



1938-R / 2938-R Series Meters

High-End Single and Dual-Channel Optical Meters

User Manual

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1 Introduction

The Newport microprocessor-based **single and dual channel models, 1938-R and 2938-R laser power/energy meters, jointly referred to as the x938 in this manual**, provide a broad range of measurements, displays, and data handling options. The x938 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, the x938 automatically identifies the sensor type, calibration, and configuration. Simply connecting the sensor causes the x938 to reconfigure and calibrate to operate with that sensor.

The x938's 7" full-color touchscreen enhances measurement and user experience. The user interface is intuitive, and can graph power or energy versus time, displaying power measurements in both numerical and graphical form simultaneously. You can zoom in on a graph, subtract background readings or zero the x938 at a touch of a screen.

The x938 can autorange, so you do not have to set Power 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.

The x938 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 Newport's PMManager. It is also capable of real-time reporting of data via USB or Ethernet* to Newport's PMManager application for display and processing of the information. The back panel USB port can be used to connect the x938 directly to PMManager. The x938 also has RS232 and Ethernet capabilities for real-time data reporting to a PC.

*Ethernet connectivity is available from meter firmware version 4.02 up.

The x938 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 x938 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 x938 for all your laser measurement needs. It includes a [Quick Reference](#) (Chapter 3) to enable you to perform basic measurements immediately, without reading the whole manual.

1.2 Related Documentation

Newport takes pride in the wealth of laser measurement information we provide including FAQ's, catalogs, spec sheets, and more. Go to <https://www.newport.com/c/light-analysis>

1.3 Support

If you have a question or require further assistance, contact Newport customer support

<https://www.newport.com/technical-support>

2 Safety Precautions

The following terms and symbols are used in this documentation and appear on the x938 where safety-related issues occur.

2.1 Definitions and Symbols

2.1.1 General Warning or Caution



Figure 2-1 General Warning or Caution Symbol

The Exclamation Symbol in the figure above appears in Warning and Caution tables throughout this document. This symbol designates an area where personal injury or damage to the equipment is possible.

2.1.2 Electric Shock



Figure 2-2 Electrical Shock Symbol

The Electrical Shock Symbol in the figure above appears throughout this manual. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, and personal injury or death.

2.1.3 Alternating voltage symbol



Figure 2-3 Alternating Voltage Symbol

This international symbol implies an alternating voltage or current.

2.1.4 Frame or Chassis



Figure 2-4 Frame or Chassis Terminal Symbol

The symbol in the figure above appears on the 1938/2938 Series Optical Power Meters. This symbol identifies the frame or chassis terminal.

2.1.5 Waste Electrical and Electronic Equipment (WEEE)





Figure 2-5 WEEE Directive Symbol

This symbol on the product or on its packaging indicates that this product must not be disposed of with regular waste. Instead, it is the user responsibility to dispose of waste equipment according to the local laws. The separate collection and recycling of the waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For information about where the user can drop off the waste equipment for recycling, please contact your local Newport Corporation representative.

2.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that are used throughout this manual to call your attention to important information regarding your safety, the safety and preservation of your equipment or an important tip.


	WARNING Situation has the potential to cause bodily harm or death.
	CAUTION Situation has the potential to cause damage to property or equipment.

NOTE: Additional information the user or operator should consider.

2.2.1 General Warnings

Observe these general warnings when operating this equipment:

- Heed all warnings on the unit and in the operating instructions.
- Do not use this equipment in or near water.
- This equipment is grounded through the grounding conductor of the power cord.
- Route power cords and other cables so they are not likely to be damaged.
- Disconnect power before cleaning the equipment. Do not use liquid or aerosol cleaners; use only a damp lint-free cloth.
- To avoid explosion, do not operate this equipment in an explosive atmosphere.

	<p style="text-align: center;">WARNING</p> <p>Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.</p>
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2.2.2 General Cautions

Observe these cautions when operating this equipment:

- If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.
- Do not block ventilation openings.
- Do not position this product in such a manner that would make it difficult to disconnect the power cord.
- Follow precautions for static sensitive devices when handling this equipment.
- This product should only be powered as described in the manual.
- There are no user-serviceable parts inside the x938 Series Optical Power Meters.
- To prevent damage to the equipment, read the instructions in the equipment manual for proper input voltage.
- Adhere to good laser safety practices when using this equipment.

3 Quick Reference

This section provides a quick reference for performing basic measurements with the x938 Laser Power/Energy meter.

3.1 Getting Started

The x938 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.

All Newport 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. The x938 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.

The Channel Options menu, reached by tapping the green down arrow 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 x938 meter:

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

To switch the x938 on:

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

To switch the x938 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 x938 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**.

7.

3.2 Thermal Sensors

3.2.1 Using x938 with Thermal Sensors

1. Plug in the thermal sensor. The x938 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.

The x938 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 chapter [16.2 Sensor Specifications](#)16.2. Otherwise, there is a risk of damaging the absorber.

3.2.2 Using x938 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.

3.2.3 Using x938 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 x938 screen flashes READY, fire the laser.

3.3 Photodiode Sensors

3.3.1 Using x938 with Photodiode Sensors

1. Plug in the photodiode sensor. The x938 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. The x938 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 chapter 16.2 [16.2 Sensor Specifications](#). Otherwise, there is a risk of damaging the sensor.

3.3.2 Setting the Measurement Parameters

1. Set **Range** to the appropriate manual range or **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** on the meter when using photodiode sensors which have physically removable attenuating filters.

When using the 918D series of sensors which have built-in filter state detection, the filter status is detected and set automatically on the meter when changing the In Out position of the integrated filter.

3.3.3 Measuring Exposure

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.

3.3.4 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.

3.3.5 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.

3.4 Pyroelectric or Photodiode Energy Sensors

3.4.1 Using x938 with Energy Sensors

1. Plug in the pyroelectric/photodiode energy sensor. The x938 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.

The x938 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 chapter [16.2 Sensor Specifications](#) Otherwise, there is a risk of damaging the absorber.

3.4.2 Zeroing the Meter with the Sensor

For the most accurate calibration, zero the energy sensor with the x938 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**.

3.4.3 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.

3.4.4 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.

3.5 Graphical Displays

To present measurements on a graduated scale (bargraph):


1. In **Power** or **Energy** mode, tap the **Channel Options** green arrow icon  then tap **Other Settings** then 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 $\pm 5x$ 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** green arrow icon  then tap **Other Settings** then 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 $\pm 5x$ 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** green arrow icon  then tap **Other Settings** then 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** or **Energy** mode, tap the **Channel Options** green arrow icon  then tap **Other Settings** then tap **Display Type**.

2. Select **Pulse**.

The main sensor measurement screen displays the relevant pulse graph.


1. Zoom and un-zoom the display by stretching and pinching the graph with two fingers, either top to bottom or side to side.
2. Pan the display by moving your finger up and down on the graph.
3. Double-tap the graph to reset the zoom and pan.
4. Tap **Autoscale Y Axis** along the bottom of the screen to scale the axis between the minimum and maximum readings.
5. 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** green arrow icon  then tap **Other Settings** then 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** green arrow icon  then tap **Other Settings** then 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 Overage.
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 (PEPS sensors only):


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

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

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

3.6 Functions

To enter the Functions menu:

- Tap the **Channel Options** green arrow icon 
- Then tap **Other Settings**.
- Then tap **Functions**

To average displayed measurements:

This function calculates a moving average and is applied only to numerical results, not graphs.

On the **Average/Aggregation** selection box, tap and select to set to **Average**

In the time selection box, set the period you wish to average power over.

To measure Peak-to-Peak power

Detects the peak and minimum power over a set time period, and calculates the difference.

On the **Average/Aggregation** selection box, tap and select to set to **Peak-to-Peak**

Tap the displayed time (ms) to set the period you wish to perform Peak-to-Peak detection over.

To display the RMS of measurements

This function calculates the Root Mean Square of the measurement over a set time period.

On the **Average/Aggregation** selection box, tap and select to set to **RMS**

Tap the displayed time (ms) to set the period you wish to perform Peak-to-Peak detection over.

To apply a fixed offset to measurements:

This sets the value to subtract from subsequent measurements.

On the **Functions** screen, tap the edit icon for **Fixed Offset**.

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.

On the **Functions** screen, tap the edit icon for **Scale Factor**.

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.

On the Functions screen, tap the edit icon for **Normalize**.

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:

On the **Functions** screen, tap the edit icon for **Density**.

In the **Set Density Parameters** dialog, select the beam shape and then enter the size. Tap **Apply**.

Measurements are shown as W/cm^2 .

3.7 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 x938 on a PC from the PMManager application, and use PMManager to log and analyze data on the PC. For details, see [Measurement Logging](#) .

4 Using the x938 Meter

This section describes the x938 meter, hardware functions, firmware upgrade, interfaces, and general operation.

Topics include:

- [x938 Hardware Components and Interfaces](#)
- Zero Adjustment
- Offset
- [Using the Settings Menu](#)
- [Configuring Measurements](#)
- [Using PMManager](#)

4.1 The x938 Meter

- The Back panel has the following sockets: AC Power Input and power supply On/OFF 'hard' switch, RS232, Ethernet and USB ports, TRIG IN BNC connector, and channel/s – two channels with the 2938-R model - including for each channel a sensor input, and BNC Analogue and TTL outputs. The WiFi antenna socket is for future use.

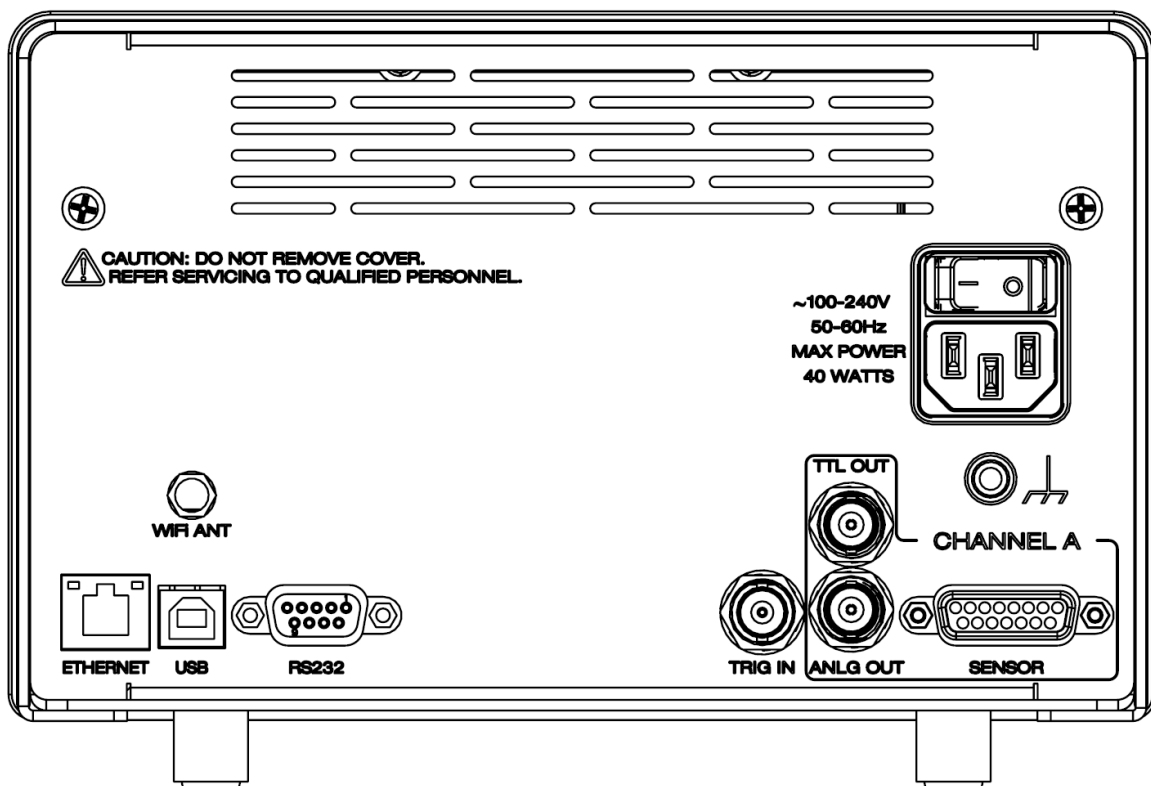


Figure 4-1 1938-R Single Channel Back Panel

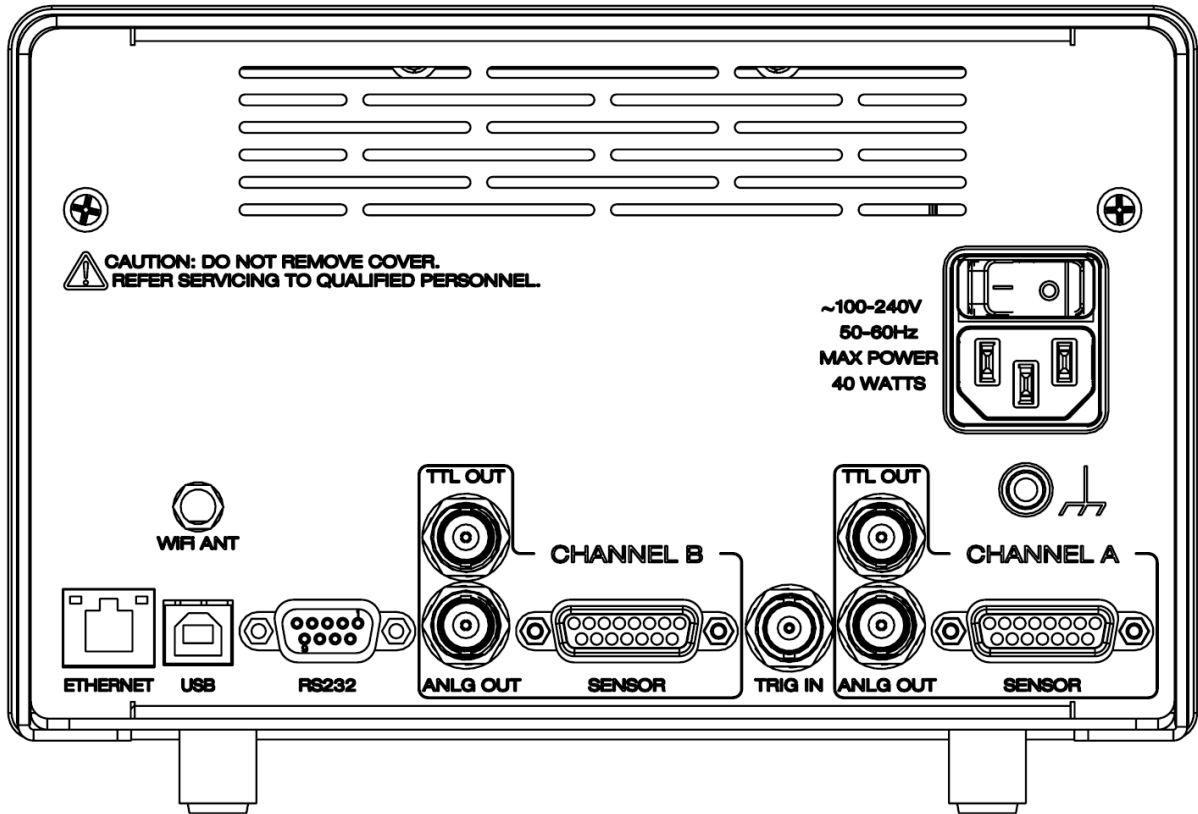


Figure 4-2 2938-R Dual Channel Back Panel

- The front panel of the x938 meter has a 7 " color touchscreen, a ON/OFF illuminated push button, USB socket for attaching a USB flash drive, and a pinhole for access to a micro-switch for field firmware upgrade. The front panel is the same for both 1938-R and 2938-R meters.

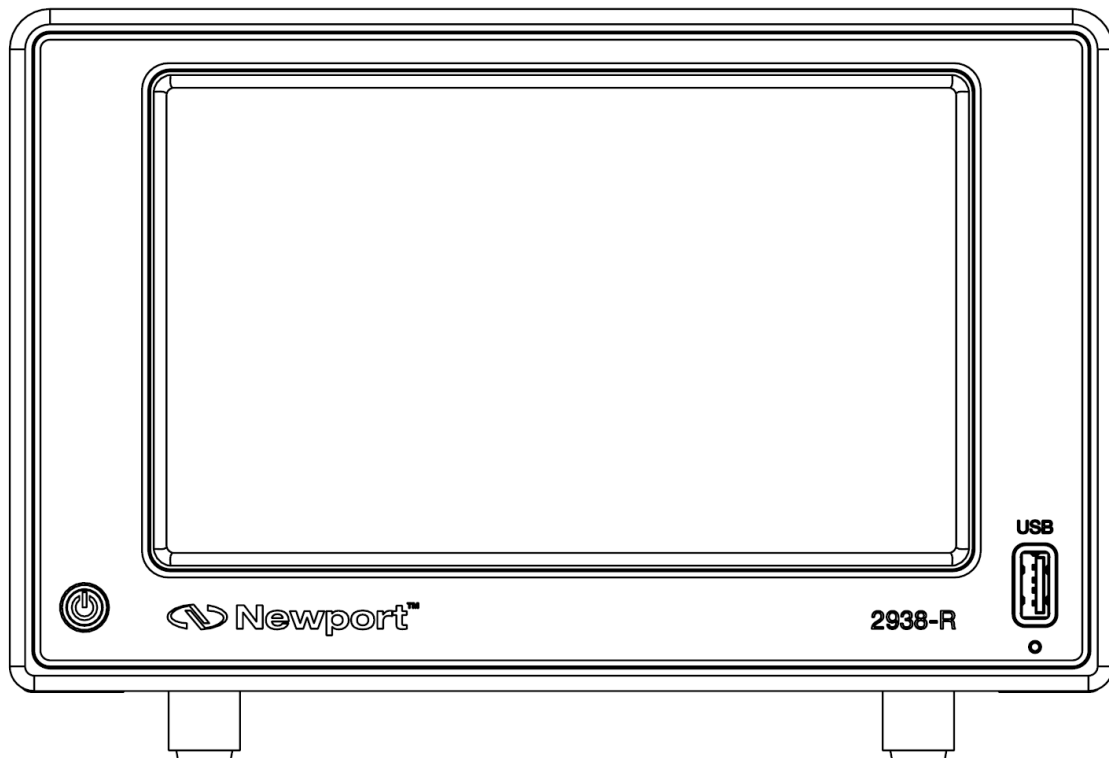


Figure 4-3 x938 Front Panel

4.2 x938 Hardware Components and Interfaces

This section describes the x938 hardware components and interfaces.

Switch

4.2.1 Sensor Input

The Sensor Input, located on the back 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 4-4](#) below.

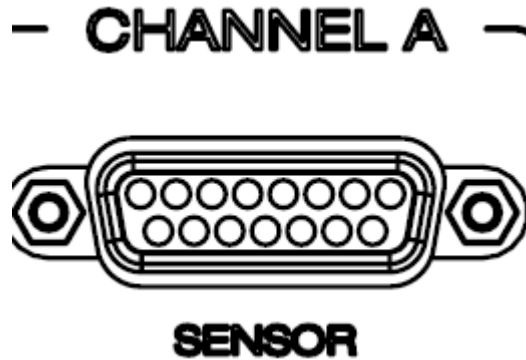


Figure 4-4 x938 Back Panel sensor input

To connect a sensor to the x938 meter:

Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor** on the back panel of the x938 meter. If using the 2938-R dual channel meter, you can use either or both of these sockets at the back of the meter. When two sensors are connected, the measurement screen is split, and displays data and allows configuration for both channels.

4.2.2 Switching ON and OFF

This section describes how to switch the x938 on and off.

To switch the x938 on:

- Make sure the mains power supply switch at the back of the meter is switched ON.
- Briefly press the power button in the front of the meter and wait a few seconds for the introductory splash screens logos to finish and for the measurement display screen to 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 configurations and the log history.

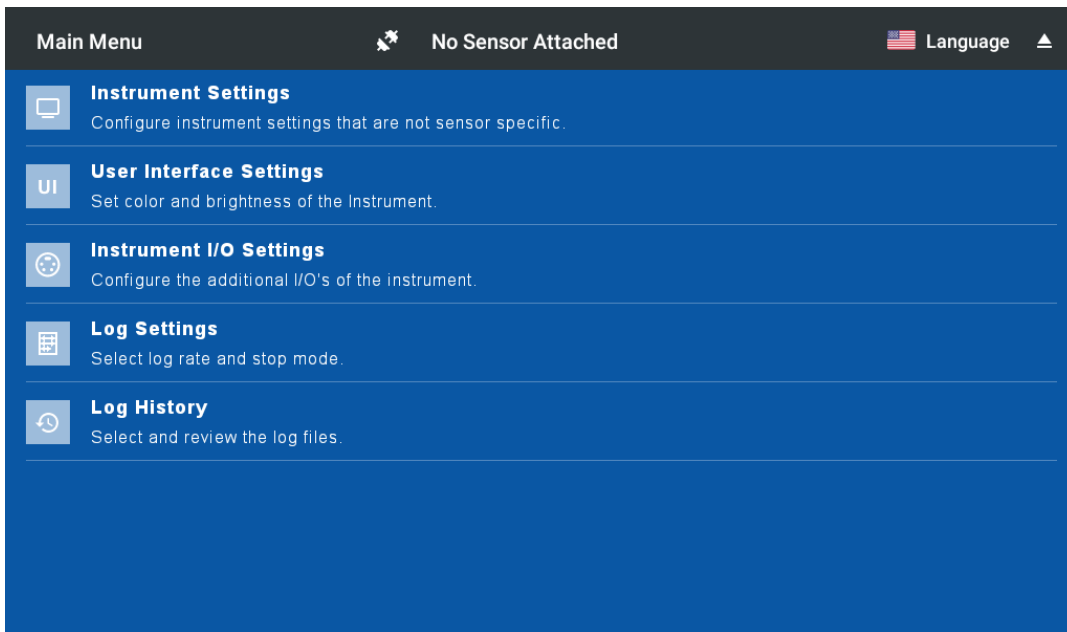


Figure 4-5 Main Settings Menu

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:

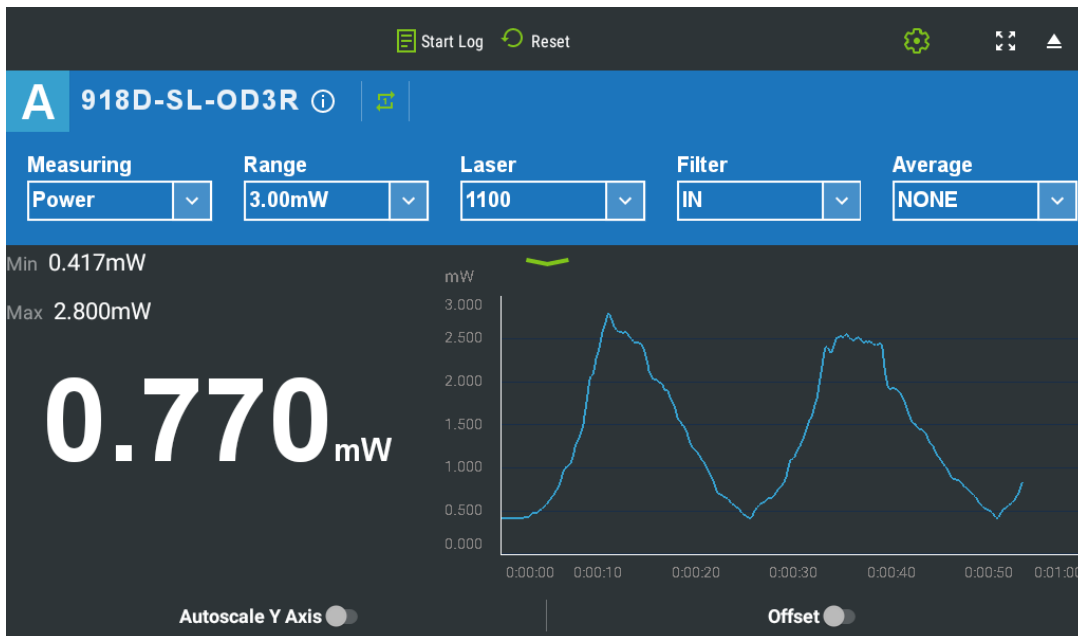


Figure 4-6 Line Graph Display

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](#), [PEPS Sensors](#), and [Pyroelectric and Photodiode Energy Sensors](#) for more information on configuring measurements with specific sensors.

