User Manual

1940-R / 2940-R SERIES METERS

HIGH-END SINGLE AND DUAL-CHANNEL OPTICAL METERS

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1 Safety Information

1.1 Safety Procedures and Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of intended use of the instrument and may impair the protection provided by the equipment. MKS Inc. assumes no liability for the customer's failure to comply with these requirements.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an MKS Calibration and Service Center for service and repair to ensure that all safety features are maintained.

SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

1.2 Symbols Used in This Instruction Manual

Definitions of, NOTE, CAUTION, WARNING and DANGER messages used throughout the manual.

NOTE	**The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.**
CAUTION	**The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of all or part of the product.**
WARNING	**The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.**
DANGER	**The DANGER sign Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.**

2 Safety Precautions

The following terms and symbols are used in this documentation and appear on the x940 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

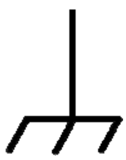


Figure 2-4 Frame or Chassis Terminal Symbol

The symbol in the figure above appears on the 1940/2940 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.

⚠	**WARNING** **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.**

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 x940 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 Introduction

The Newport microprocessor-based **single and dual channel models, 1940-R and 2940-R laser power/energy meters, jointly referred to as the x940 in this manual**, provide a broad range of measurements, displays, and data handling options. The x940 operates with thermal, and photodiode sensors. Smart connector technology enables sensor configuration and calibration information to be stored in an EEPROM in the sensor connector plug, and when the sensor is attached, the x940 automatically identifies the sensor type, calibration, and configuration. Simply connecting the sensor causes the x940 to reconfigure and calibrate to operate with that sensor.

The x940's 7" full-color touchscreen together with panel buttons and a large rotatable and clickable knob, enhance 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 x940 at a touch.

The x940 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 x940 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 such as Newport's PMManager. It is also capable of real-time reporting of data via USB, RS232 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 x940 directly to PMManager. The x940 also has RS232 and Ethernet capabilities for real-time data reporting to a PC.

The x940 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 x940 has the ability for field upgrade of the embedded software (firmware) when required.

3.1 This Document

This document covers everything you need to know to use the x940 for all your laser measurement needs. It includes a Quick Reference (Chapter 4) to enable you to perform basic measurements immediately, without reading the whole manual.

3.2 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

3.3 Support

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

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

4 Quick Reference

This section provides a quick reference for performing basic measurements with the x940 Laser Power/Energy meter.

4.1 Getting Started

The x940 is equipped with a 7" full-color touch screen as well as panel buttons.

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 General 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 x940 provides an indication when recalibration is due:

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

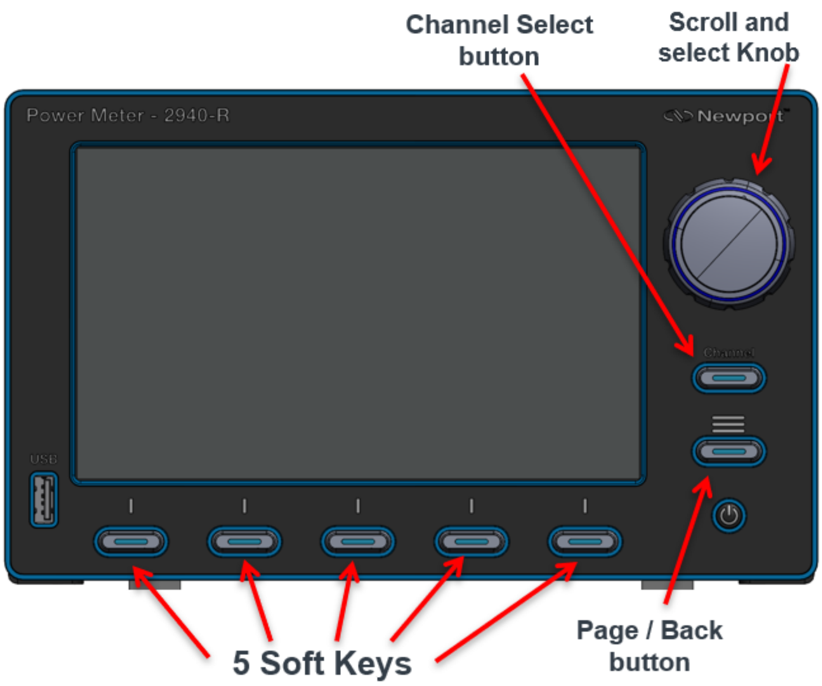
If a sensor is due for calibration, a message to that effect is displayed when it is connected, along with its channel name, model number, serial number, and calibration due date.

