1kHz, 10kHz, 50kHz, 250kHz
Dynamic range	10 decades
Pyroelectric Sensor Input	
Input Range	0 - 5V full scale
A to D Sampling rate	25kHz
A to D resolution	12 bits no sign (0.025% resolution)
Electrical accuracy	±0.25% new; ±0.5% after 1 year
Electrical input noise	4mV
General Specifications	
Detector Compatibility	Thermal (including BeamTrack), Photodiode and Pyroelectric (PE-C) (including PL05 versions of all)
Unsupported Sensors	BC20
Analog output	User selected 1v, 2v, 5v, or 10v full-scale; 0.03% resolution. 100 ohms impedance
Analog output accuracy	±0.2% (of reading) ±0.3% of full scale volts
Dimensions	200W x 49D x 130H (mm)
Mass	1kg
Display	1024x600 pixel TFT LCD; Active area 154x91mm (7”) Touchscreen Interface
Display digit height	18mm
LCD Backlight	LED’s. Operates from charger or battery. Backlight level is user-adjustable.
Loudspeaker	Yes
Battery	4x Li-Ion 3.7V, 10.4 Amp-hour battery pack built in
Charger input	DC 12-16v, 18W Charge time approx. 7 hours Automatically stops charging when battery is full

Operating Temperature Range	0 – 40 degrees C
Communications	
USB to External Flash Drive	For data logging
PC Interface	USB; RS232 (max baud rate 115200)
Ethernet	RJ45 socket 10/100 Ethernet (10Base-T/100Base-TX)
Ethernet protocols used	HTTP, UDP, DHCP, TCP
Other I/O’s	External Trigger, TTL Output

15.2 Sensor Specifications

Table 15-2 Max Power Specifications of Sensors

Sensor	Max Power (WATTS)	Max Avg. Power Density at Max Power	Absorber Type
PD300/UV/IR	300mW	50W/cm²	PD
PD300-3W	3W	100W/cm²	PD
PD300RM-UV/8W	-	10W/cm²/50W/cm²	PD
IS6	30W	200W/cm²	IS
RM9	100mW	30W/cm²	PE
3A-IS	3W	200W/cm²	Int Sph PD
3A	3W	1000W/cm²	BB
3A-P	3W	50W/cm²	P
3A-P-THz	10THz	50W/cm²	P
3A-FS	3W	1000W/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	0.5KW/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
L40(150)A	35(150)W	12KW/cm²	BB
L40(150)A-LP1	35(150)W	38KW/cm²	LP1
L40(150)A-EX	35(150)W	2KW/cm²	EX
L50(300)A	50(300)W	9.5KW/cm²	BB
L50(300)A-PF-65	50(300)W	3KW/cm²	PF
F150A-BB-26	150W	12KW/cm²	BB
FL250A-BB-35	250W	10KW/cm²	BB
FL400A-BB-50	400W	8.5KW/cm²	BB
FL500A	500W	7KW/cm²	BB

FL600A-LP1-50	600W	11KW/cm²	LP1
FL1100A-BB-65	1100W	5.5KW/cm²	BB
L250W	250W	10KW/cm²	BB
L100(500)A-PF-120	500W	2KW/cm²	PF
1000W/WP-BB-34/ 1000W-LP1-34	1000W	6KW/cm²	BB/BB/LP1
L1500W-BB-50/ L1500W-LP1-50	1500W	4/3.5KW/cm²	BB/LP1
L2000W-BB-120	2000W	60W/cm²	BB
5000W-BB-50/ 5000W-LP1-50	5000W	2KW/cm²	BB/LP1
10K-W-BB-45	10,000W	10KW/cm²	BB
30K-W-BB-74	30,000W	10KW/cm²	BB
100K-W	100,000W	-	-
120K-W	120,000W	-	-
Comet 1K/ Comet 10K	1KW / 10KW	4KW/cm² / 1KW/cm²	BB
BDFL500A-BB-50	500W	7KW/cm²	BB
BDFL1500A-BB-65	1500W	1.5KW/cm²	BB
BD5000W-BB-50	5000W	3KW/cm²	BB
BD10K-W	10,000W	10KW/cm²	BB
3A-QUAD	3W	1KW/cm²	BB
3A-P-QUAD	3W	50W/cm²	P
10A-PPS	10W	28KW/cm²	BB
50(150)A-BB-26-QUAD	50(150)W	12KW/cm²	BB
F150A-BB-26-PPS	150W	12KW/cm²	BB
FL250A-BB-50-PPS	250W	10KW/cm²	BB
1000W-BB-34-QUAD	1000W	6KW/cm²	BB
PD10-C	50mW	50W/cm²	PD
PE9-C/ PE9-ES-C	2W	30W/cm²	PE/PE-ES
PE10BF-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	40W	100W/cm²	PE-DIF