To switch the x938 off:

- Press the front panel power button for a few seconds until the meter turns off.

4.2.3 x938 Touchscreen User Interface

The x938 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 4-7 below displays the layout of a typical x938 measurement screen.

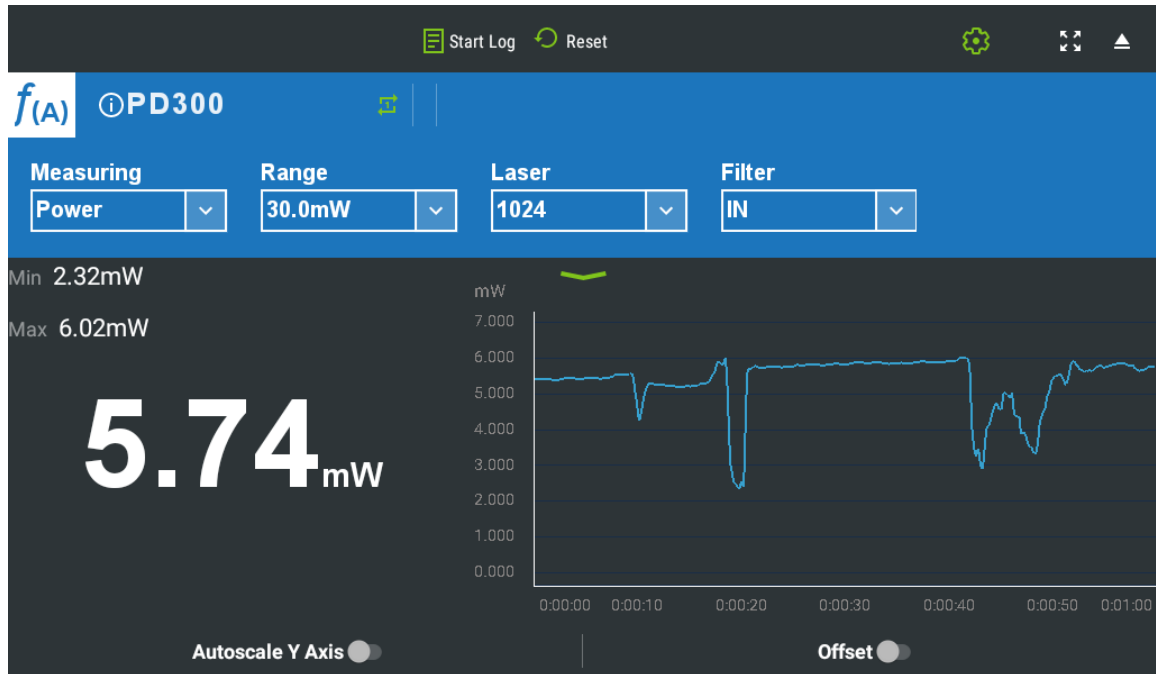


Figure 4-7 x938 Measurement Screen Layout

When a sensor is attached to the x938, 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, expand screen, and a battery power indicator.
- The second line contains the sensor name and a circled i icon which opens a window containing detailed sensor information. **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.
- An f indication will appear when one or more math functions are set.
- 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, Filter IN/OUT, 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.

4.2.4 Analog Output

The x938 provides an analog voltage output via a BNC socket on the rear panel marked **ANLG OUT** (see [Figure 4-8](#)). 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.

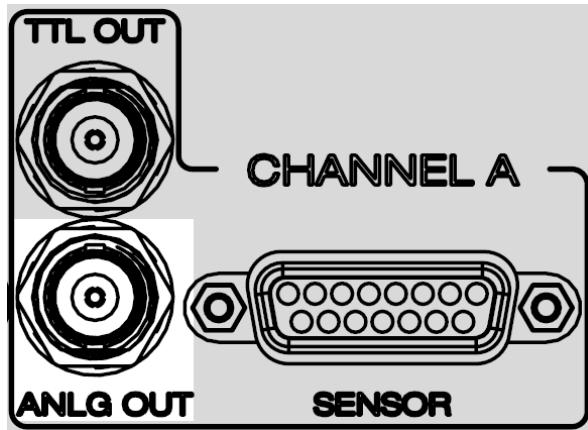



Figure 4-8 x938 Analog Output socket

To set the analog output voltage:

1. From the sensor measurement screen, tap the **Channel Options** green arrow icon  then tap **Other Settings** then tap **H/W Settings**.

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

2. To the right of **Analog Output** is a max voltage selection box, 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.

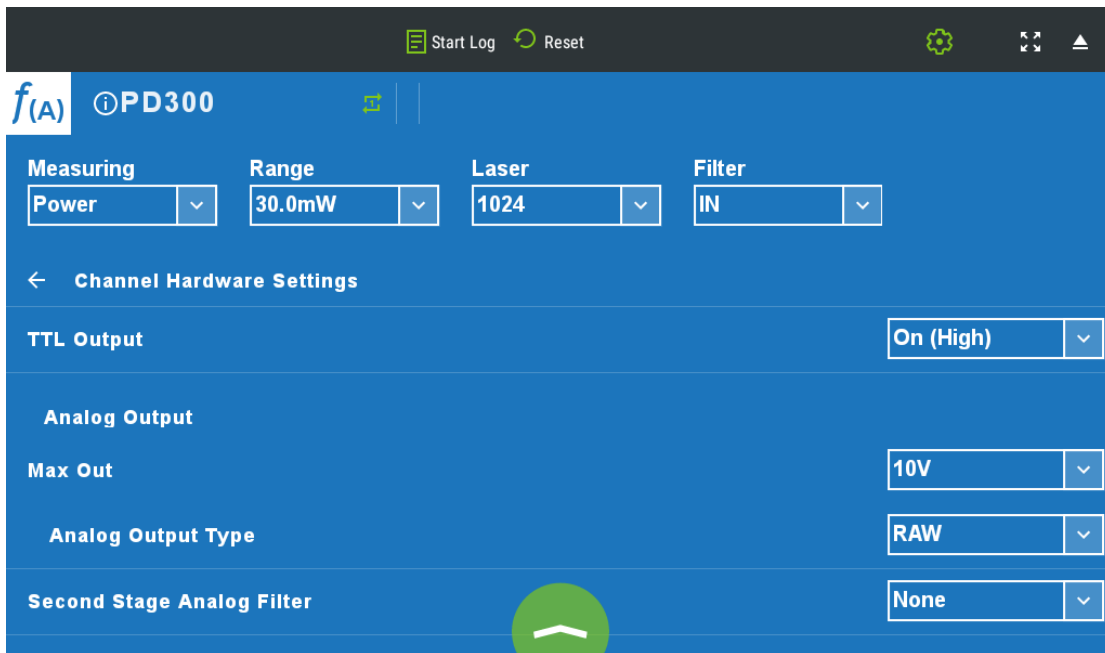


Figure 4-9 Channel Hardware Settings Screen

Analog Output: Digital

The digital output is the analog voltage representation of the measured (processed) laser power as displayed on the x938 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 15 times per second with the latest pulse energy.

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

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** green arrow icon  then tap **Other Settings** then tap **H/W Settings**.


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

2. From the **Analog Output Type** selection box, 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** green arrow icon  then tap **Other Settings** then tap **H/W Settings**.

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

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

4.2.5 RS232

The x938 is equipped for RS232 communications.

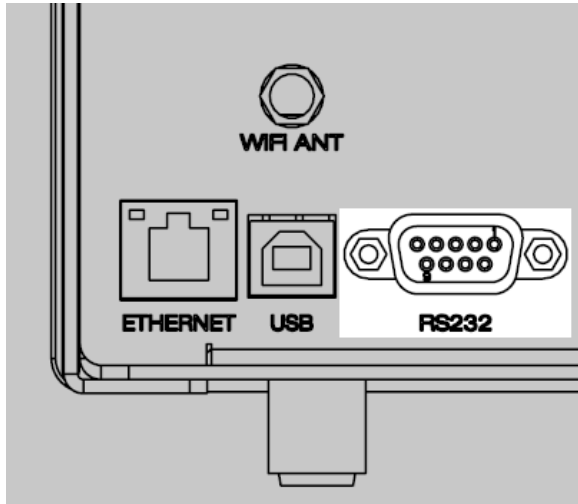


Figure 4-10 x938 Rear View with RS232 input highlighted

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.

4.2.6 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).

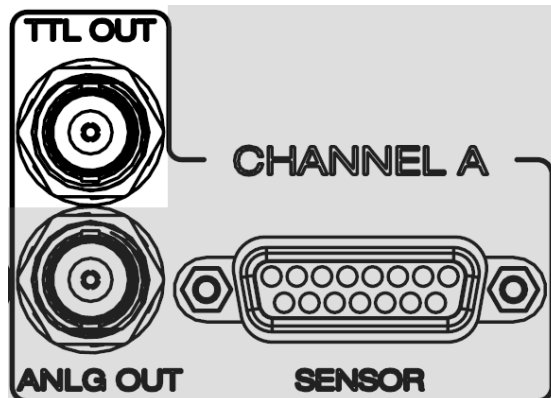


Figure 4-11 TTL Output

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 0 volts.
- On (High) – The TTL Output is set to output 5 volts.
- Signal on Error – The TTL output is set to High 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 readings 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.

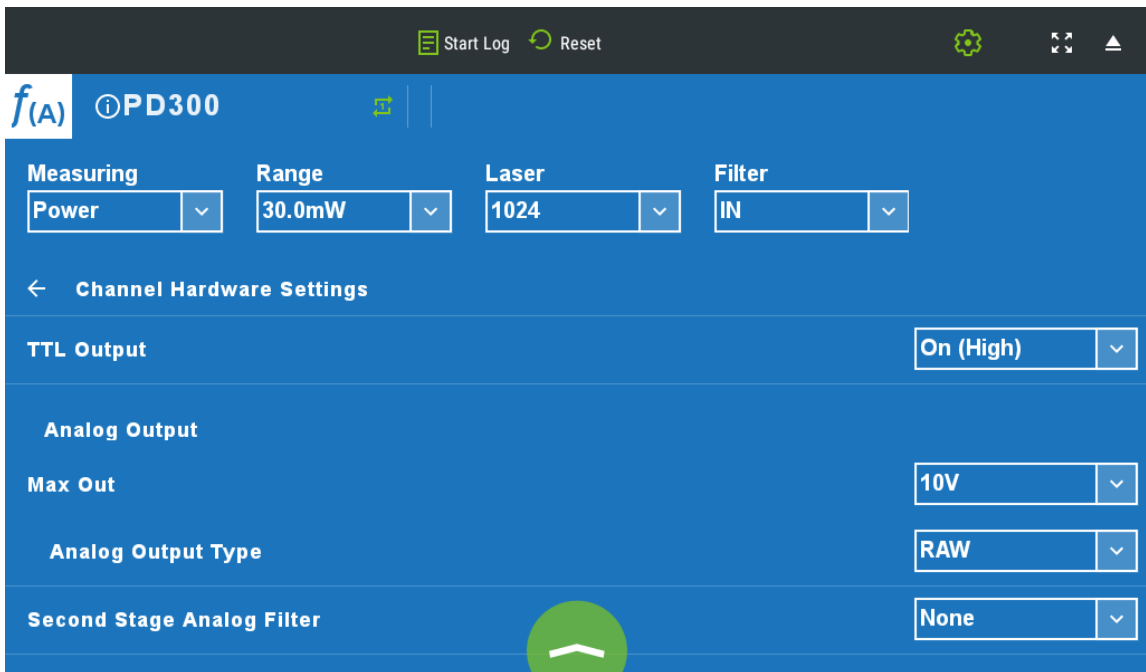


Figure 4-12 Channel Hardware Settings Screen

4.2.7 External Trigger

The x938 includes an External Trigger BNC connector.

The one TRIG IN input can be utilised with either of both channels when using the dual channel 2938-R meter.

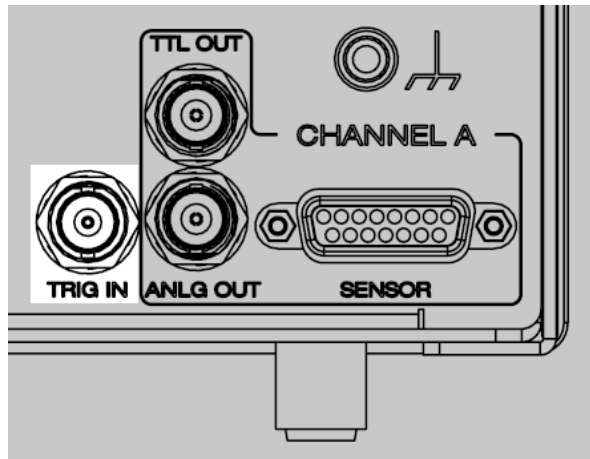


Figure 4-13 x938 Rear View with TRIG IN highlighted

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 x938 measures any 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.

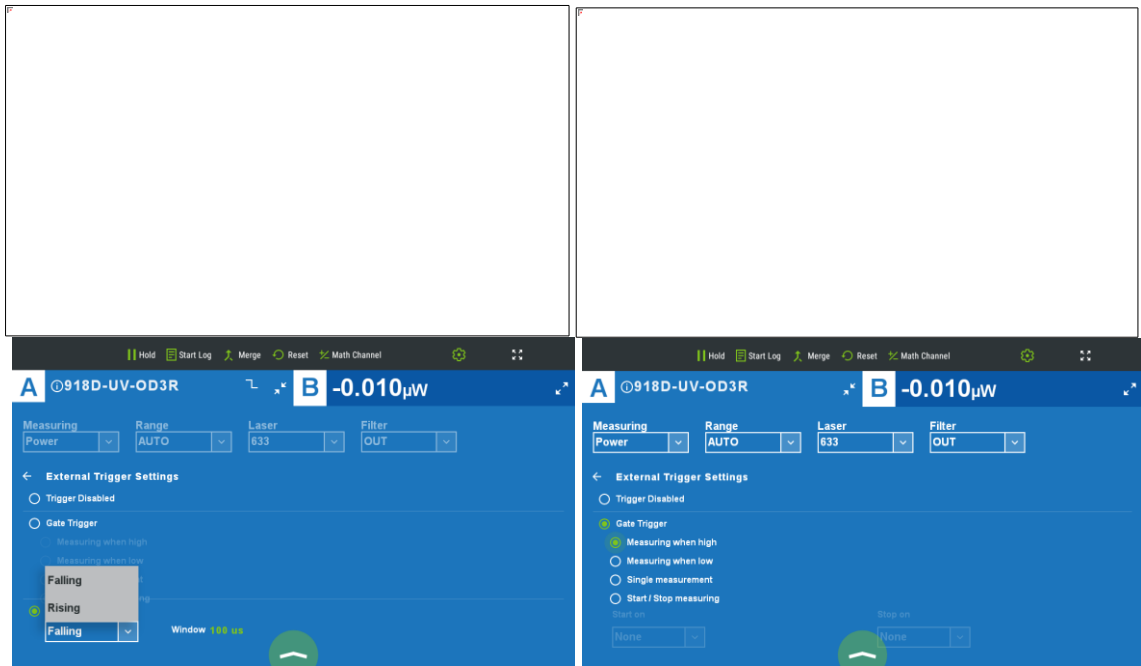
- Trigger on Falling Edge:

This trigger mode applies to PyroC sensors only.


In this mode, the x938 measures any 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.



To set the external trigger:

1. Tap the **Channel Options** green arrow icon  then tap **Other Settings** then tap **H/W Settings**
2. Swipe up in the H/W Settings display, and then tap on the status (in green text) of the **External Trigger Settings**, then the dialog is displayed.
3. Tap the Pulse Trigger for Rising Edge, Falling Edge.

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. Tap the Gate Trigger for High, Low, Single, Start/Stop Triggering

Table 1-1 External Trigger Input Modes

Input Mode	Description
Rising Edge	<ul style="list-style-type: none"> • 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 <i>after</i> 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	<ul style="list-style-type: none"> • 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 <i>after</i> 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.

4.2.8 USB PC Interface Socket

The back panel USB socket enables connecting the meter to a PC, for use with an application such as PMManager. Connecting to PMManager enables full remote control of the x938. When the connection is made with the PC application, the x938 touch screen is locked to prevent conflict with the PC application, and “Touch Response Locked” is displayed at the top of the x938 screen.

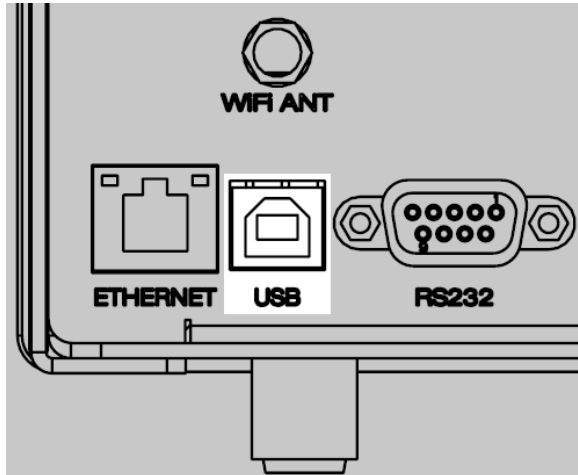


Figure 4-14 x938 Rear View with USB socket highlighted

4.2.9 USB Flash Drive Socket

The USB front panel input socket enables connection of an external USB Flash Drive storage device. The storage device is required for performing field upgrade and is also used for transferring recorded log files to a PC for analysis using an application such as PMManager.

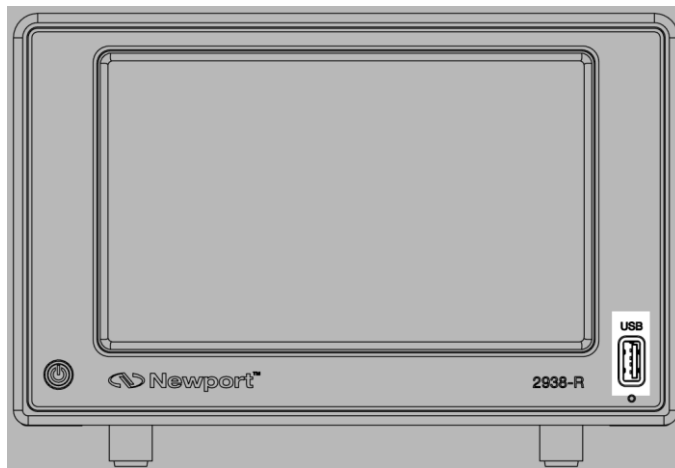


Figure 4-15 x938 Front View with USB highlighted

When removing the external storage device from the x938, first tap the ‘eject’ triangle icon on the upper right-hand side of the screen and wait a few moments for the flash drive to disconnect and the for the icon to disappear. See Figure 4-16

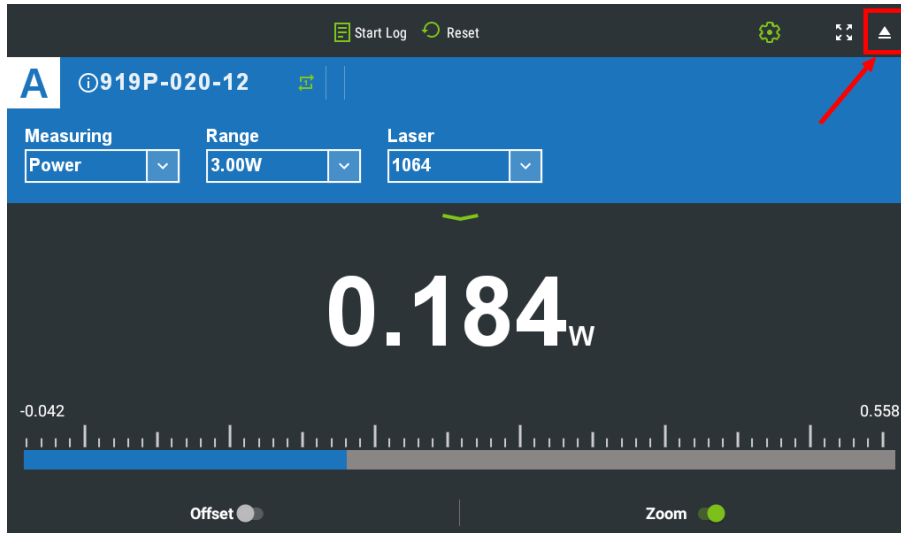


Figure 4-16 x938 Screen with USB Flash Drive release icon highlighted

4.2.10 Field Upgrade of the x938 Firmware

The x938 has the necessary infrastructure for performing field upgrade of the embedded software.