The Bottom Bar menu options can be accessed either by tapping them on the touchscreen, or pressing the relevant *softkey* below the bottom menu item.

Other selectable items on the screen may be accessed either by tapping them on the touchscreen, or using the large rotatable knob to navigate and then clicking the knob inwards to select.

The Page/Back Menu button either returns to the previous display or pages through the bottom bar menus.

For the 2940-R two channel model, there is also a Channel Select button.



To connect a single sensor to the x940 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 x940 on:

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

To switch the x940 off:

- Press the power button on the front of the meter.

To set general meter settings:

1. Disconnect the sensor.

   The **General Settings** screen is displayed.

2. Select **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: Select the current date to update the date. In the dialog, roll the month/date/year to the desired date. Select **OK** to exit. Select the current time to update time. In the dialog, roll the hour and minutes to set time according to the 24-hour clock. Select **OK** to exit.

The x940 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. Select **Instrument Settings**.
4. From the Instrument Settings screen, select **Zero** at the bottom of the screen.

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

4.2 Thermal Sensors

4.2.1 Using x940 with Thermal Sensors

1. Plug in the thermal sensor. The x940 reconfigures itself to work with the attached sensor.

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

2. Select the parameters to amend any new values.

   The x940 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 15 Sensor Specifications. Otherwise, there is a risk of damaging the absorber.

4.2.2 Using x940 to Measure Laser Power

1. Set **Measuring Mode** to **Power**.
2. Set **Range** to AUTO or one of the manual ranges. The correct manual range is the lowest one that is larger than the expected maximum power of the laser.
3. Set **Laser** to the appropriate laser wavelength.

4.2.3 Using x940 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 x940 screen flashes READY, fire the laser.

4.3 Photodiode Sensors

4.3.1 Using x940 with Photodiode Sensors

1. Plug in the photodiode sensor. The x940 reconfigures itself to work with the attached sensor.

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

2. Select the parameters to amend them to desired values.

   The x940 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 1515 Sensor Specifications. Otherwise, there is a risk of damaging the sensor.

4.3.2 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 select the edit icon that is next to it to display the **Modify Laser** dialog. Using the keyboard displayed, type in the wavelength you want. Select **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.

4.3.3 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, select the **start/stop** button at the bottom of the screen.
5. Accumulated energy exposure is displayed on the screen, as well as the elapsed time.

4.3.4 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 is best used in conjunction with logging or fast analog output.

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.

4.3.5 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 selecting the arrow and then entering a Pulse Frequency between 5 and 100 Hz.
4. Click **Apply** to exit.

4.4 Graphical Displays

To present measurements on a graduated scale (bargraph):

1. In **Power** or **Energy** mode, roll through the bottom bar until you can select **Display Type**.
2. **In** the **Display Type** dialog, select **Bar**.

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

To simulate an analog needle:

1. In **Power** or **Energy** mode roll through the bottom bar until you can select **Display Type**.
2. In the **Display Type** dialog, select **Needle**.

   The main sensor measurement screen displays a needle graph.
3. To expand the needle graph, slide **Zoom** in the bottom bar. 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** in the bottom bar. 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, roll through the bottom bar until you can select **Display Type**.
2. In the **Display Type** dialog, select **Line**.

   The main sensor measurement screen displays a 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. Select **Autoscale Y Axis** in the bottom bar to scale the axis between the minimum and maximum readings.
7. Select **Reset** in the bottom bar 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, roll through the bottom bar until you can select **Display Type**.
2. In the **Display Type** dialog, select **Pulse**.

The main sensor measurement screen displays a 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. Select **Autoscale Y Axis** in the bottom bar to scale the axis between the minimum and maximum readings.
7. Select **Reset** in the bottom bar 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, roll through the bottom bar until you can select **Display Type**.
2. In the **Display Type** dialog, select **Pass/Fail**.

   The main sensor measurement screen displays a Pass/Fail screen.
3. Select **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, roll through the bottom bar until you can select **Display Type**.
2. In the **Display Type** dialog, select **Statistics**.

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

4.5 Functions

To enter the Functions menu, roll through the bottom bar until you can select 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, select and 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, select and set to **Peak-to-Peak**

Select 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, select and set to **RMS**

Select 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, select 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. Select **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, select the edit icon for **Scale Factor**.

In the **Set Scale Factor** dialog, type in a scale factor and select **Apply**.

To normalize against a reference measurement:
Define a baseline against which to compare subsequent measurements.

On the Functions screen, select 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. Select **Apply**.

To display as power/energy density:

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

In the **Set Density Parameters** dialog, select the beam shape and then enter the size. Select **Apply**. Measurements are shown as W/cm².