PE50BF-C	25W	20W/cm²	PE-BF
PE50BF-DIF-C/ PE50BF-DIFH-C	40W	200W/cm²	PE-BF-DIF
PE50-DIF-ER-C	60W	500W/cm²	PE-DIF-ER
FPE80BF-DIF-C	200W	120W/cm²	PE-BF-DIF
PE100BF-DIF-C	50W	500W/cm²	PE-BF-DIF

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

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	0.6	7
PF	1.5	1.5	5
N	0.3	1	15
PE Metallic	0.1	0.5	4
PE, BB	0.5	0.5	1
PE-DIF	1	2	20
PE BB-DIF	3	3	10

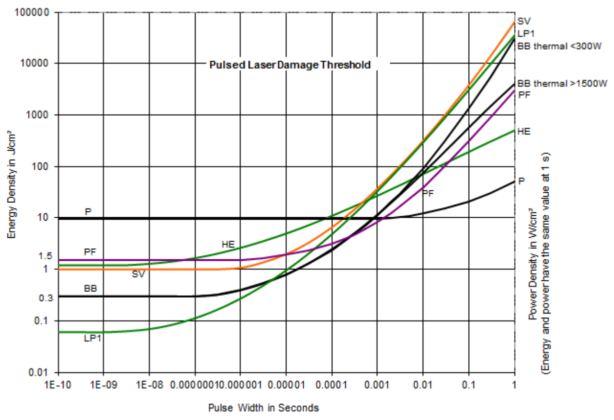


Figure 15-1 Pulsed Laser Damage Threshold for Thermal Sensors

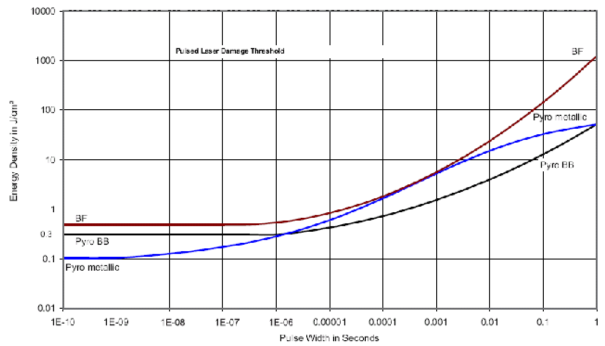


Figure 15-2 Pulsed Laser Damage Threshold for Pyroelectric Sensors

Key

PD - Photodiode

P - P type volume absorber for short pulse lasers

PF - Volume absorber for short pulses and high average powers

HE/HE1 - Volume absorber for high energy pulses

EX - Excimer type, volume absorber

PE - Pyroelectric metallic or black absorber

BB - Broadband surface absorber, high power density

LP1 - Broadband surface absorber for highest power density

BF - Very high damage threshold, long pulses

FS - Fused silica window close to detector for divergent beams

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

Centauri User Manual

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

https://www.ophiropt.com/laser--measurement/laser-power-energy-meters/services/manuals