To update the x938 firmware:

1. Download the latest x938 firmware upgrade package from the Newport website:
<https://www.newport.com/c/optical-meters>
2. The upgrade package is contained as a folder within a ZIP file. Extract from the ZIP file the folder (called 'x938_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 front panel of the meter (see Figure 3-20).

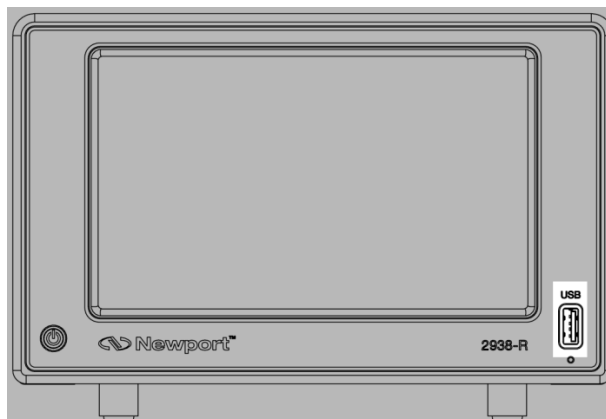


Figure 4-17 Front panel of x938 Meter with USB input highlighted

4. Insert a pin in the pinhole (see Figure 4-18) to access the micro-switch.
5. Turn on the x938 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 x938 restarts with the new firmware version.

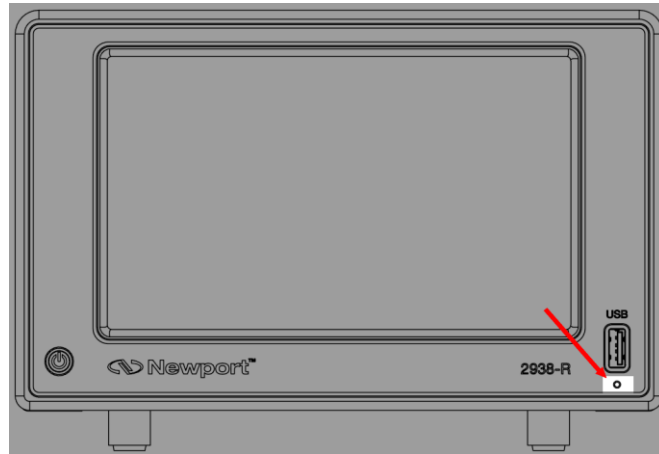


Figure 4-18 Right side of x938 Meter with pinhole highlighted

4.2.11 Loudspeaker

The loudspeaker allows the x938 to sound audio warnings. Perforations for the speaker are located towards the front of the bottom panel. The volume and types of audio warnings are configured on the User Interface Settings page.

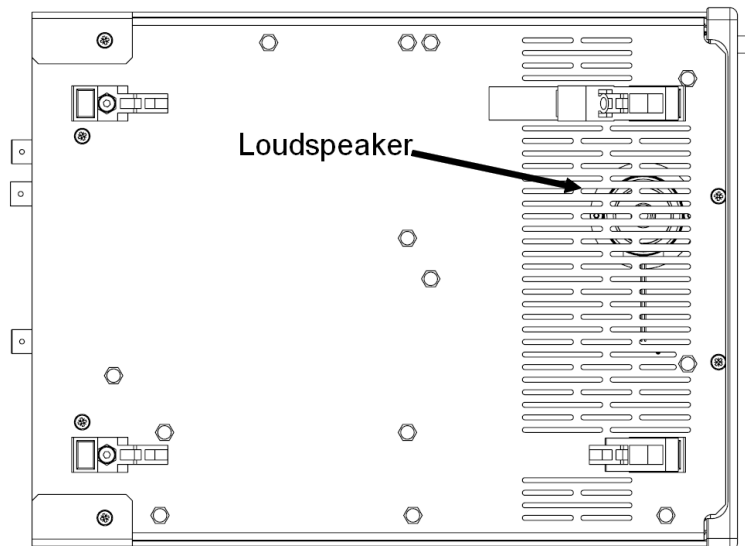


Figure 4-19 x938 Bottom Panel with speaker highlighted

If enabled, the loudspeaker sounds beeps 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.

4.2.12 WiFi Antenna Socket

For future use

4.2.13 Ethernet Communication

Ethernet connectivity is available from meter firmware version 4.02 up.

The back panel Ethernet socket enables connecting the meter to a PC, for use with an application such as PMManager. Connecting to PMManager enables full remote control of the x938. When the connection is made with the PC application, the x938 touch screen is locked to prevent conflict with the PC application, and “Touch Response Locked” is displayed at the top of the x938 screen.

4.3 Zero Adjustment

This section provides a complete overview of zeroing related with the x938.

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 x938 run for at least 10 minutes before performing zero adjustment.
3. Tap the **Settings** icon at the top of the screen. The **Settings** screen is displayed.
4. Tap **Instrument Settings**.
5. From the **Instrument Settings** screen, tap **Zero** at the top of the screen.
The **Zeroing Instrument** dialog is displayed.
6. Tap **Start**. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” appears.
7. 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 x938 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.

4.4 Offset

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

4.4.1 For Thermal and Photodiode Sensors Measuring Power

The Offset function can be used to subtract the residual background signal, if desired. The same holds true when the ambient environment has a thermal background, such that x938 shows a non-zero power reading even when there is no laser: you can subtract the background using the Offset function. For example, the x938 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 x938 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 4-20 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.

4.4.2 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.

4.4.3 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.

4.4.4 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 $0 - (-10) = 10\text{dB}$.

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.

4.5 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.

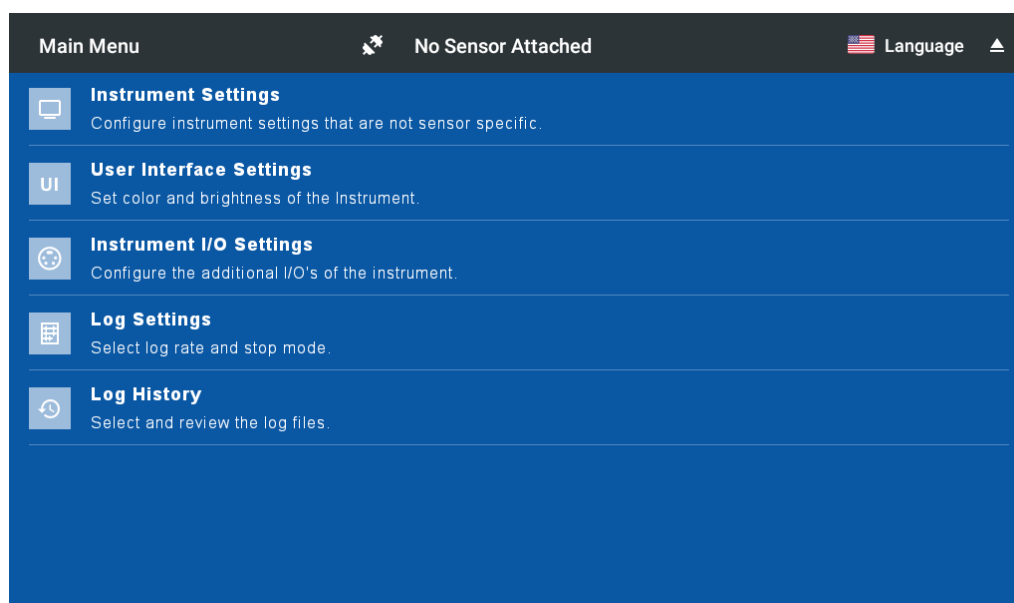


Figure 4-21 Main Settings Menu

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:

- Real-Time Clock
- Line Frequency
- Color Scheme
- Brightness Control
- Audio Warnings
- RS232 Baud Rate
- Log Settings
- Log History

When no sensor is connected, the x938 **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.

4.5.1 Instrument Settings

This screen displays the meter's serial number, firmware version, last calibration date and the next calibration date.

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

The x938 automatically saves all current settings for the next time the meter is turned on.

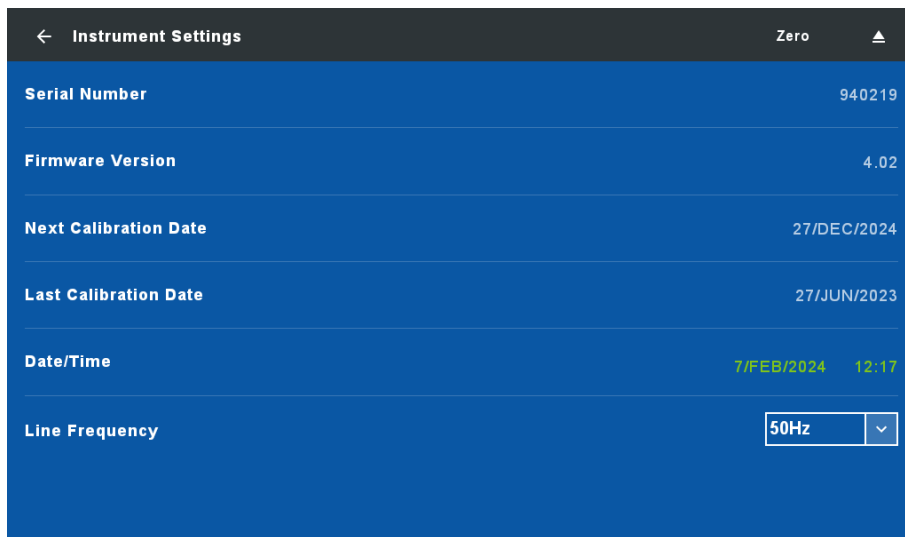


Figure 4-22 Instrument Settings Screen

Real-Time Clock

The x938 is equipped with a real time clock which enables setting the present date and time in the meter. The date and time are preserved, even when the mains power supply is disconnected, by an internal 3 Volt coin cell battery.



The internal 3 Volt coin cell battery is a non-rechargeable battery.

Do not attempt to charge it.

The real time clock is used for assigning a timestamp to each measurement when logging.

The real time clock also facilitates onscreen notifications if either the sensor or meter is due for calibration – see the section on Calibration Reminders in this manual.

You can set the date and time as follows: -

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.

4.5.2 User Interface Settings

This screen enables setting the color scheme and brightness of the x938 display, the interface language, and configuration of audio warning.

Color Scheme

You can configure the x938 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**



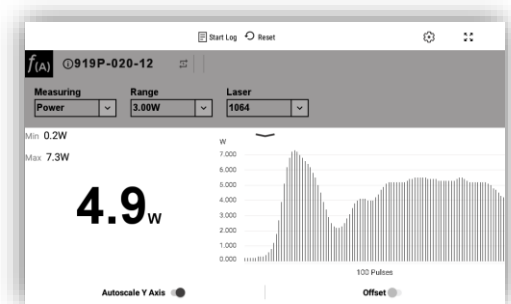
Monochrome

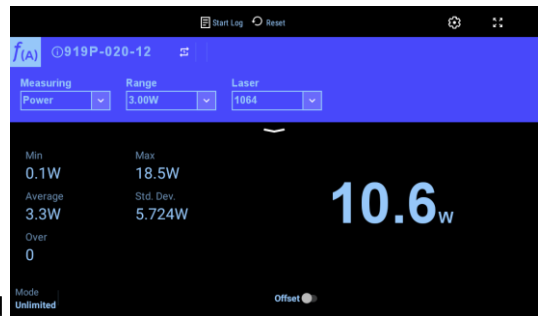
Monochrome schemes are for use with lasers that demand use of protective glasses that filter out colors in the visible part of the wavelength spectrum. Color-enhanced features are not functional in the monochrome screens.

To set the screen color scheme to monochrome:

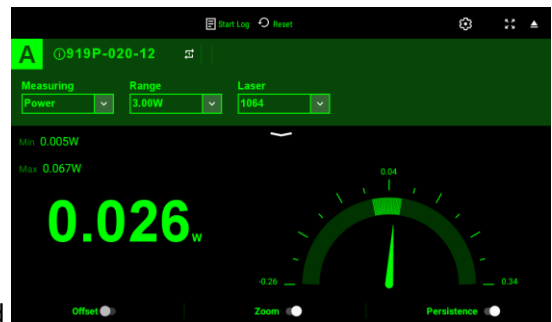
1. From the **Settings** screen, tap **User Interface Settings**.
2. On the **Color Scheme** line, tap the current color scheme and then tap to select one of the following color schemes:

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

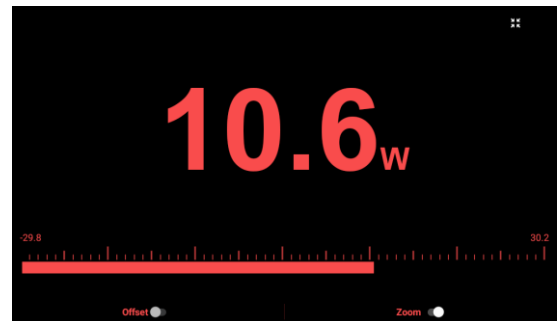




- **Blue on Black:** Sky blue text on black background



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



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

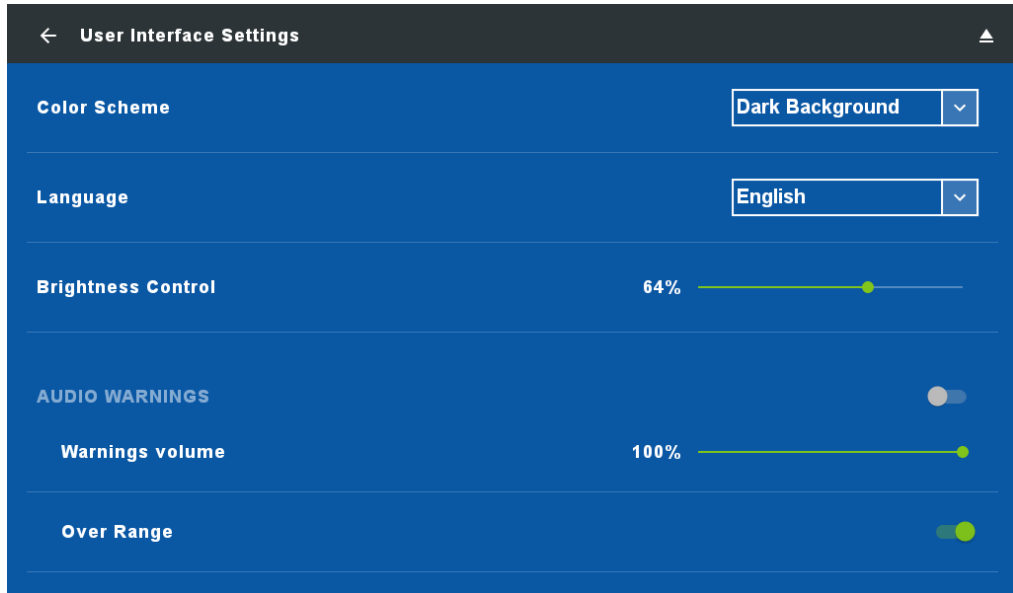


Figure 4-23 User Interface Settings Screen

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.

Language

The language selection can be 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

4.5.3 Instrument I/O Settings

You can configure additional I/O settings for x938 from the Instrument I/O Settings screen

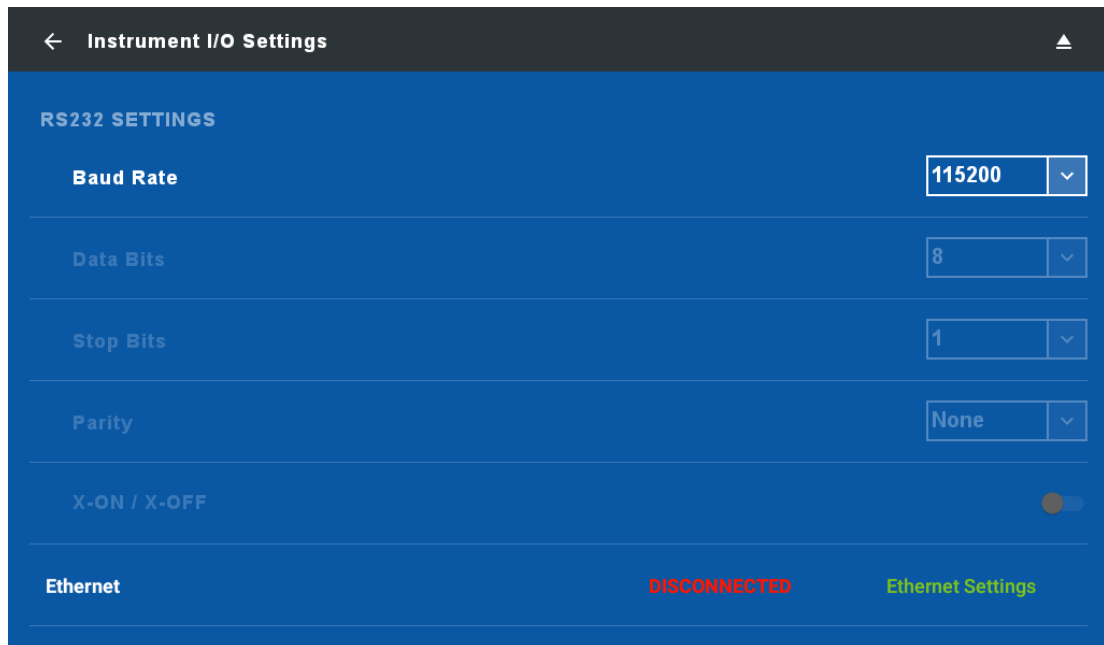


Figure 4-24 Instrument I/O Settings Screen

RS232 Baud Rate

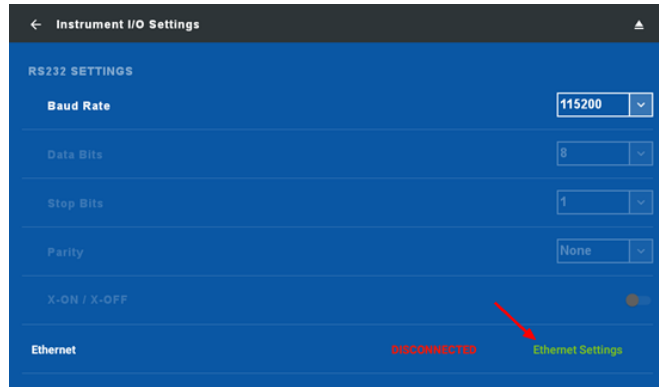
You can set the baud rate for communication through the x938 serial COM port. For further information see RS232.

Ethernet Connectivity

You can setup Ethernet configuration for communication through the Ethernet port.

***Ethernet connectivity is available from meter firmware version 4.02 up.**

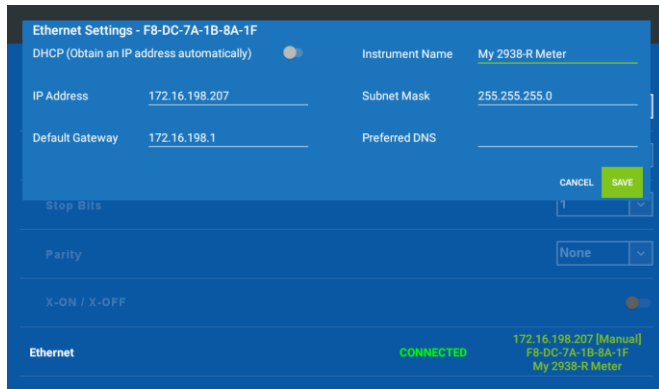
When the meter is not connected via Ethernet, 'Disconnected' will appear in red.



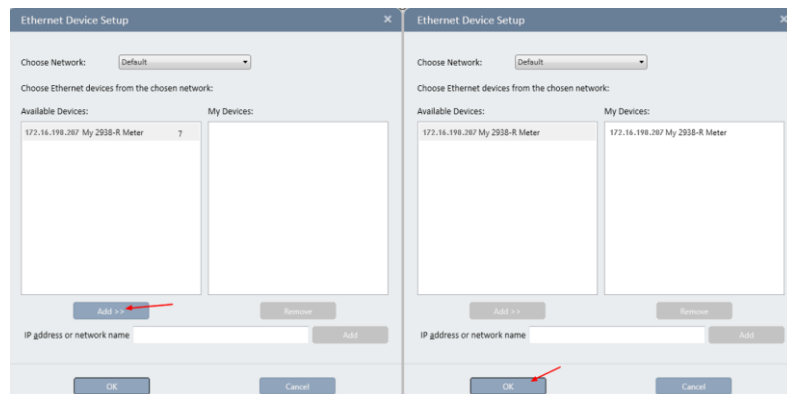
When the meter is connected via Ethernet, 'Connected' will appear in green.

Selecting 'Ethernet Settings' will open a window with various fields.

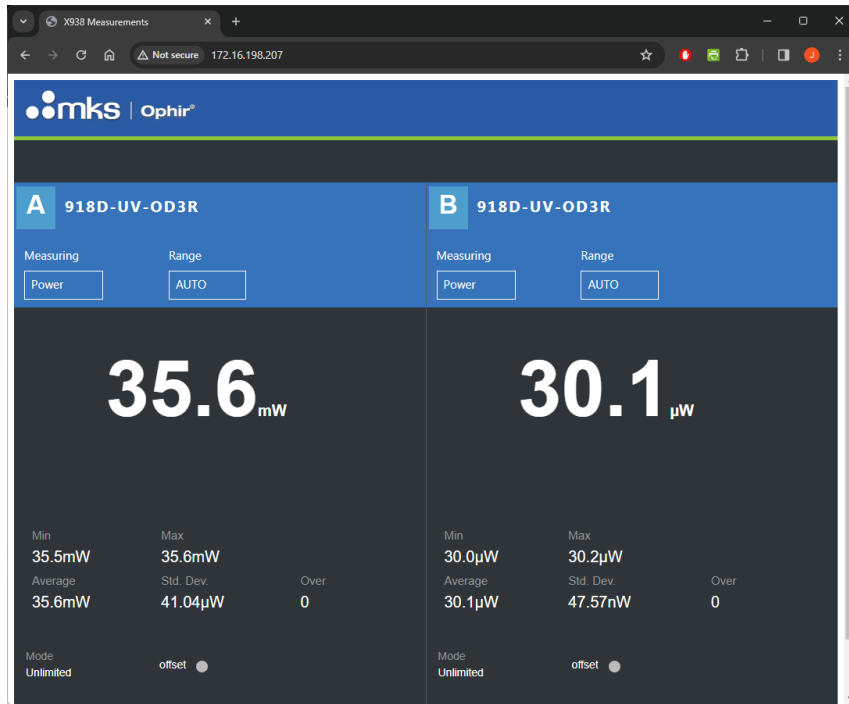
The IP Address and additional fields can be entered either manually, or received from a connected network automatically via DHCP.