4.6 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 x940 on a PC from the PMManager application, and use PMManager to log and analyze data on the PC. For details, see Measurement Logging .

5 Using the x940 Meter

This section describes the x940 meter, hardware functions, interfaces, and general operation.

Topics include:

- x940 Hardware Components and Interfaces
- Zero Adjustment
- Offset
- Using the General Settings Menu
- Configuring Measurements
- Using PMManager

5.1 The x940 Meter

- The Back panel has the following sockets: AC Power Input, RS232, Ethernet and USB ports, TRIG IN BNC connector, and channel/s sockets– two channels with the 2940-R model - for each sensor input, and BNC Analogue and TTL outputs. The Wi-Fi antenna socket and the 'GP Out' BNC connectors are for future use.

Figure 5-1 1940-R Single Channel Back Panel

Figure 5-2 2940-R Dual Channel Back Panel

- The front panel of the x940 meter has a 7 " color touchscreen, a ON/OFF illuminated push button, a USB socket for attaching a USB flash drive, soft keys and a turntable clickable knob. The front panel is the same for both 1940-R and 2940-R meters, except for the channel select key.

Figure 5-3 1940 Front Panel

Figure 5-4 2940 Front Panel

5.2 x940 Hardware Components and Interfaces

This section describes the x940 hardware components and interfaces.

5.2.1 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 5-5 below.

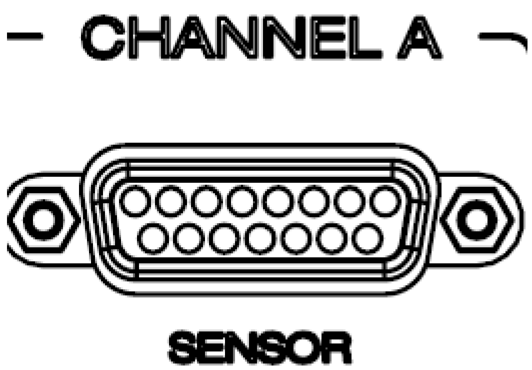


Figure 5-5 x940 Back Panel sensor input

To connect a sensor to the x940 meter:

Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor** on the back panel of the x940 meter. If using the 2940-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 can be split or merged, to display measurements and allow configuration for both channels.

5.2.2 Switching ON and OFF

This section describes how to switch the x940 on and off.

To switch the x940 on:

- Press in the power button on 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 **General Settings** menu is displayed, providing access to various configurations and the log history.

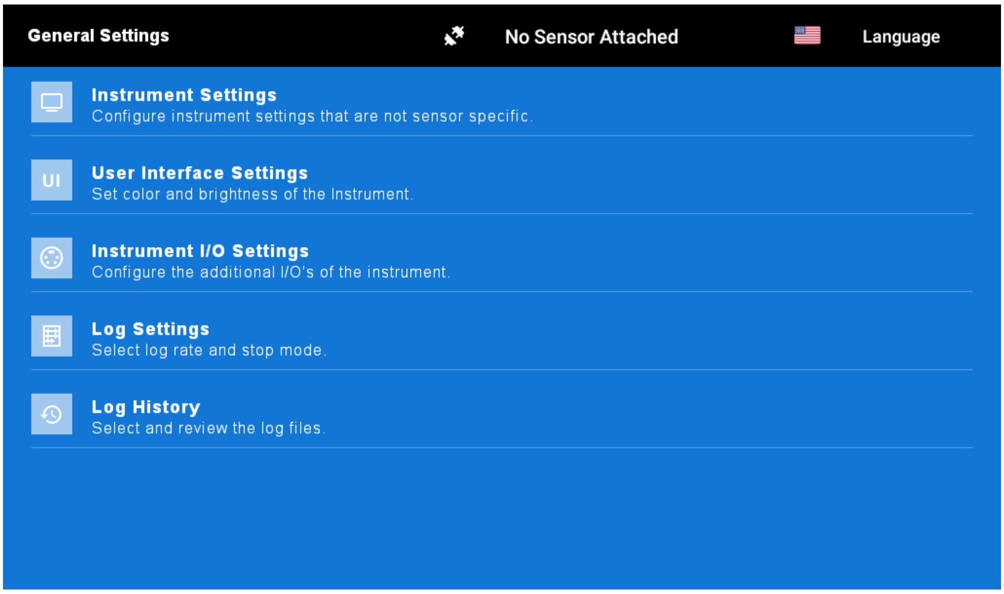


Figure 5-6 Main Settings Menu

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

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

To switch the x940 off:

- Press out the front panel power button.

5.2.3 x940 User Interface

The x940 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 5-7 below displays the layout of a typical x940 measurement screen.