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 PMManager PC application.



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.

4.5.4 Log Settings

This screen is described in Chapter 13.1 Log Settings.

4.5.5 Log History

This screen is described in Chapter 13.5

4.6 Configuring Measurements

The [Quick Reference](#) contains a quick introduction to using the x938 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.

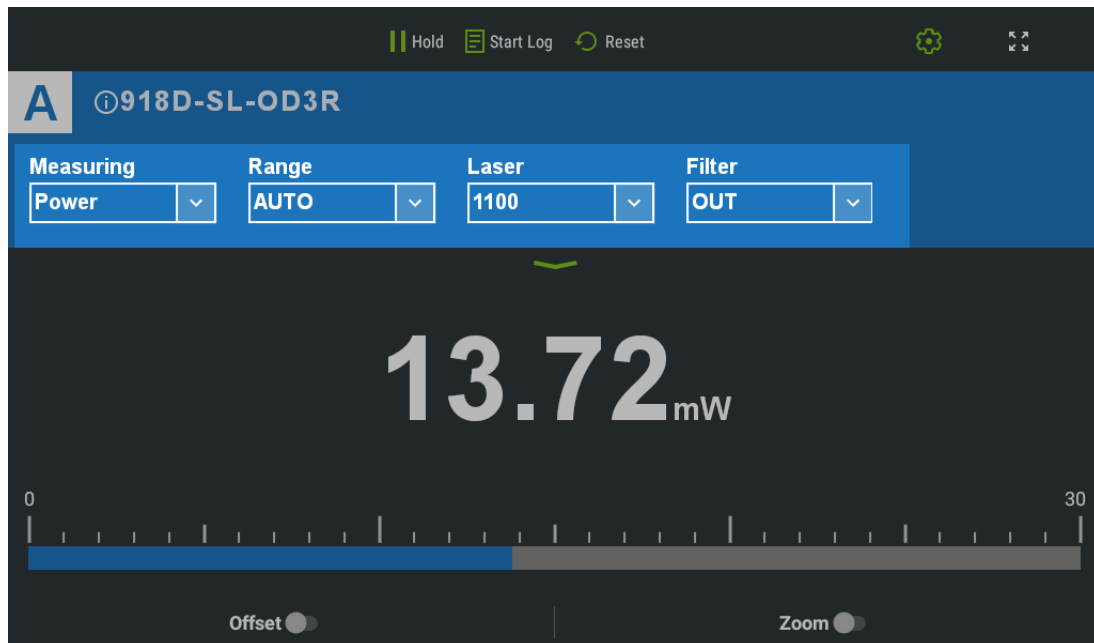




Figure 4-25 Photodiode sensor measurement screen with sensor parameters highlighted

The measurement screen comprises the following:

- On the top line are the Start Log and Reset buttons, and the Settings menu icon
- On the second line are the sensor's name and serial number and an indication whether a function is configured.
- On the third line are the sensor parameter settings. The sensor parameters, including Measuring Mode, Range, Laser, Filter, are configured with a tap on the parameter, and then the value is selected from the drop down list.
- **Channel Options** green arrow icon 
- 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 with the 2929-R meter are described in [2938-R 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](#)


- [PEPS Sensors](#)
- [Pyroelectric and Photodiode Energy Sensors](#)

4.6.1 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 green down arrow icon (), enables configuration of display type, functions, and hardware settings. It also enables zero adjustments directly from the measurement screen.

Channel Options Menu

From the measurement screen, tap the **Channel Options** green arrow icon ().

Two selections are available at the screen bottom:

1. **Channel Settings** allows you to reorder the display of settings such as the Range, Laser Measuring Mode etc
2. **Other Settings**, whose options are:
 - Display Type
 - Functions
 - Zero
 - H/W Settings

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.

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.

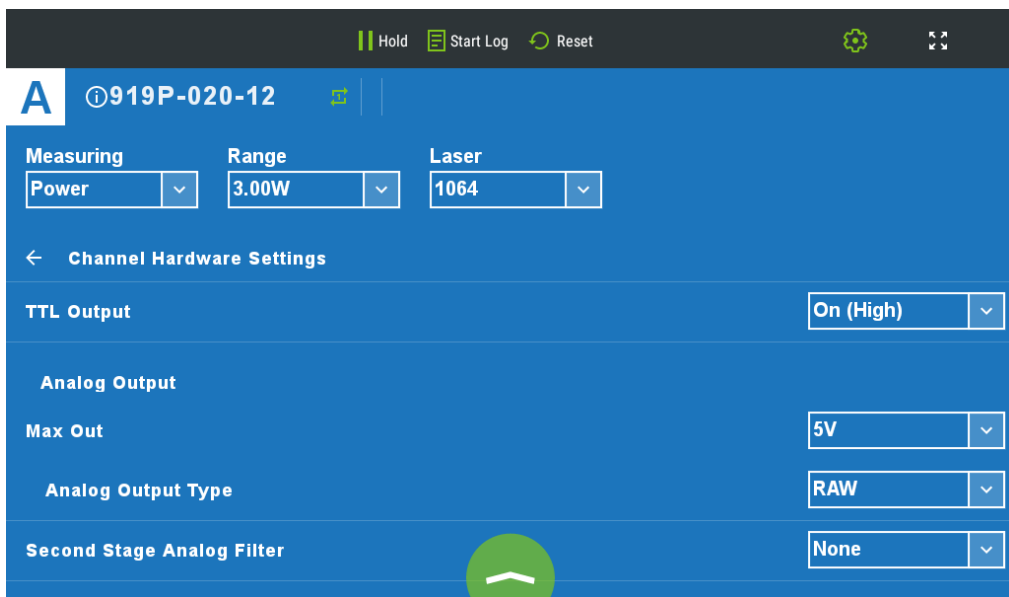


Figure 4-26 Channel Hardware Settings Screen

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 x938 provides an analog voltage output via a BNC socket on the rear panel marked ANLG (see Figure 4-8). 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](#).

4.7 Using PMManager

You can connect x938 to PMManager for complete remote control from a PC. While the x938 is connected to PMManager in this way, the PC acts as a full-featured display, and the x938 is locked; the notice "Touch Response Locked" is displayed on the screen.

To connect x938 to PMManager

- Connect the supplied USB cable from the PC to the USB back panel socket on the x938.
- Alternatively, connect a network cable to the Ethernet back panel socket on the x938.

5 Points to Consider

Before using the x938 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?

The x938 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 x938 meter, and the data logging and math processing capabilities that make the x938 meter the complete answer to your measurement needs.

6 Thermal Sensors

For a list of the available thermal sensor models that can be used with the x938, see chapter [16.2 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 chapter [16.2 Sensor Specifications](#).

If the sensor is a water-cooled type, ensure that the cooling water is flowing at an adequate rate (see [Table 6-1 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 6-1 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 x938. Energy of a single pulse is measured on the x938 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 x938 can be set to various settings while operating, and it automatically saves the settings for the next power-up. This way the x938 is in the desired configuration when turned on the next time.

On power-up, the x938 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 x938 with Thermal Absorber Sensors](#)
- [Measuring Laser Power with Thermal Sensors](#)
- [Measuring Laser Energy with Thermal Sensors](#)
- [Measuring Laser Pulsed Power with Thermal Sensors](#)

6.1 Operation of x938 with Thermal Absorber Sensors

To use x938 with thermal sensors:

1. Connect the thermal sensor to the x938 meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor** on the back panel of the meter. The x938 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 x938 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 chapter [16.2 Sensor Specifications](#), as there is a risk of damaging the absorber.

6.2 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.

To measure laser power using thermal sensors:

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

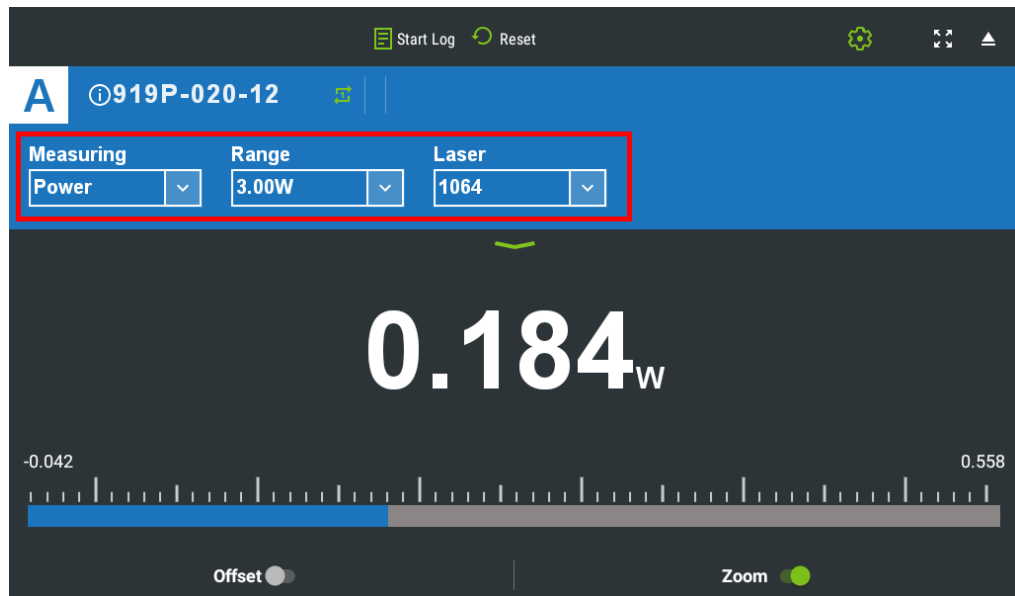


Figure 6-1 Setting the Sensor Parameters

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 x938 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.

6.3 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 false triggers that might otherwise be seen as energy pulses. The factory setting of the energy threshold is **Med** for medium. If the meter false triggers on noise, set the threshold to **High**. If you are measuring small energies and the meter does not trigger, set the threshold to **Low**.

If the x938 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 x938 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.

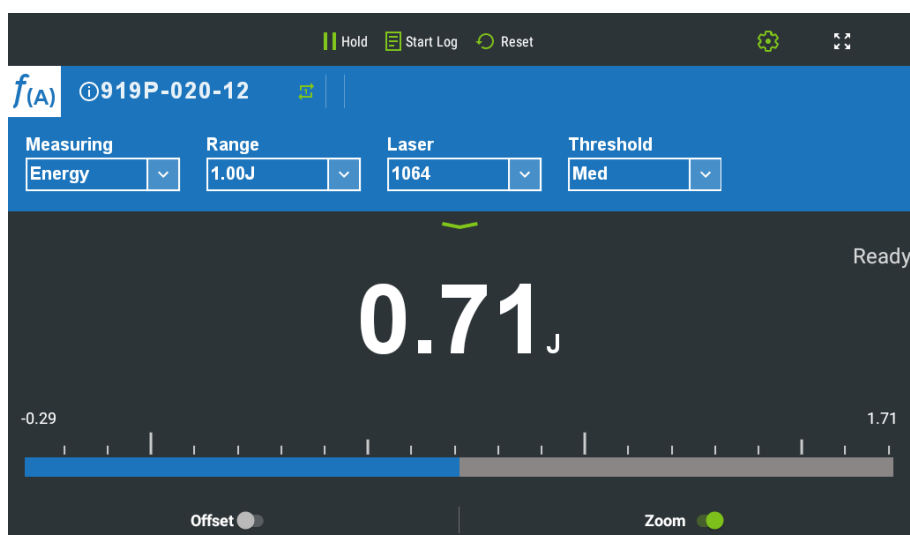


Figure 6-2 Energy measurement with Thermal Sensor

6.3.1 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:

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

- 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:

$$\text{Average Energy per pulse} = \text{Total Energy} / \text{Number of Pulses}$$

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

6.3.2 Measuring Energy of Rapidly Repeating Pulses

With a typical thermal sensor, the x938 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:

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

For rapidly repeating pulses, you can use one of the Newport Pyroelectric sensors, as long as the pulse energies do not exceed the ratings of the pyroelectric absorbers. The pyroelectric sensors are compatible with x938 and just have to be plugged in to be used.

6.4 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 false triggers that might otherwise be seen as energy pulses. The factory setting of the energy threshold is **Med** for medium. If the meter triggers on noise, set the threshold to **High**. If you are measuring small energies and the meter does not trigger, set the threshold to **Low**.

If the x938 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 x938 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 power is displayed.
7. Return to Step 1 for the next measurement.

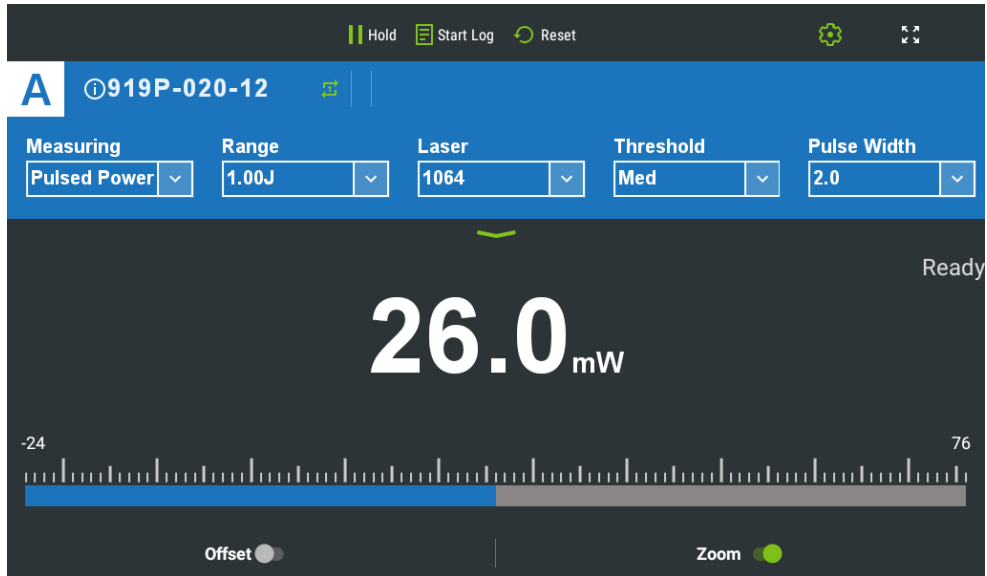


Figure 6-3 Thermal Sensor Pulsed Power

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

6.4.1 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.

7 PEPS Sensors

For a list of the available PEPS sensor models that can be used with x938, see chapter [16.2 Sensor Specifications](#).

Some of Newport'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 PEPS line of sensors are thermal sensors that can measure beam position and beam size while measuring power. The PEPS sensor provides additional information on your laser beam – centering, beam position and wander, beam size as well as power and single shot energy. The PEPS 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.

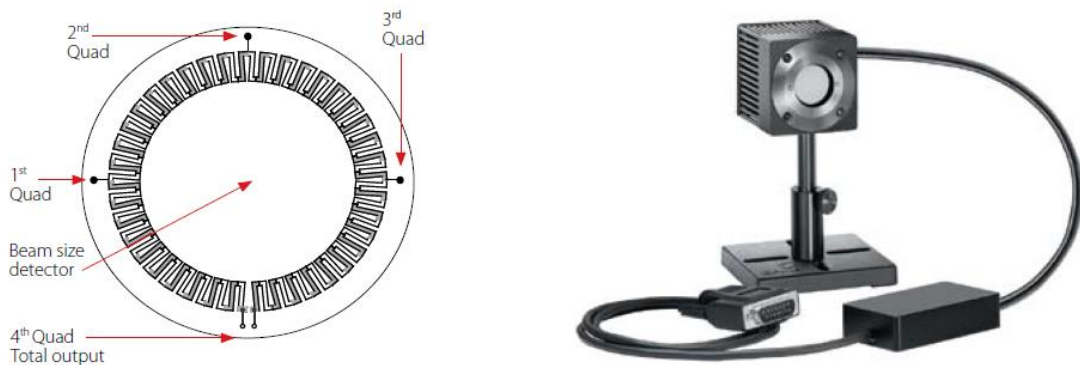


Figure 7-1 PEPS Sensor

This section describes the x938'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](#)

7.1 Setting Measurement Parameters

Measurements can be displayed in Position (for PEPS 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 7-2 below](#) at the end of this procedure.

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

1. Connect the relevant PEPS sensor to the x938.
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 x938 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.

7.2 Tracking Laser Beam Position and Size

To track position and size while measuring power when using PEPS 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.

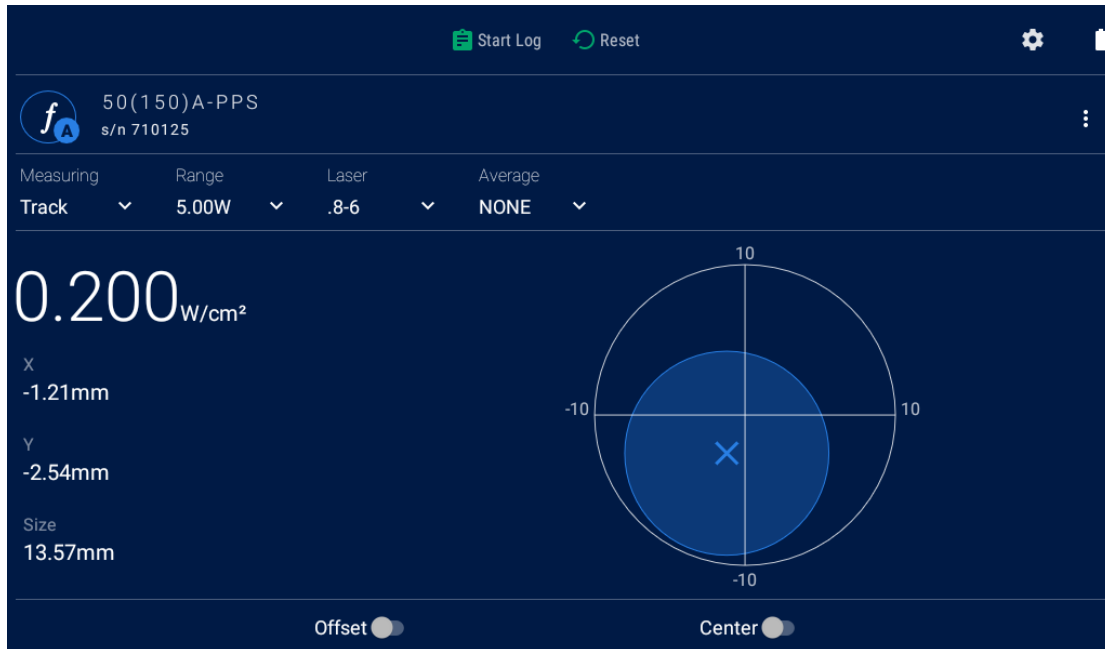


Figure 7-2 Position Display with PEPS Sensor

7.3 Tracking Stability - Laser Beam Position Over Time

To track laser beam position over time using PEPS 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**).

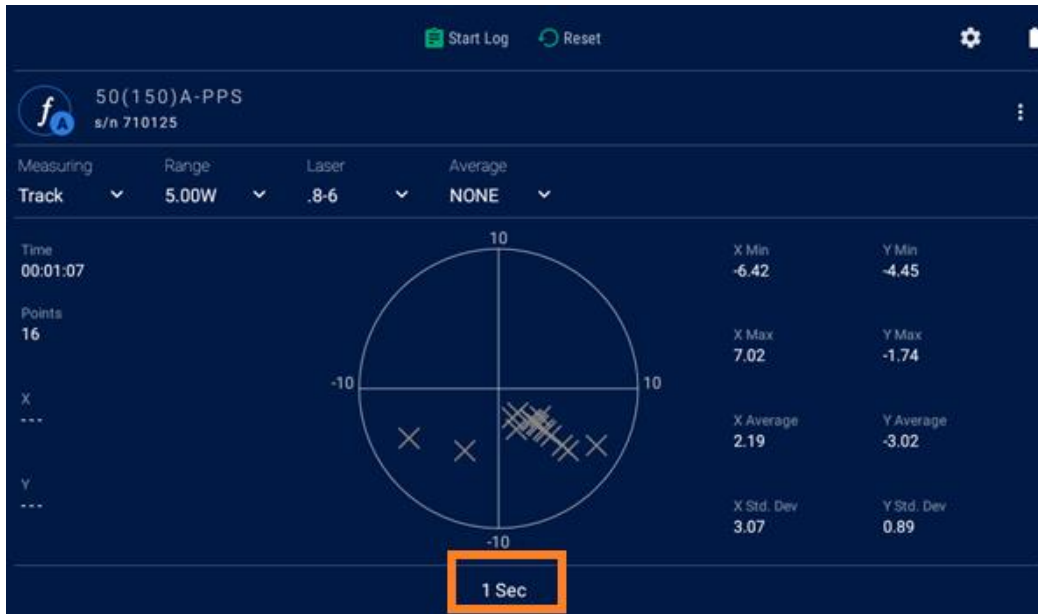


Figure 7-3 Stability Display with PEPS Sensor

8 Photodiode Sensors



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 chapter [16.2 Sensor Specifications](#).

If the power of your laser exceeds the maximum specified for photodiode sensors with a filter, you can purchase a thermal or integrating sphere sensor for that wavelength. Consult your Newport agent for details.

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 x938 meter amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the x938, the noise level is very low, and the photodiode sensors with the x938 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 are constructed with a built-in filter so the basic sensor can measure to 30mW or more without saturation. When an additional filter is installed, the maximum power is on the order of 3W.

Sensors such as the 818 series have threaded removable filters.

The 918D series detectors have an integrated (non-removable) attenuator filter with a built-in switch in the detector head, sensing the position of the attenuator. The x938 power meter will then automatically detect the filter IN/OUT status and automatically use proper calibration data for presence or absence of the attenuator in front of the photodiode sensor.

The photodiode saturates when the output current gets too high, 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.

Photodiode sensors have built in wavelength correction curves for measurements either with the filter installed (filter-in) or removed (filter-out). These curves are stored in the sensor EEROM. The correction curves 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.

For a list of the available photodiode sensor models, see chapter [16.2 Sensor Specifications](#).

The following Subtopics in this Chapter include:

- [Operation of x938 with Photodiode Sensors](#)
- [Measuring Laser Power with Photodiode Sensors](#)
- [Averaging and Measuring Very Low Power Measurements](#)
- [Measuring Total Exposure](#)

8.1 Operation of x938 with Photodiode Sensors

To use x938 with photodiode sensors:

1. Connect the photodiode sensor to the x938 meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor** on the back panel of the x938 meter. x938 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 sensor parameter you want to change, and then tap the relevant value.
3. Repeat for all parameters to be modified.

Note: The x938 automatically saves the current sensor 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 chapter [16.2 Sensor Specifications](#) as there is a risk of damaging the absorber.

8.2 Measuring Laser Power with Photodiode Sensors

The following procedure describes how to use photodiode sensors to measure laser power. You can specify the expected laser **Range**, **Laser** setting, if applicable 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 over the entire measurement range. When you choose the correct laser setting, the correction factor for that wavelength is automatically introduced.

Some of the photodiode sensors are equipped with a built-in filter so that the photodiode can measure up to 30mW without saturating the detector.

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 x938 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 x938 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 **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. 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.

Figure 8-1 below demonstrates a sample Bar Graph showing laser power measurements, including range, laser wavelength and filter. In this display, you can [Zoom](#) by stretching the screen with two fingers, and tap Offset. (Click the above links for more details.)

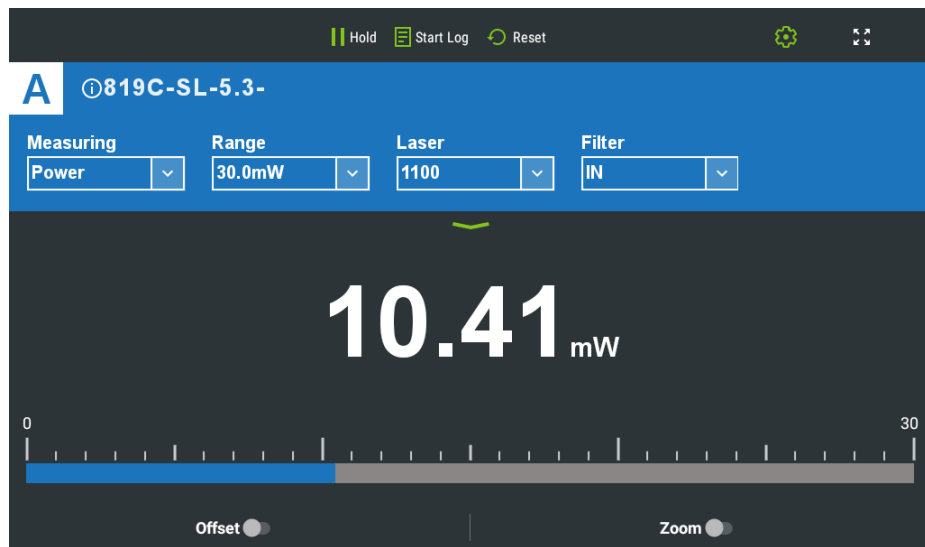


Figure 8-1 Photodiode Power Bar Graph

8.3 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 x938 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 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](#).

8.4 Measuring Total Exposure

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

In Exposure mode, x938 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**.

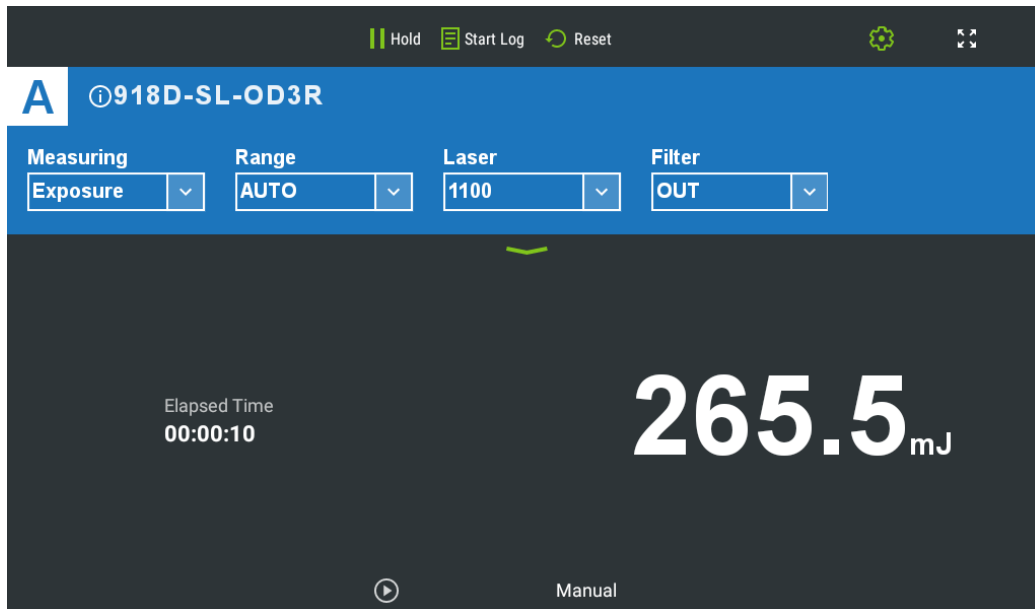


Figure 8-2 Photodiode Exposure Measurement

8.4.1 Exposure Limitations

Function Limitations

When measuring exposure, only Scale Factor is enabled.

8.5 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, 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.

8.6 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.

9 Pyroelectric and Photodiode Energy Sensors

x938 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 x938, see chapter [16.2 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 chapter [16.2 Sensor Specifications](#).

Topics include:

- [Pyroelectric Sensors – Method of Operation](#)
- [Photodiode Energy Sensors – Method of Operation](#)
- [Measuring Pulses of High Energy Density](#)
- [Operation of x938 with Pyroelectric and Photodiode Energy Sensors](#)

9.1 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 Newport 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, Newport 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 x938 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, x938 is also able to display average power.

9.2 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.

9.3 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.
- Newport has sensors specifically designed for high energy density pulses. Some of these sensors can measure energy densities up to several Joules/cm². Contact your Newport dealer for details.

9.4 Operation of x938 with Pyroelectric and Photodiode Energy Sensors

On power-up, the x938 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 x938 with pyroelectric and photodiode energy sensors:

1. Connect the pyroelectric (or photodiode) energy sensor to the x938 meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked Sensor on the back panel of the x938 meter. x938 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 x938 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 x938 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 chapter [16.2 Sensor Specifications](#), as there is a risk of damaging the absorber.

9.4.1 Zeroing the Energy Sensor with the x938 Meter

For the most accurate calibration, you should zero the pyroelectric energy sensor with your x938. 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 x938 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 x938 again, you should zero it again.

9.4.2 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.

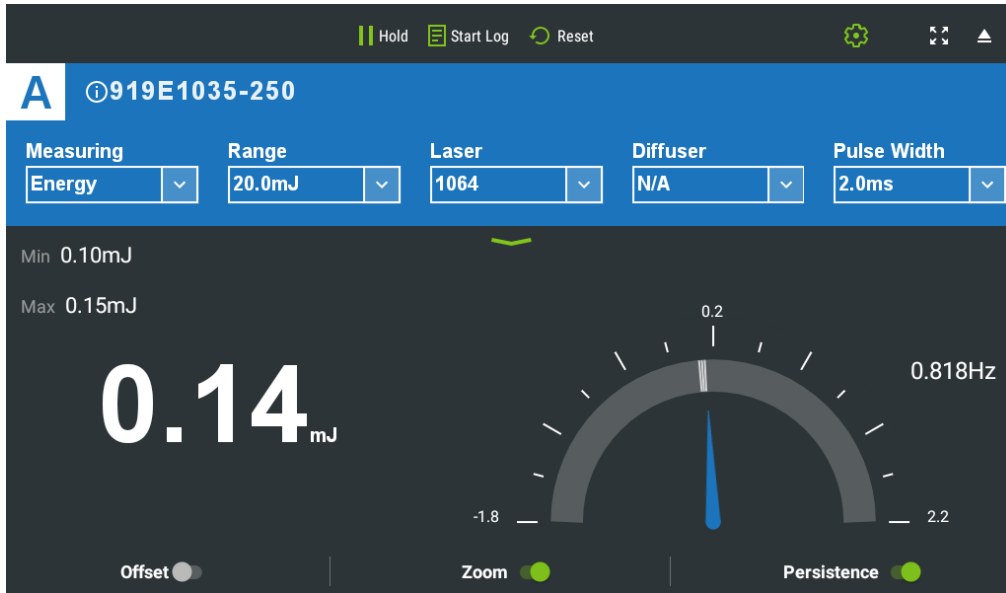


Figure 9-1 Pyroelectric Energy Needle

9.4.3 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 x938 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. Newport also offers a shock absorbing mounting post (P/N 7Z08268) that helps reduce vibration on the sensor.

9.4.4 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, μ J, and so on.

9.4.5 Measuring Average Power

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

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

where the energy and frequency of the pulses were measured by x938.

Note: x938 use when measuring power is the same as when measuring energy, and is described in full in section [Operation of x938 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 9-2 Pyroelectric Power Bargraph

9.4.6 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**.

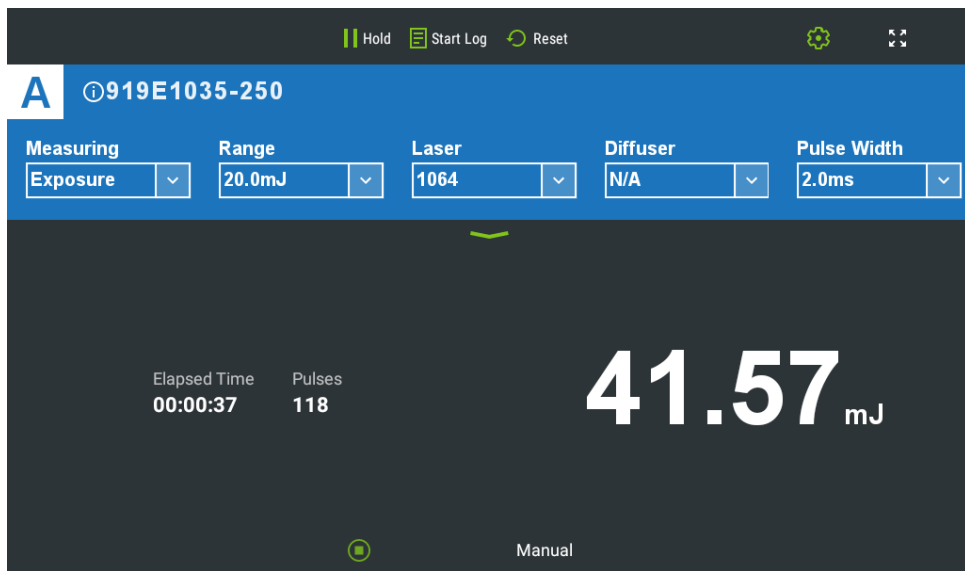



Figure 9-3 Pyroelectric Exposure Measurement

10 Graphical Displays

The x938 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 with the 2938-R meter (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 PEPS sensors):

- [Position](#)
- [Stability](#)

10.1 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.

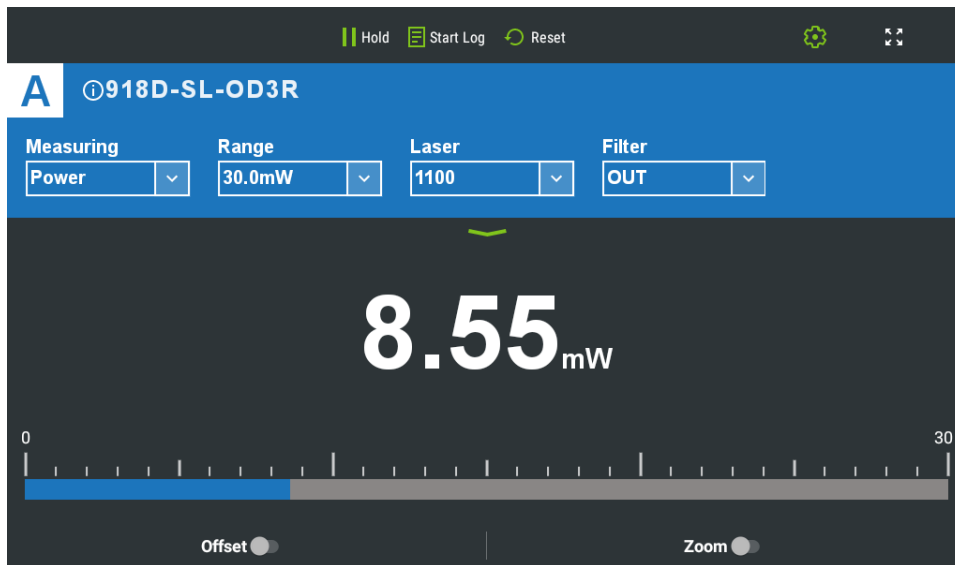


Figure 10-1 Bargraph Display

The bargraph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- On the second line are the sensor's name and an icon for further sensor information, an indication whether a function is configured f (A).
- On the third line you can configure measurement parameters.
- Below that is the green down arrow Channel Options menu icon
- A large numeric display and the bargraph are shown in the middle of the screen.
- The Offset and Zoom buttons on bottom of screen.

To present measurements on a graduated scale (bargraph):

1. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **Display Type**.
2. From the **Display Type** dialog, tap to select **Bar**.

The bargraph view is displayed.

3. To expand the bargraph scale $\pm 5x$ 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](#).

10.1.1 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 10-2 Bargraph Display

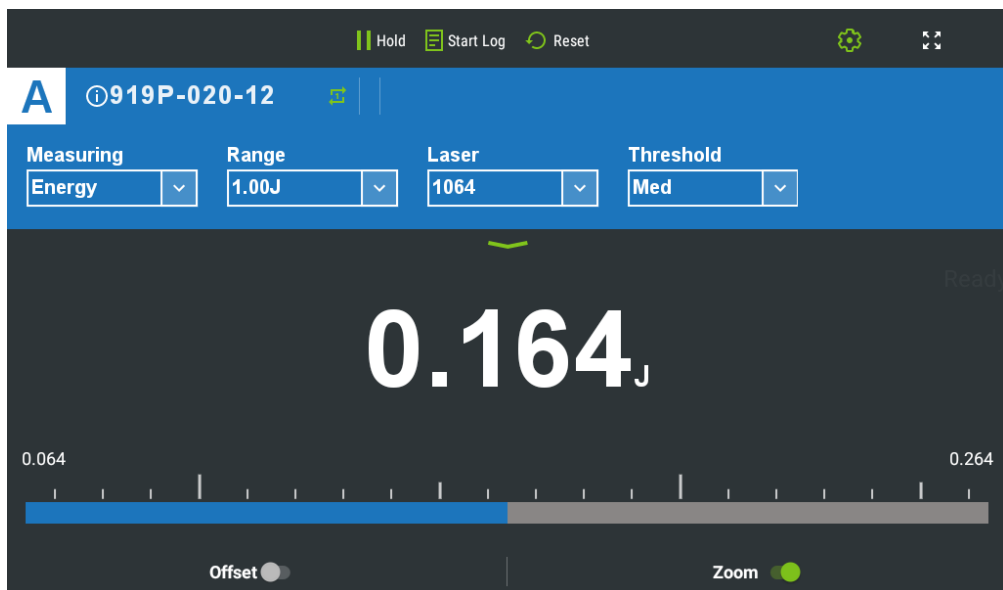


Figure 10-3 Bargraph Display with Zoom

10.2 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.

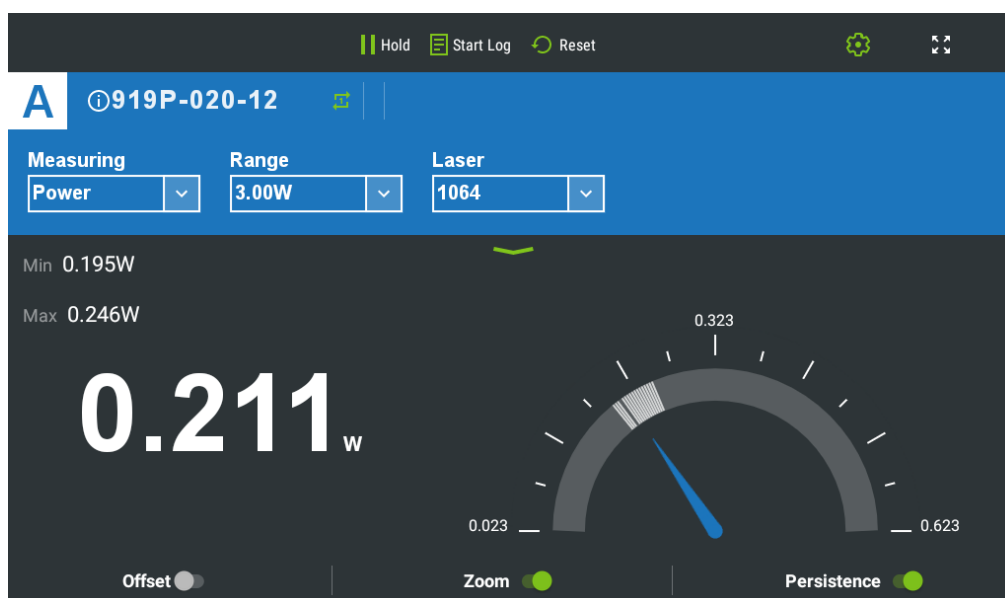


Figure 10-4 Needle Display

The Needle graph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- On the second line are the sensor's name and serial number, an indication whether a function is configured (f), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Below that is the green down arrow Channel Options menu icon
- 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. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **Display Type**.
2. Tap to select **Needle**.
Needle representation is displayed.
3. To expand the needle graph $\pm 5x$ 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.

10.2.1 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.

10.3 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 10-5 Line Graph

The Line graph display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- 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.
- Below that is the green down arrow Channel Options menu icon
- There is a large numeric display plus Max and Min values
- Autoscale Y Axis and Offset buttons on the bottom of the screen.

To graph laser output over time:

1. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **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.

10.3.1 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.

10.3.2 Reset

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

10.4 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 or Thermal sensors in one-shot Energy mode .

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.

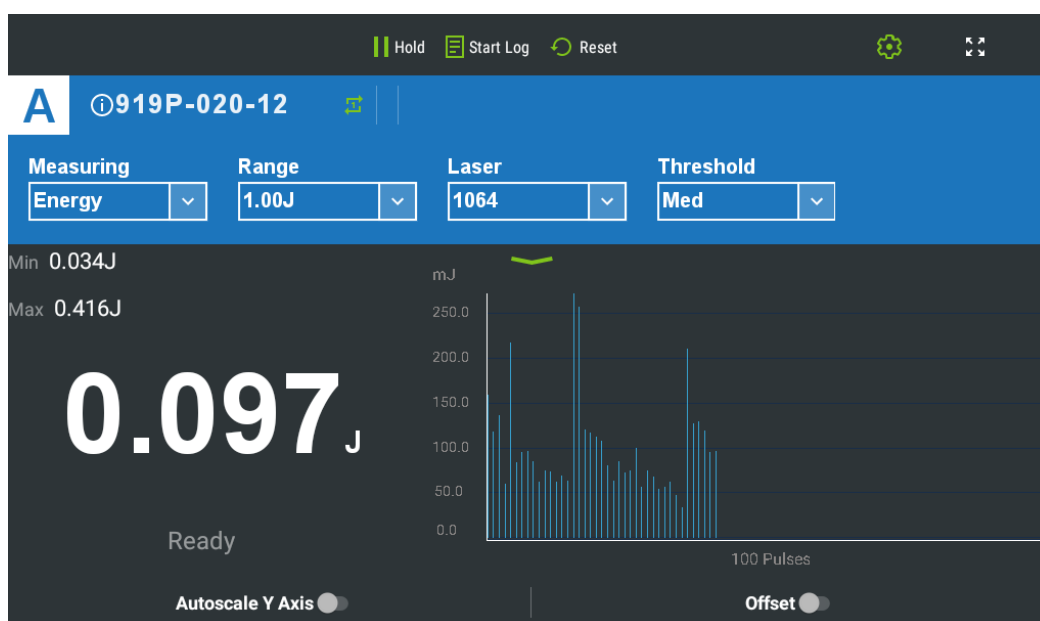


Figure 10-6 Pulse Chart

The Pulse Chart display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- 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.
- Below that is the green down arrow Channel Options menu icon
- Large numeric display and Max and Min values are above the Pulse Chart.
- The Pulse Chart 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. Tap the Channel **Options green arrow icon** and then tap **Other Settings** then **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.

10.5 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.

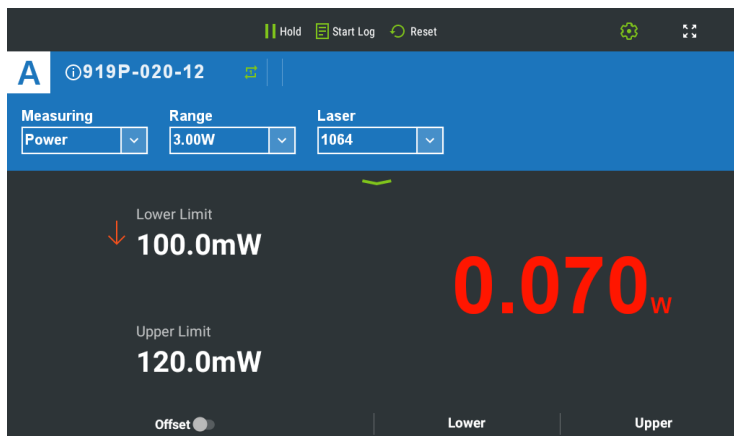


Figure 10-7 Pass/Fail Under the Lower Limit

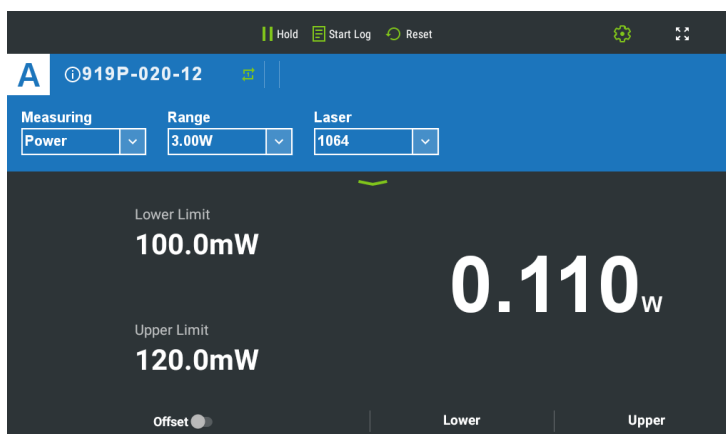


Figure 10-8 Pass/Fail within Limits

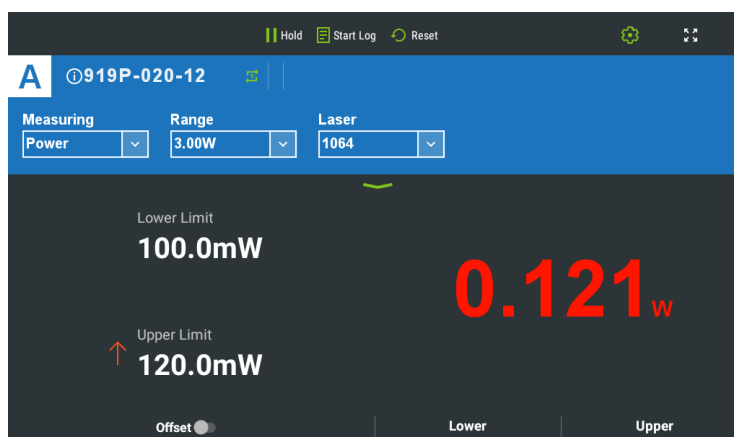


Figure 10-9 Pass/Fail over the Upper Limit

The Pass/Fail display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- 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.
- Below that is the green down arrow Channel Options menu icon
- Upper Limit and Lower Limit are to the left of the large numeric display.
- Out-of-range warning: red numeric display, red arrow shows limit violated.
- Offset button, and buttons for setting upper and lower limits on bottom of screen.