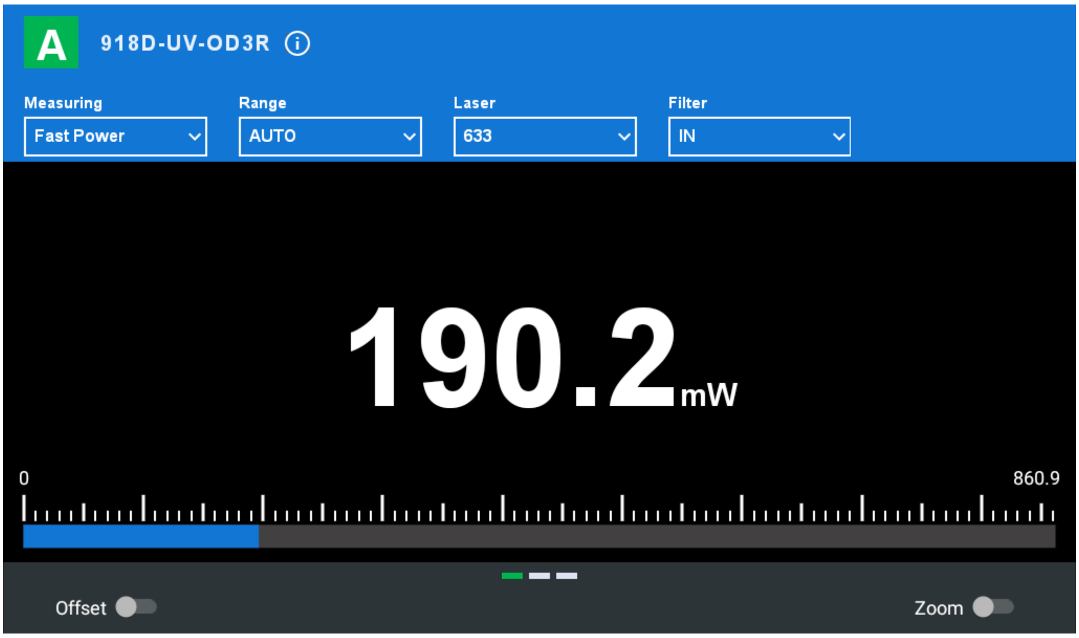


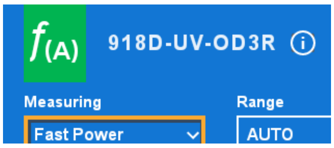
Figure 5-7 x940 Measurement Screen Layout

When a sensor is attached to the x940, the measurement screen is displayed, and the touchscreen contains the following areas:

The top line contains the Channel A or B designation, the sensor name and a circled i icon which opens a window containing detailed sensor information.

Selecting **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. Calibration dates are set in the factory.

An ƒ indication will appear in the Channel designation when one or more math functions are set.



The second 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.

At the bottom of the screen is the Bottom Bar menu. Options can be accessed either by tapping them on the touchscreen, or pressing the relevant softkey below the bottom menu item.

5.2.4 Analog Output

The x940 provides an analog voltage output via a BNC socket on the rear panel marked **ANLG OUT** (see Figure 5-8). The analog output is useful for driving analog devices. When the Range Type is set to Physical, then the voltage of the Raw analog output is scaled to the proportion of measurement within the set measurement Range, and scaled such that the full measurement range is equivalent to the full voltage range - either 1, 2, 5, or 10 volts as configured.

(When range type is set to Logical, then only the Digital analog output voltage is precisely scaled to the measurement, while the Raw analog output will then not be precisely scaled to the set range.)

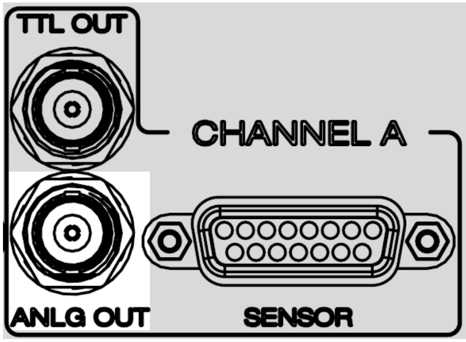


Figure 5-8 x940 Analog Output socket

To set the analog output voltage:

1. Roll through the bottom bar until you can select **H/W Settings**.

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

2. To the right of **Analog Output** is a max voltage selection box, select the relevant voltage setting: (**1V**, **2V**, **5V**, **10V**).
   The analog output is driven through an impedance of 50 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.