To set pass/fail tracking:

1. Tap the Channel **Options green arrow icon** and then tap **Other Settings** then **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.

10.5.1 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.

10.6 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.

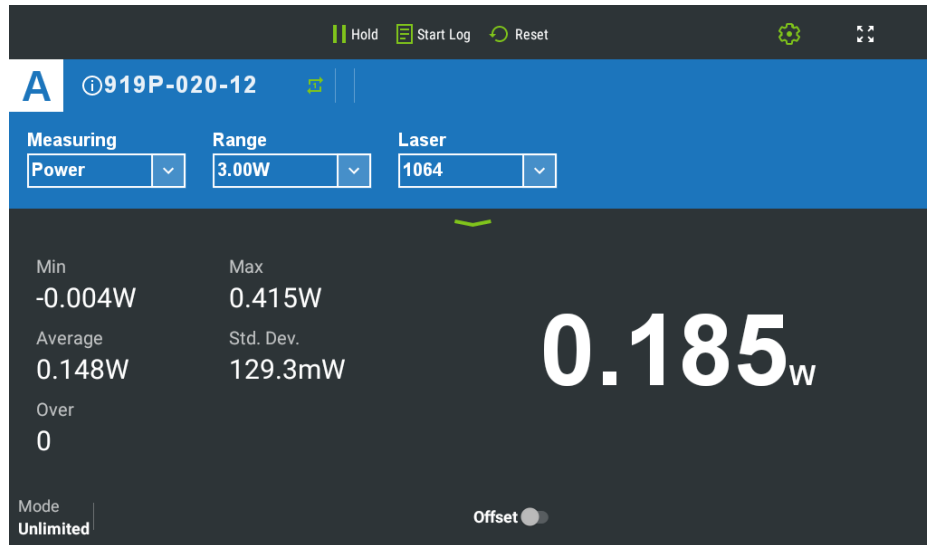


Figure 10-10 Statistics display

The Statistics display comprises the following components:

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

To display real-time statistics:

1. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **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.

10.7 Exposure (for Pyroelectric Sensors)

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

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

Figure 10-11 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](#).

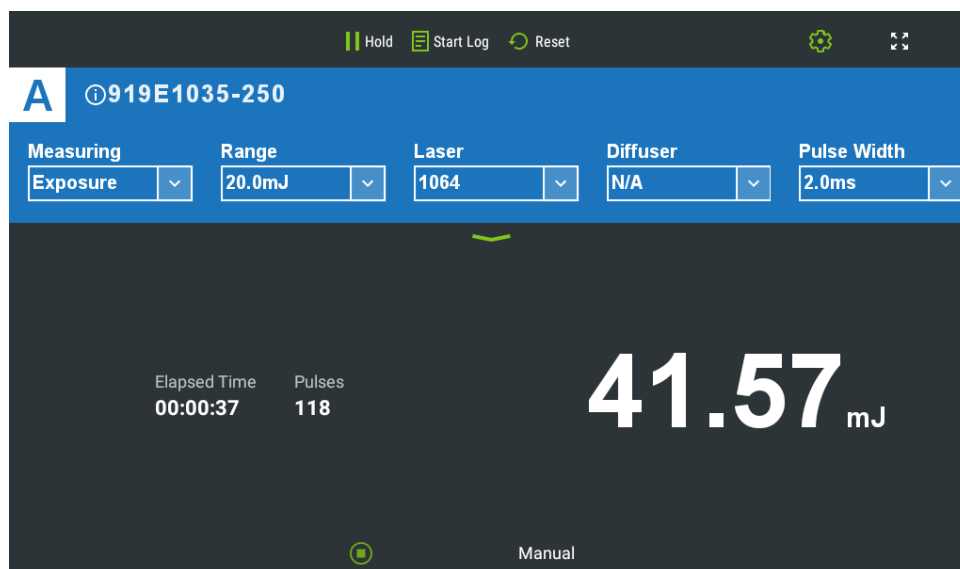


Figure 10-11 Pyroelectric Exposure Measurements

The Exposure display comprises the following components:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- On the second line are the sensor's name and serial number, indication whether a function is configured (f), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.

- Below that is the green down arrow Channel Options menu icon
- 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.

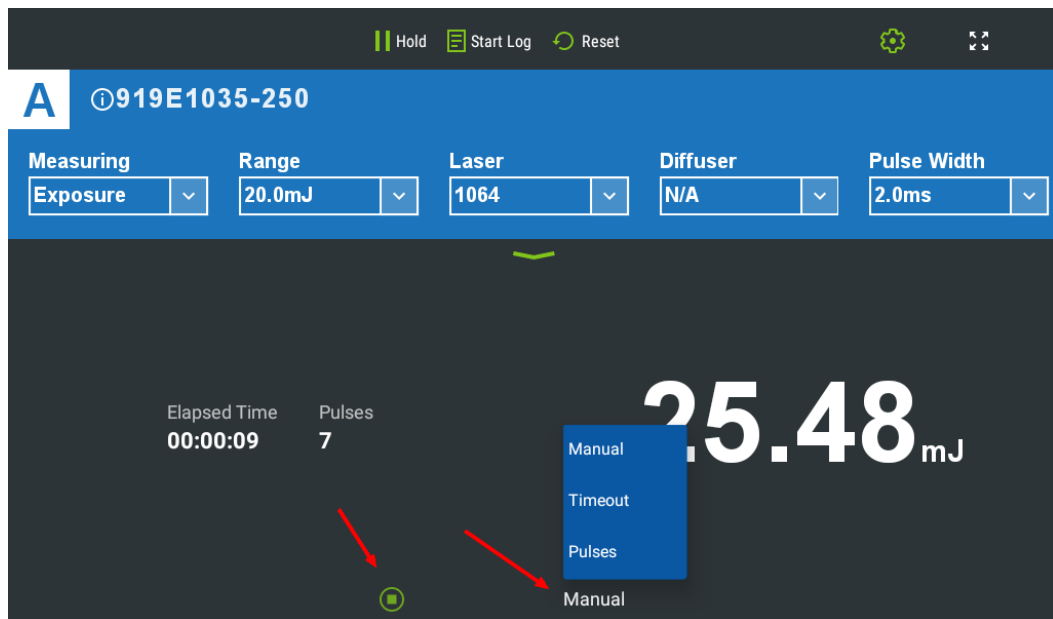


Figure 10-12 Pyroelectric Exposure Screen indicating the start/stop button and the Manual Option Selected

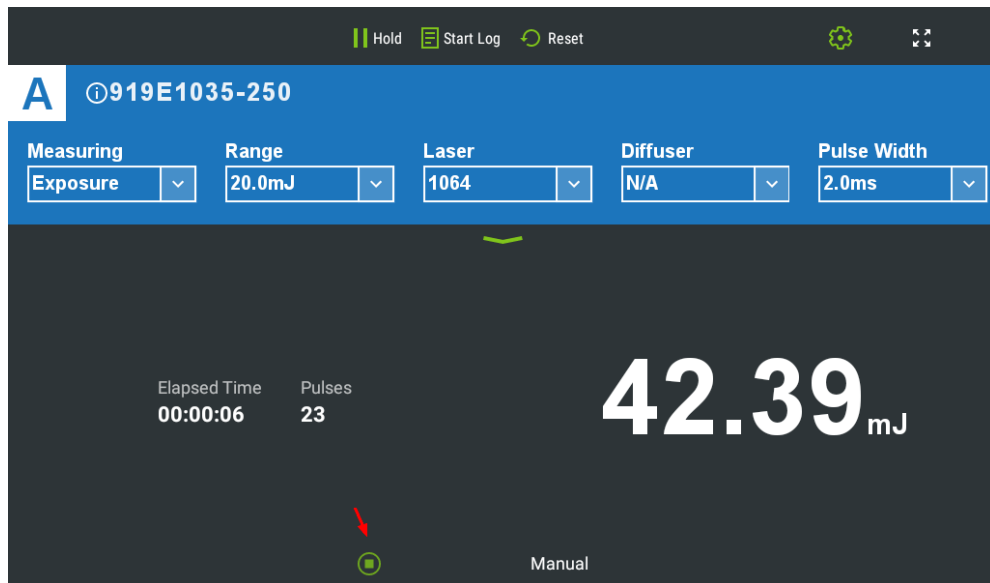


Figure 10-13 Pyroelectric Exposure Screen indicating the numerical display and the stop button

10.7.1 Measuring Modes

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

- Exposure

10.7.2 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.

10.8 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.

10.9 Position (for PEPS Sensors)

The PEPS line of sensors are thermal sensors that can measure beam position and beam size while measuring power. The PEPS 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 x938'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 10-14 below shows a sample PEPS sensor position graph. See also Offset.

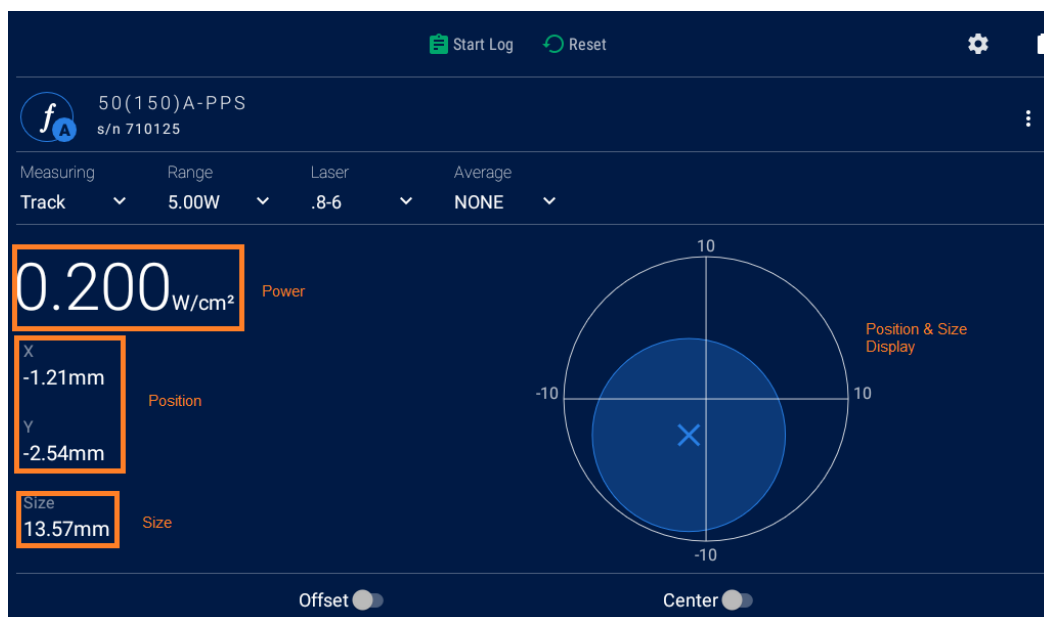


Figure 10-14 PEPS Position and Size Display

The position display comprises the following sections:

- On the top line are the Start Log and Reset buttons, and the Settings icon.
- On the second line are the sensor's name and serial number, indication whether a function is configured (f), and the Channel Options menu icon.
- On the third line, you can configure management parameters.
- Below that is the green down arrow Channel Options menu icon
- 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 PEPS sensor in Track mode.

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

1. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **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 PEPS 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.

10.9.1 Measuring Modes

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

- Track

10.10 Stability (for PEPS 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 PEPS sensors (thermal sensors with additional circuitry for measuring position and size) with the Measurement mode set to Track.

Figure 10-15 below shows a sample PEPS sensor stability graph.

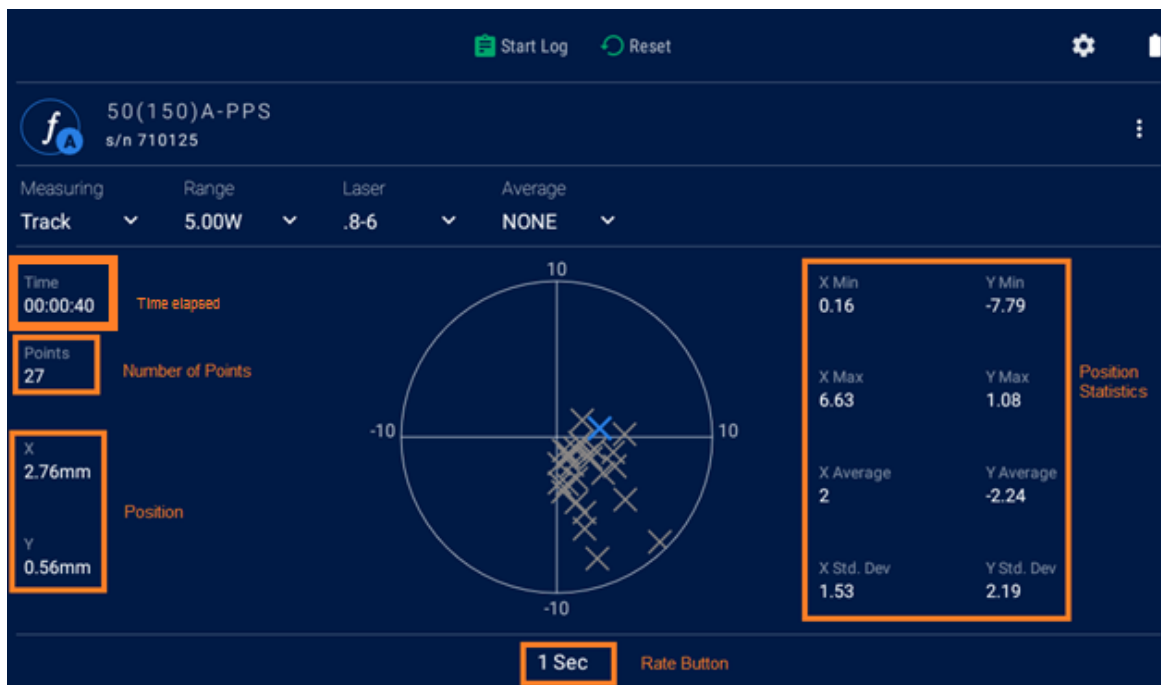


Figure 10-15 PEPS Stability Display

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

- On the top line are the Start Log and Reset buttons, and the Settings icon.

- On the second line are the sensor's name and serial number, indication whether a function is configured (f), and the Channel Options menu icon.
- On the third line, you can configure measurement parameters.
- Below that is the green down arrow Channel Options menu icon
- 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 PEPS sensor in Track mode.

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

1. Tap the **Channel Options green arrow icon** and then tap **Other Settings** then **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.

10.10.1 Measuring Modes

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

- Track

11 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](#)

11.1 Display on Main Measurement Screen

If any functions are enabled, then the letter "f" is displayed next to the sensor information. In the graphic below from a 2938-R dual-channel meter, Channel A has a function configured, while Channel B does not.

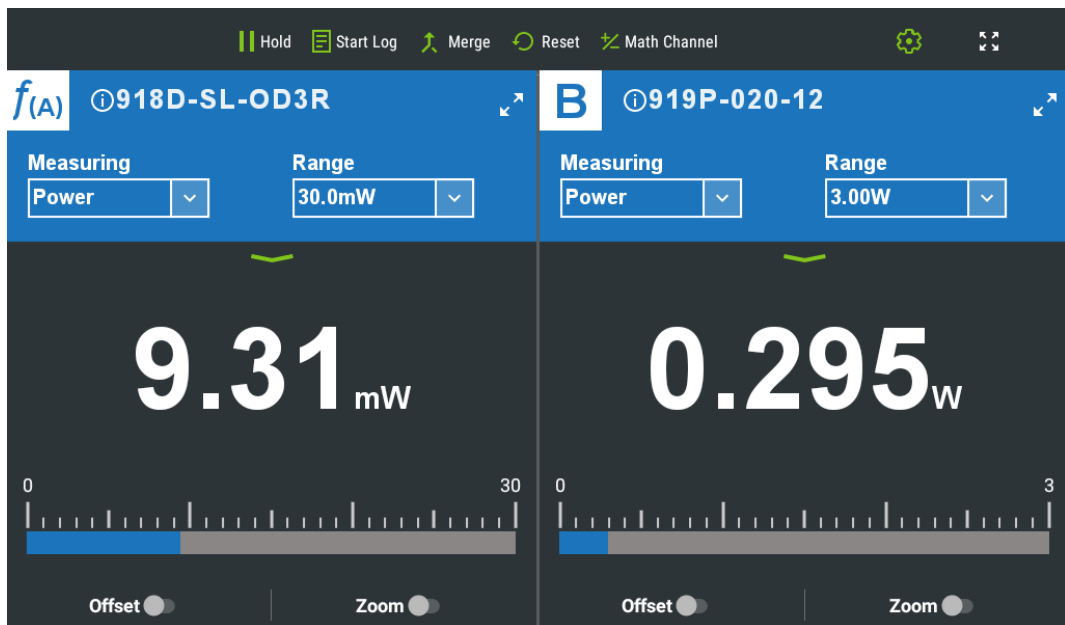


Figure 11-1 Function Indicated for Channel A

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

11.2 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.

To enter the **Functions** menu tap the **Channel Options** green arrow icon  then tap **Other Settings**. then tap **Functions**.

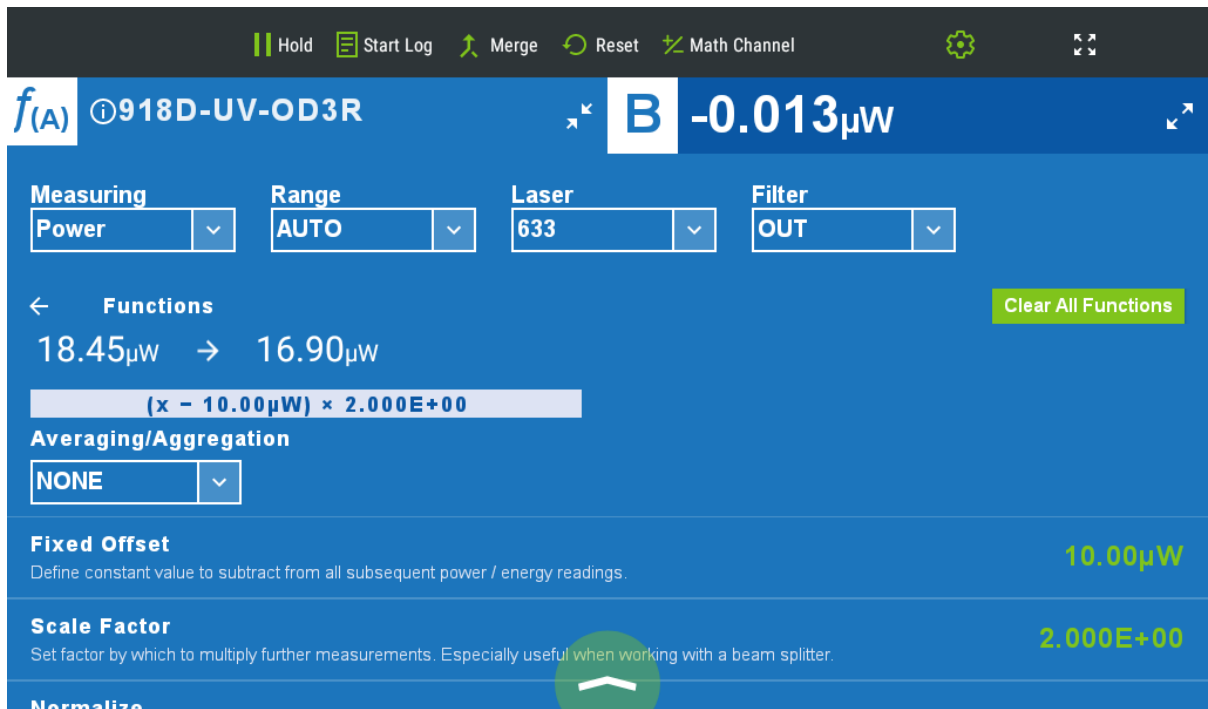


Figure 11-2 Functions Screen

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.
- The next line displays side by side the original measurement unaffected by functions > adjusted measurement with all configured functions.
- List of functions and their current settings, with arrow or edit icon to enable re-setting the function.

This section describes the available functions:

- Average: how to set the time period for average power readings.
- Peak to Peak
- RMS
- 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.
- dBm

11.3 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:

On the **Average/Aggregation** line, tap an option to set the **Average** to the period you wish to average power over, or set to **NONE** to disable.

11.4 Peak to Peak

Detects the peak and minimum power over a set time period, and calculates the difference.

To measure Peak-to-Peak power

On the **Average/Aggregation** selection box, tap and select to set to **Peak-to-Peak**

Tap the displayed time (ms) to set the period you wish to perform Peak-to-Peak detection over.

11.5 RMS

This function calculates the Root Mean Square of the measurement over a set time period.

To display the RMS of measurements

On the **Average/Aggregation** selection box, tap and select to set to **RMS**

Tap the displayed time (ms) to set the period you wish to perform Peak-to-Peak detection over.

11.6 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:

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

The **Set Fixed Offset** dialog is displayed

Set the value to subtract from all subsequent measurements, either typing in a new value, or setting it to the present measurement.

Tap **Apply** to save and exit dialog.

11.7 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.

To apply a scale factor to measurements:

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

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

Type in the value by which to multiply subsequent measurements. The scale factor can be between 0.00001 and 9999, only positive.

Tap **Apply** to save and exit.

11.8 Normalize

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

Note: The **Normalize** option is grayed out if dBm or if Density is set.

To normalize against a baseline value:

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

The **Set Normalize** dialog is displayed.

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.

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.

11.9 Density

The x938 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 dBm function is set, if **Normalize** is set, if 818-RAD is the sensor in use, or if Exposure is the current measuring mode.

11.10 dBm

Provides measurements in dBm units (logarithmic scale)

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

11.11 Function Limitations

- For thermal sensors in single-shot energy mode, Average is disabled.
- For PEPS 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 function dBm is set, then Normalize is disabled.

12 2938-R Dual-Channel Features

If you have the dual-channel 2938-R meter, you can compare two channels numerically and graphically. There are two sensor input connectors at the back of the meter, and sensors can be connected to either or both of them.

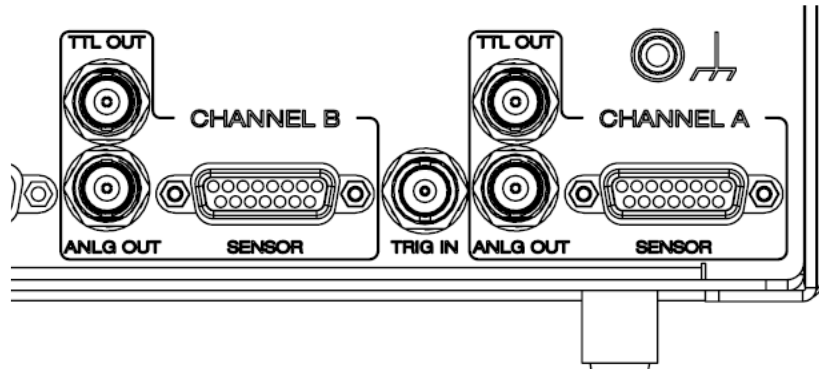


Figure 12-1 x938 Back Panel

12.1 Dual-Channel Operation

When two sensors are attached to the 2938-R, 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.

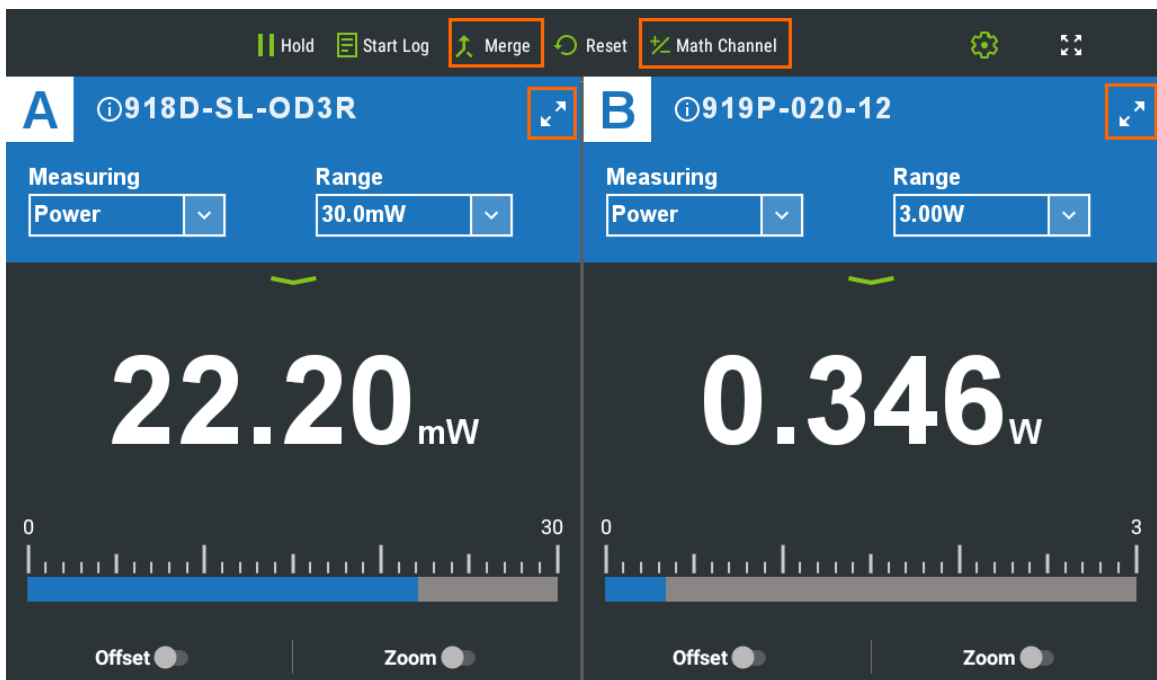


Figure 12-2 Dual Channel Operation in Split Mode

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.

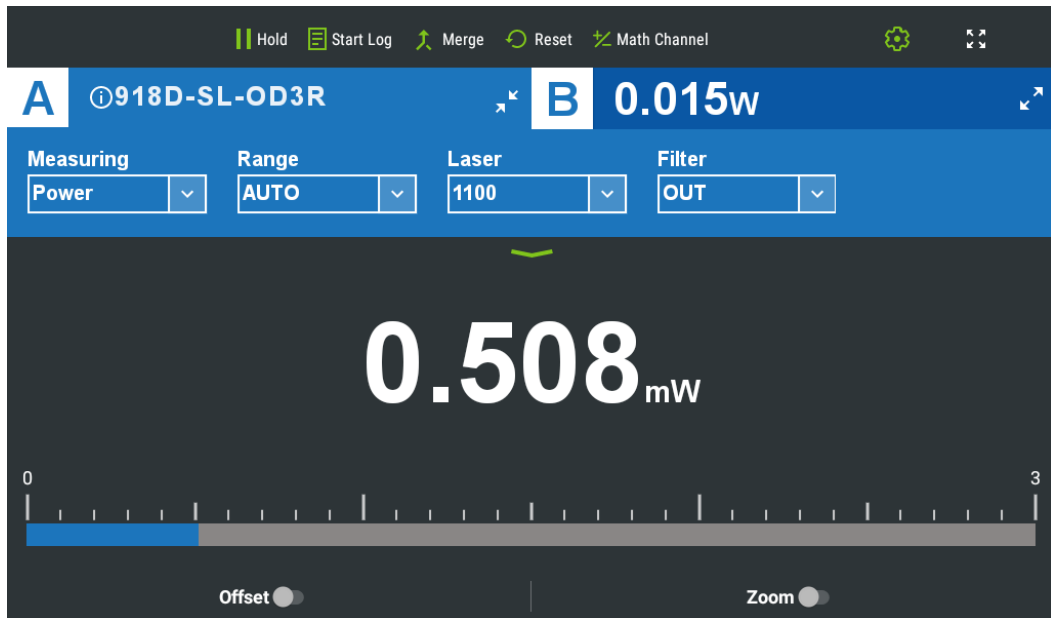


Figure 12-3 Dual Channel Operation with focus on Channel A (which has a function configured)

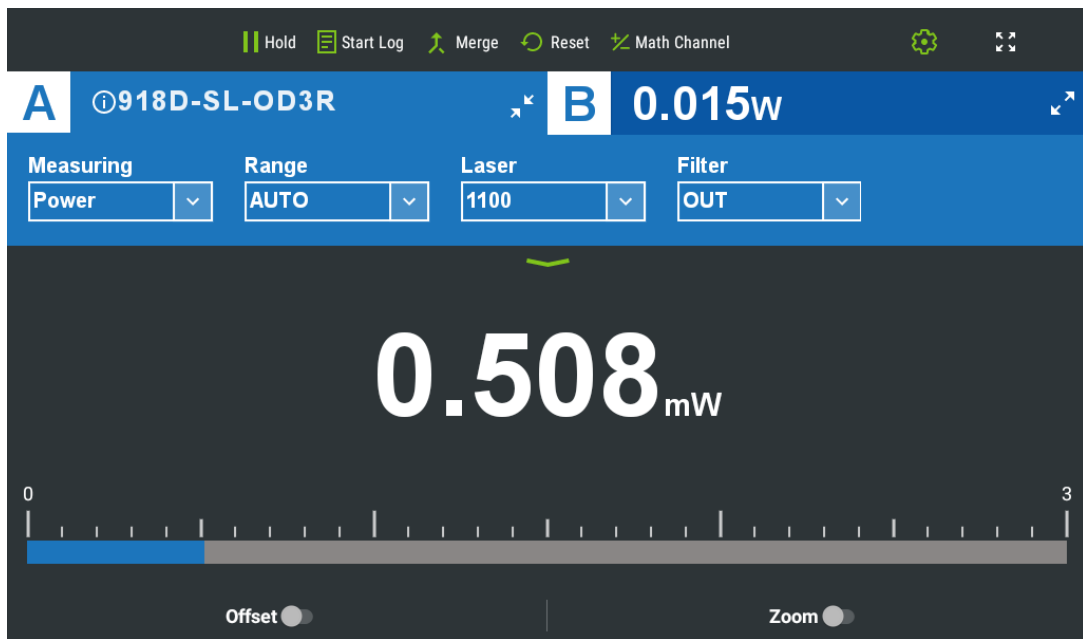


Figure 12-4 Dual Channel Operation with focus on Channel B

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 12-5 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.

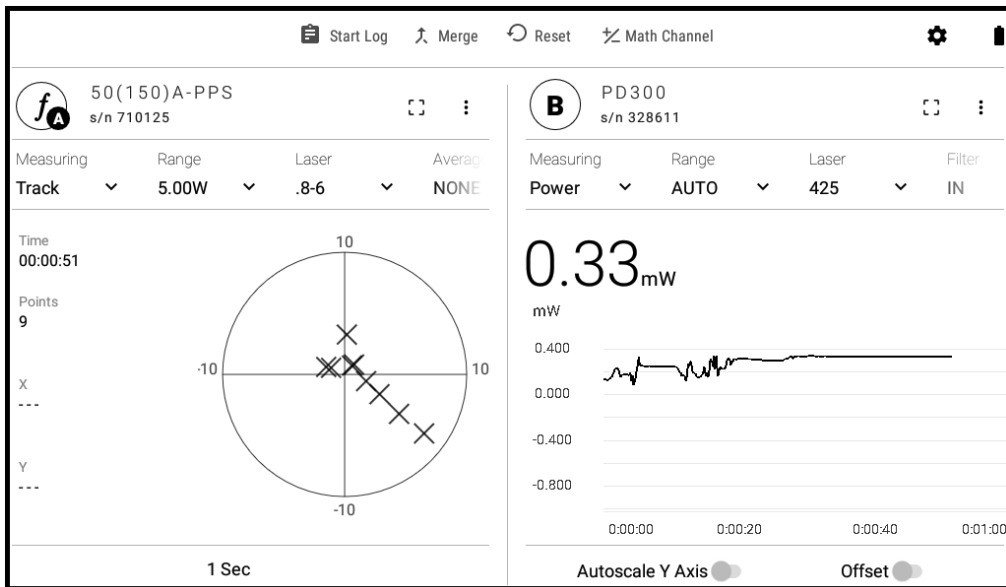


Figure 12-6 Track Graph in split display with Line Graph

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

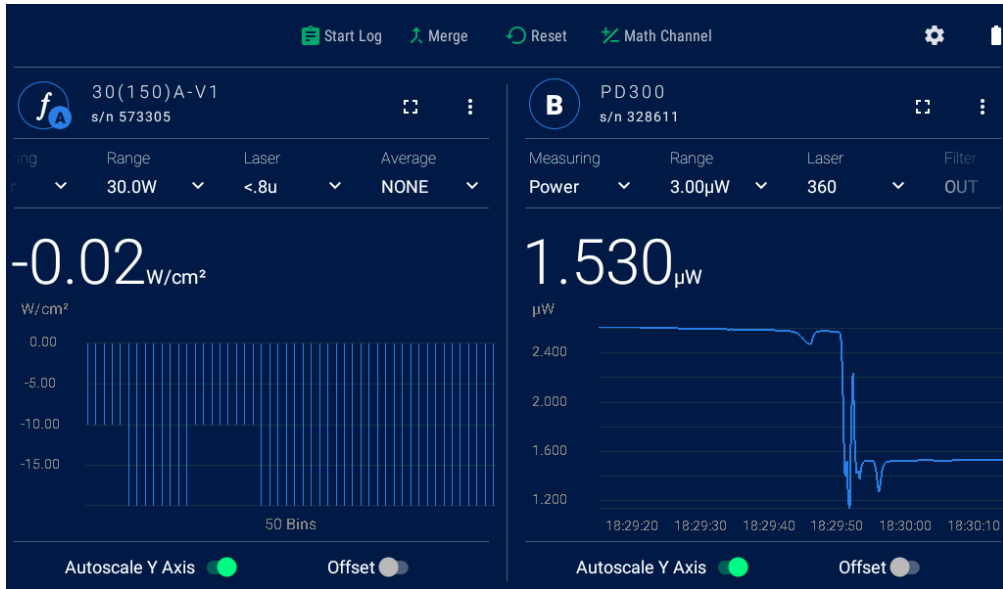


Figure 12-7 Split Screen A Pulse Graph B Line Graph

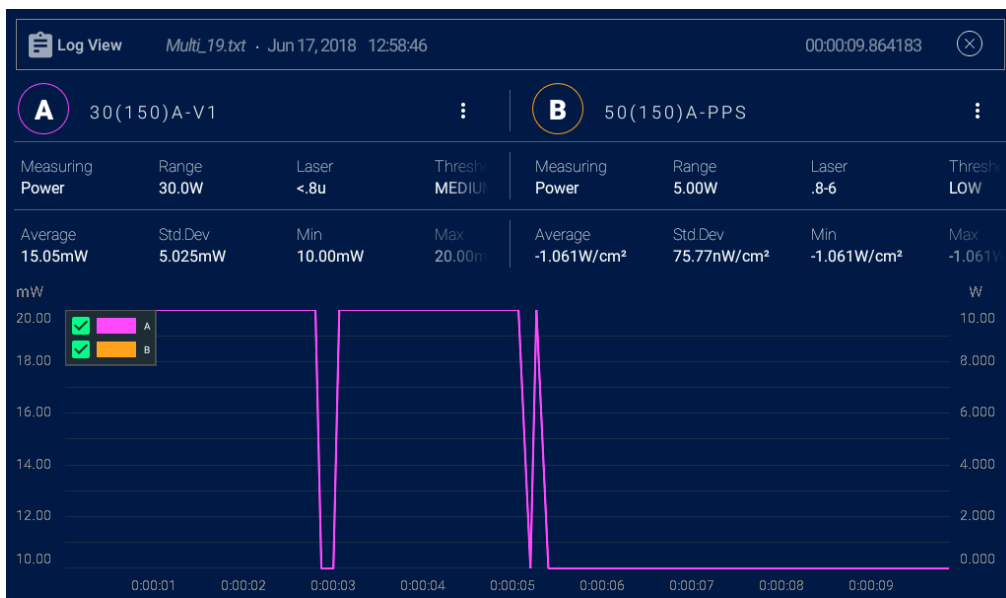


Figure 12-8 Split Screen A Pulse Graph B Line Graph

Figure 12-9 shows the Log View for a split measuring screen. See Display Log as graph.

12.2 Math Channel

The dual-channel 2938-R enables comparison of the measurements of the two channels. The results can be displayed numerically and graphically and can be logged. The Math Channel displays the comparison. The comparison operation options are:

- A/B
- B/A
- A-B
- B-A

- A+B
- A*B

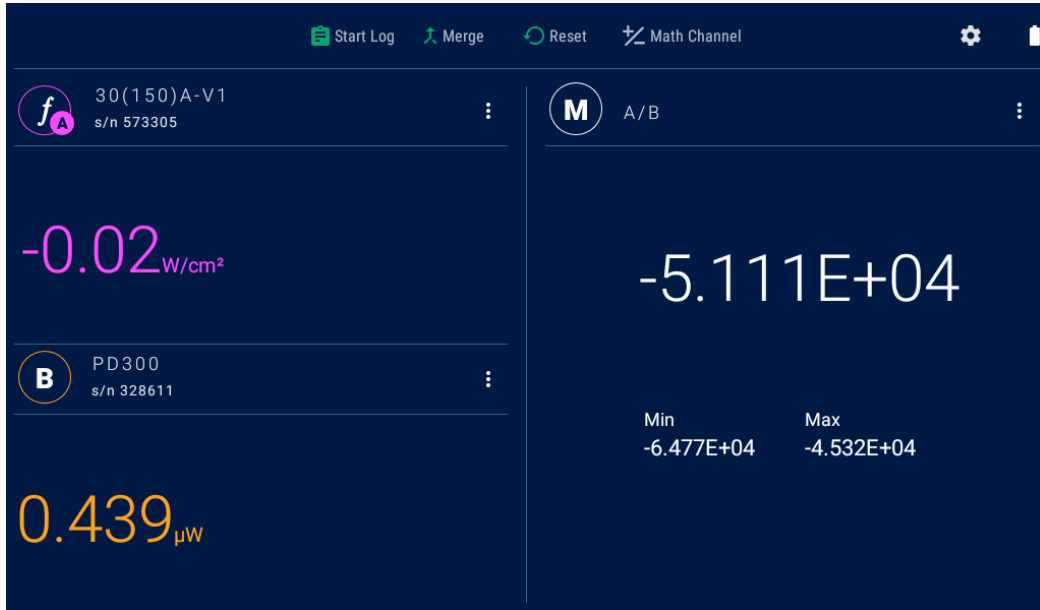


Figure 12-10 Math Channel in Operation (split display)

When two sensors are connected to the x938, 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 (f) 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 via 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 12-11 Merged Math Channel Display

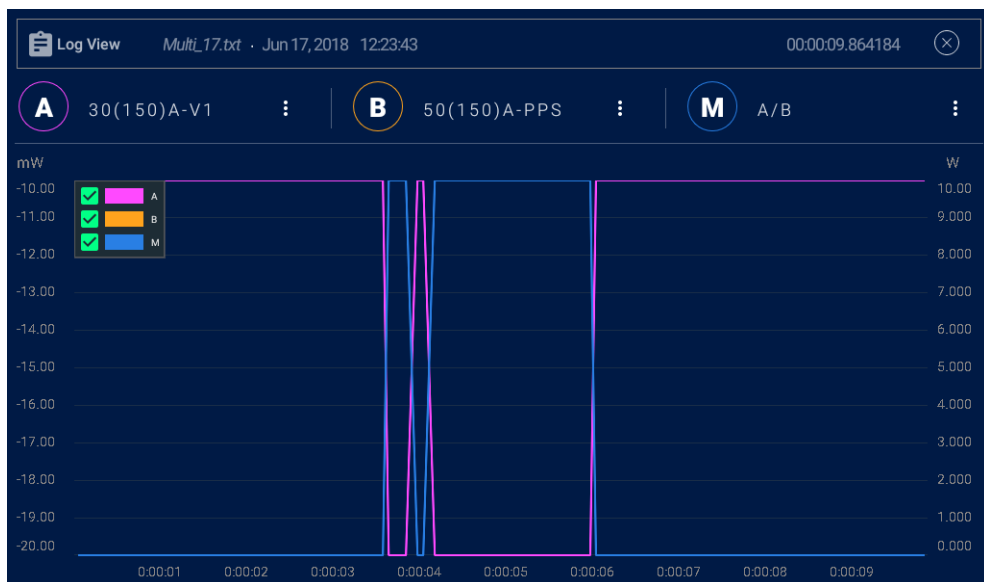


Figure 12-12 Log View of a Merged Math Channel

13 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. x938 provides the ability to store the data and review it with Newport's PMManager 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](#)

13.1 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.

13.2 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.

13.2.1 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.

13.2.2 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.

13.2.3 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.

13.3 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: x938 does not provide the user with the capability to add notes to a log file.

13.4 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.

13.5 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.

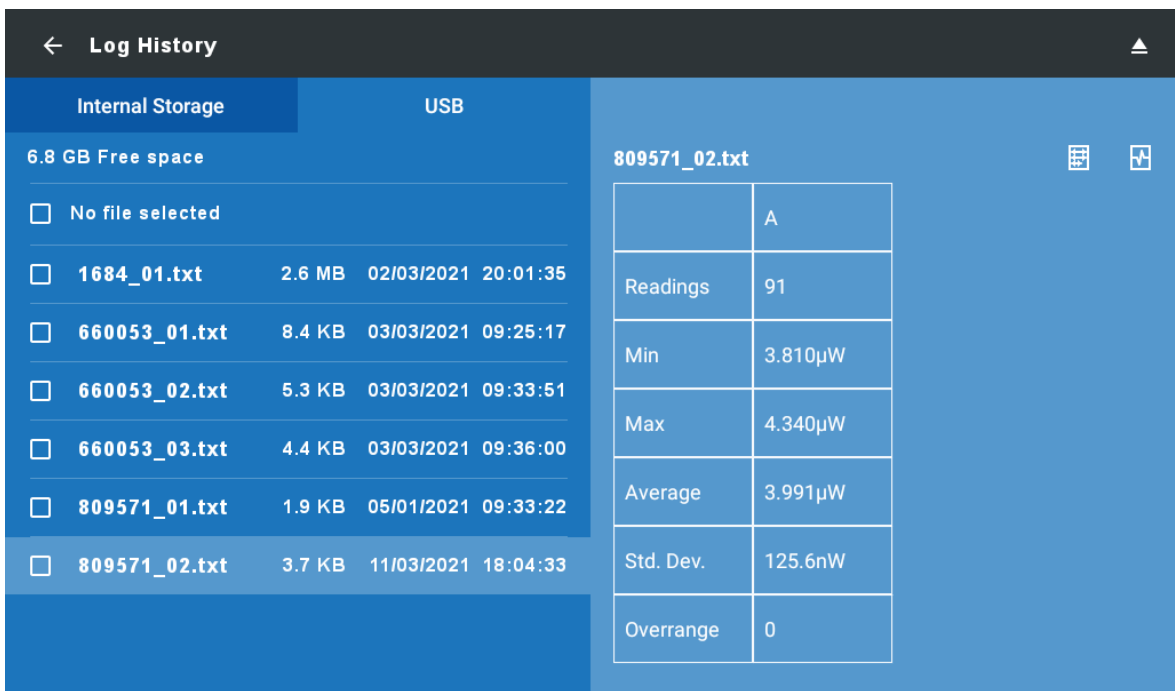
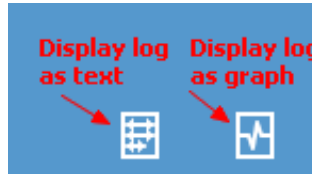


Figure 13-1 List of Log Files saved on an external storage device

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



13.5.1 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.

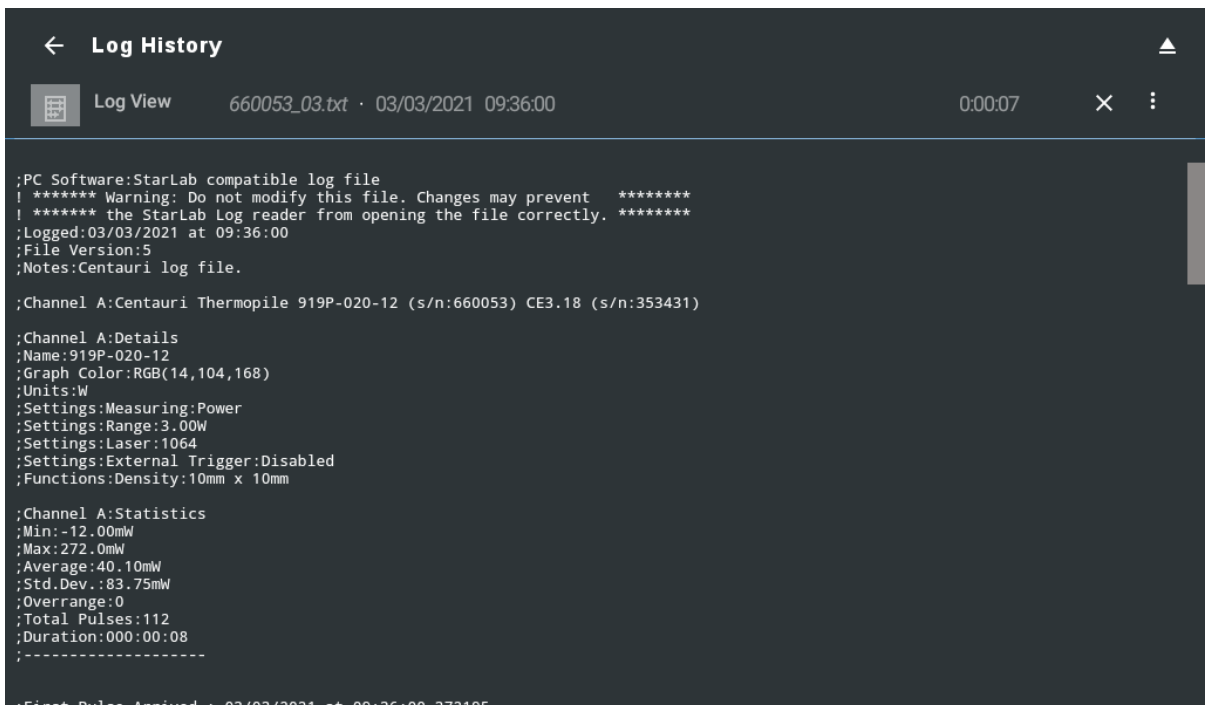


Figure 13-2 Top of text view

Further down the page is the list of logged measurements.

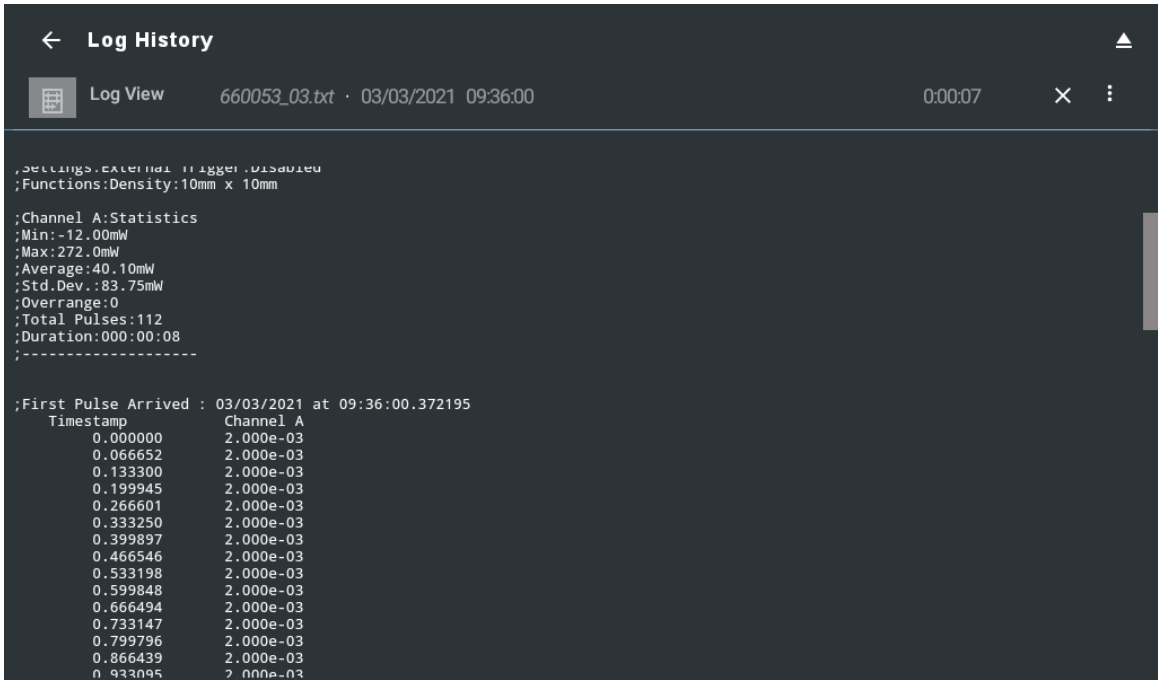


Figure 13-3 Further down in text view

13.5.2 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.

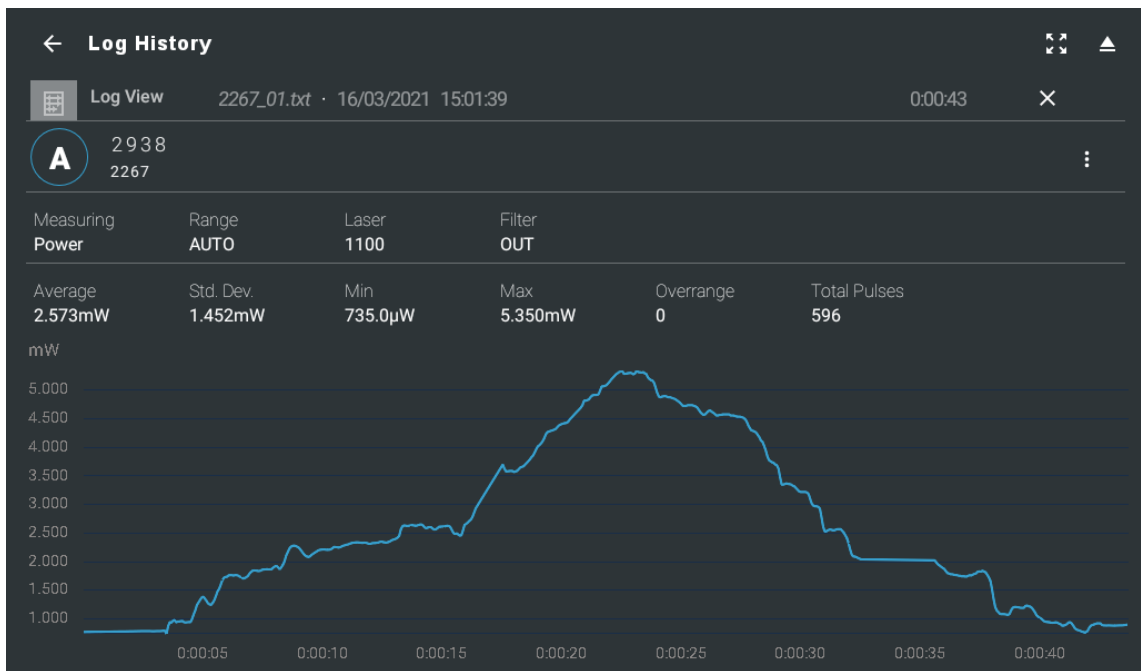


Figure 13-4 Log Graph View Screen

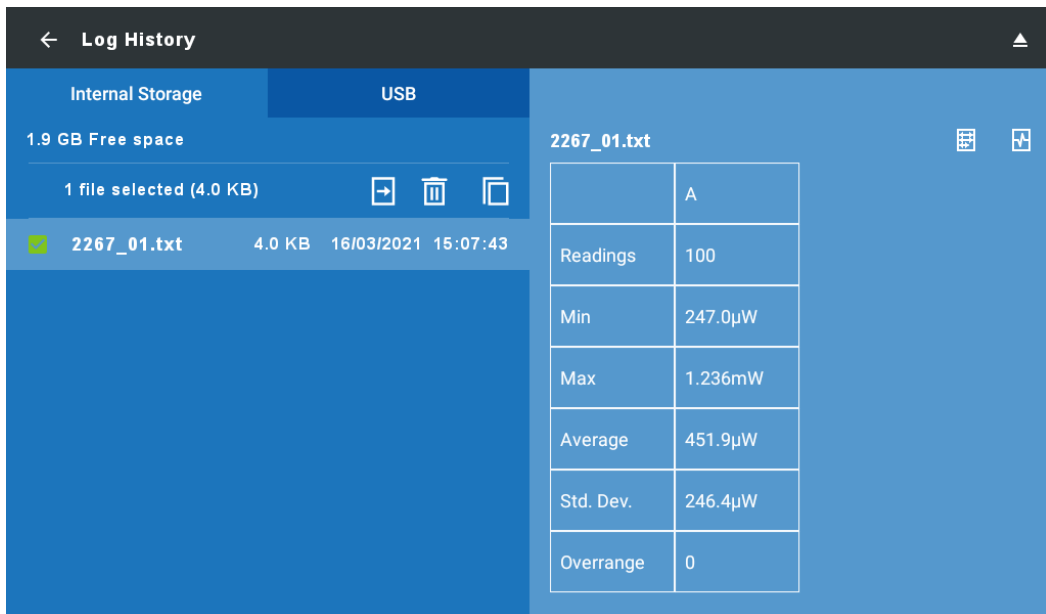
- The top line displays the name of the file, the date, time, logging time elapsed, a button to close the screen, and an icon to allow proper removal of the USB flash drive.

- 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.

13.5.3 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.



13.6 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.

13.7 Viewing the Log File on Your Computer

In addition to reviewing the logged data on x938, you can transfer the data for review at your workstation. You can also view the files directly on PMManager 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 x938 and attach it to your PC.
3. Start the PMManager application and select the **Logging Menu**.
4. Select **Open Log File**, and select the Log file from the flash drive.

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

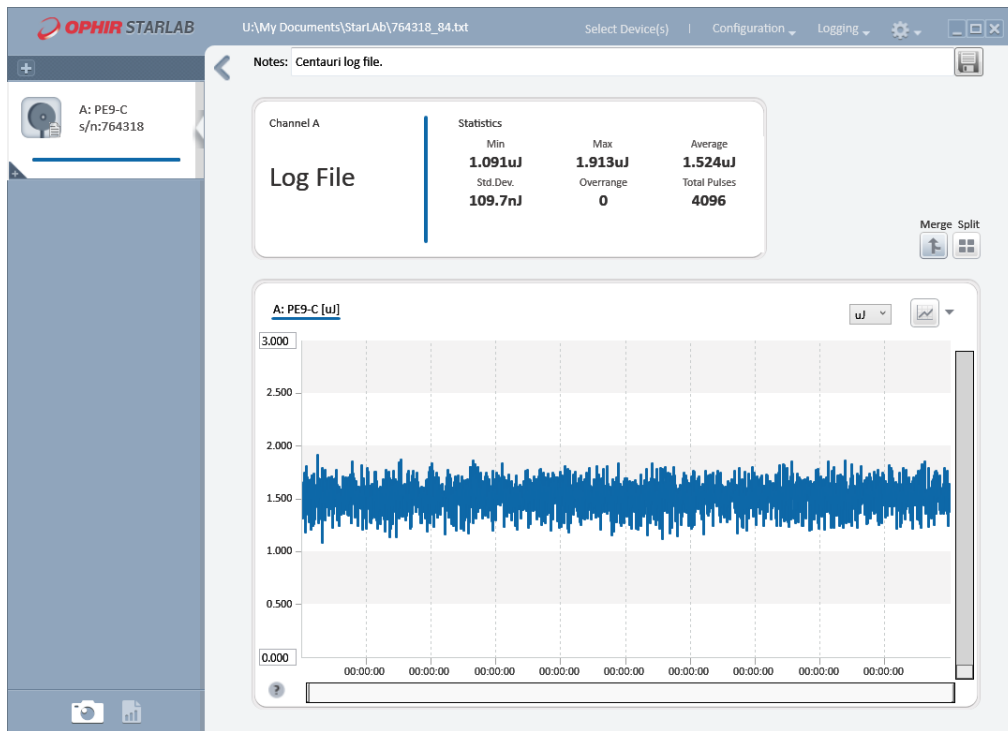


Figure 13-5 Log File in PMManager

14 Circuit Description

The x938 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

14.1 Analog Module

14.1.1 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 x938. 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.

14.1.2 Fast Analog Input

In addition to the above basic analog circuit, the x938 contains a second fast analog input. This supports certain Newport 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.

14.1.3 Analog Output

The analog output is driven through an impedance of 100 ohms and provided as a means of integrating the x938 meter with other instruments (such as an oscilloscope).

14.2 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.

14.2.1 Power Supply

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

14.2.2 EMI Protection

The digital processor circuit and the whole x938 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.

15 Error Messages and Troubleshooting

15.1 Error Messages

The x938 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.
- 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.

15.2 Troubleshooting

15.2.1 x938 Meter

Table 15-1 x938 Meter

Problem	Cause/Remedy

15.2.2 Thermal Sensors, Energy Measurements

Table 15-2 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 .

15.2.3 Thermal Sensors, Power

Table 15-3 Thermal Sensors, Power

Problem	Cause/Remedy
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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.

15.2.4 Pyroelectric Sensors

Table 15-4 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.

15.3 Maintenance

15.3.1 Maintenance of Thermal Sensors

To trace the signal from the thermal sensor to x938:

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 chapter [16.2 Sensor Specifications](#).
3. Using a multimeter set to current, unplug the sensor from the x938 and check that this current appears between Pin 1 and 9 of the D type plug.

16 x938 Specifications

16.1 Meter Specifications

Table 16-1 System/Meter Specifications

General Specifications	
Sensor Compatibility	Thermopile (919P, PEPS series) Photodiode (918D, 818, 819C/D series, 818-MSCOPE) Pyroelectric (919E, LIAD series)
Sensor Connector	15-pin D-Sub type Male; One in 1938-R model (Channel A) Two in 2938-R model (Channel A and Channel B)
Dimensions	216W x 296D x 147H (mm)
Mass	2.8 kg
Display	1024x600 pixel TFT LCD Active area 154x91mm (7") Touchscreen Interface
Display digit height	18mm
LCD Backlight	LED's Backlight level is user adjustable.
Loudspeaker	For audio warnings
Lithium Coin Cell Battery	For clock Backup 3 Volts ENERGIZER Model CR2032 Non-rechargeable battery. Do not attempt to charge.
Operating Temperature Range	5 – 40 degrees C
Relative Humidity	<70% RH Non-condensing
Altitude	<3000m
Use location	Indoor use only
Power Supply	~100-240V AC 50-60Hz Max power 40 Watts
Overvoltage category II	II
Pollution degree of the intended environment	PD2
Degree of ingress protection (IEC 60529)	IPX0

Communications	
Analog Output	User selected 1v, 2v, 5v, or 10v full-scale 0.03% resolution 100 ohms impedance
Analog Output Connector	BNC socket Inner connector positive and outer connector negative (shield) One in 1938-R model (Channel A) Two in 2938-R model (Channel A and Channel B)
Analog output accuracy	±0.2% (of reading) ±0.3% of full scale volts
USB to External Flash Drive	USB A type socket For data logging
USB PC Interface	USB B type socket
RS232 PC Interface	RS232 9 pin D-sub socket Max baud rate 115200
External Trigger input	BNC socket Inner connector positive and outer connector negative (shield) 0 – 5 Volts
TTL Signal Output	BNC socket Inner connector positive and outer connector negative (shield) TTL level voltages One in 1938-R model (Channel A) Two in 2938-R model (Channel A and Channel B)
Ethernet	RJ45 socket 10/100 Ethernet (10Base-T/100Base-TX)
Ethernet protocols supported	Telnet, HTTP, UDP, DHCP
WiFi	Antenna socket for future use

Input Specifications	
Thermal Sensors	
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)	$\pm 0.25\% \pm 20\text{pA}$ new; $\pm 0.5\% \pm 50\text{pA}$ after 1 year
Electrical accuracy (above 1.5mA)	$\pm 0.5\%$
Electrical input noise level	500nV + 0.0015% of input range @3Hz.
Dynamic range	10 decades
Input Specifications	
Photodiode-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)	$\pm 0.25\% \pm 20\text{pA}$ new; $\pm 0.5\% \pm 50\text{pA}$ after 1 year
Electrical accuracy (above 1.5mA)	$\pm 0.5\%$
Electrical input noise level	0.1pA + 0.0015% of input range @3Hz.
Dynamic range	10 decades
Input Specifications	
Photodiode-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)	$\pm 0.25\% \pm 20\text{pA}$ new; $\pm 0.5\% \pm 50\text{pA}$ after 1 year
Electrical accuracy (above 1.5mA)	$\pm 0.5\%$
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

Input Specifications	
Pyroelectric Sensors	
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

16.2 Sensor Specifications

Table 16-2 Max Power Specifications of Sensors

Sensor	Max Power (WATTS)	Max Avg. Power Density at Max Power	Absorber Type
918D-SL/IR/UV-OD3R	2W	30W/cm ²	PD
918D-UV-OD3R	0.2W	30W/cm ²	PD
818-SL/IR/UV-DB	2W	30W/cm ²	PD
818-UV-DB	0.2W	30W/cm ²	PD
819C-UV-2-CAL	0.1W		Int Sph PD
819C-UV-5.3-CAL	0.5W		Int Sph PD
819C-SL-2-CAL2	2W		Int Sph PD
819C-SL-5.3-CAL2	4W		Int Sph PD
819C-IG-2-CAL	1.5W		Int Sph PD
819C-IG-5.3-CAL	4.5W		Int Sph PD
819D-UV-2-CAL	0.1W		Int Sph PD
819D-UV-5.3-CAL	0.5W		Int Sph PD
819D-SL-2-CAL2	2W		Int Sph PD
819D-SL-5.3-CAL2	10W		Int Sph PD
819D-IG-2-CAL	2.5W		Int Sph PD
819D-IG-5.3-CAL	9W		Int Sph PD
819-SL-06-WL			PD
819-IG-06-WL			PD
919P-003-10	3W	1000W/cm ²	BB
919P-010-16	10W	28KW/cm ²	BB
919P-020-12	4(20)W	23KW/cm ²	BB
919P-030-18	30W	20KW/cm ²	BB
919P-050-18HP	50W	0.5KW/cm ²	PF-DIF
919P-050-26	50(150)W	12KW/cm ²	BB
919P-040-50	35(150)W	12KW/cm ²	BB
919P-150-26	150W	12KW/cm ²	BB
919P-250-35	250W	10KW/cm ²	BB
919P-500-65	500W	7KW/cm ²	BB
919P-5KW-50	5000W	2KW/cm ²	BB

919E-20U-10-20K	50mW	50W/cm ²	PD
919E-200U-8-25K	2W	30W/cm ²	PE-ES
919E-0.1-12-25K	2W	50W/cm ²	PE
919E-0.1-12-250	3W	50W/cm ²	PE-BF
919E-10-24-10K	25W	20W/cm ²	PE
919E-10-20-250	30W	120W/cm ²	PE-BF-DIF
919E-10-35-10K	40W	100W/cm ²	PE-DIF
919E-10-35-250	40W	200W/cm ²	PE-BF-DIF
919E-30-46-10K	60W	500W/cm ²	PE-DIF-ER

PD – Photodiode

Int Sph – Integrating Sphere

PF – Volume absorber for short pulses and high average powers

PE – Pyroelectric metallic or black absorber

BB – Broadband surface absorber, high power density

BF – Very high damage threshold, long pulses

ES – Extra Slim

Table 16-3 Maximum Energy Densities for Various Absorbers (Single Pulse)

Absorber Type	Max Energy Density J/cm ²		
	Pulse Length		
	10ns	1μs	300μs
BB	0.3	0.5	3
PF	1.5	1.5	5
PE Metallic	0.1	0.5	4
PE-DIF	1	2	20

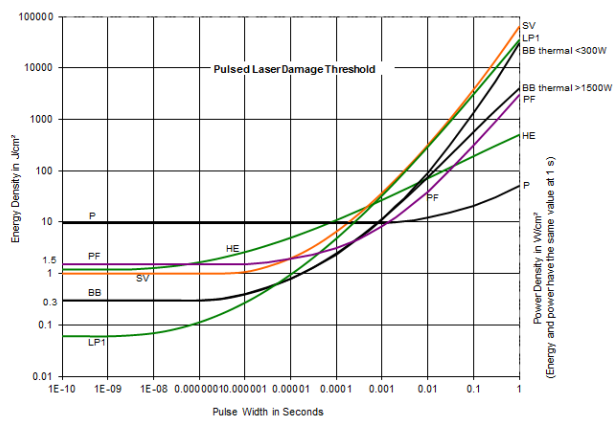


Figure 16-1 Pulsed Laser Damage Threshold for Thermopile Sensors

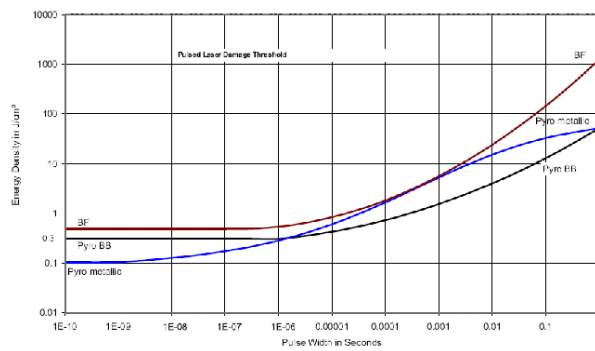


Figure 16-2 Pulsed Laser Damage Threshold for Pyroelectric Sensors

Note: For more detailed sensor specifications please visit our website:
<https://www.newport.com/c/optical-sensors>



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<https://www.newport.com>

x938 User Manual
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For the latest manual version, please visit our website: <https://www.newport.com/c/optical-meters>