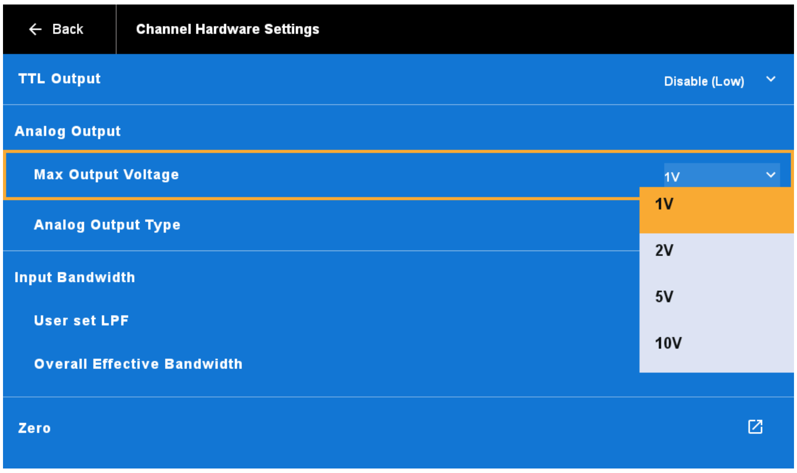


Figure 5-9 Channel Hardware Settings Screen

Analog Output: Digital

This is only available when the **Range Type** is set to **Logical**.

The digital output is the analog voltage representation of the measured (processed) laser power as displayed on the x940 screen.

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

(For thermal sensors in single shot energy mode, the analog output is held until the next pulse is measured.)

Analog Output: Raw

The Raw analog output is continuous: it is not updated as the digital output is. The analog input from the photodiode sensor is routed directly to the analog output voltage, with amplification of the signal.

If a user selected LPF Input Bandwidth is chosen under Channel Hardware settings, that bandwidth limiter it is applied to the raw analog output.

To set the analog output type

1. Roll through the bottom bar until you can select **H/W Settings**.
2. The **Channel Hardware Settings** screen is displayed.
3. From the **Analog Output Type** selection box, select the relevant setting: (**Digital/Raw**.

Input Bandwidth limiter – User Set LPF

This **User Set** L**ow** P**ass** F**ilter** allows you to apply an additional analog filter to the measurement to reduce noise or spikes.

To set the LPF:

1. Roll through the bottom bar until you can select **H/W Settings**.
2. The **Channel Hardware Settings** screen is displayed.
3. From the **Second Stage Analog Filter** line, select from the selection box and then select the relevant frequency setting: (**None, 250 kHz, 50kHz, 10kHz, 1kHz, 100Hz, 5Hz, 0.5Hz**).

5.2.5 RS232

The x940 is equipped for RS232 communications.

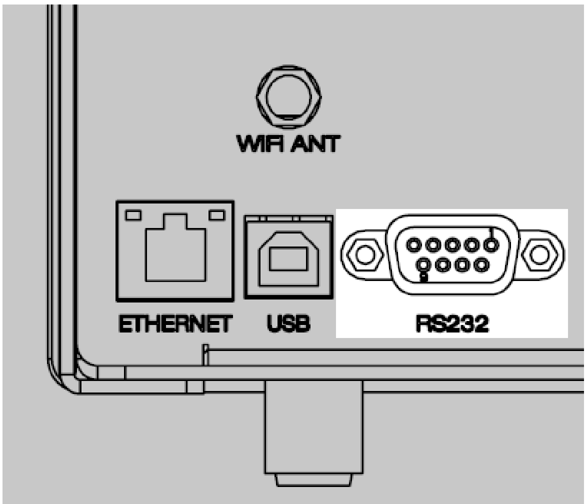


Figure 5-10 x940 Rear View with RS232 input highlighted

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 **General Settings** screen on the bottom bar, select **Instrument I/O Settings**.

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

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

5.2.6 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).

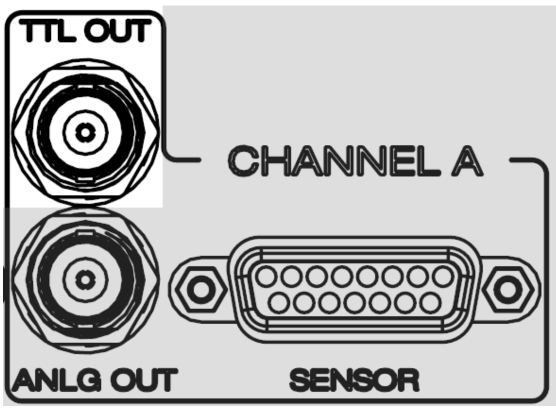


Figure 5-11 TTL Output

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. Roll through the bottom bar until you can select **H/W Settings**.

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

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

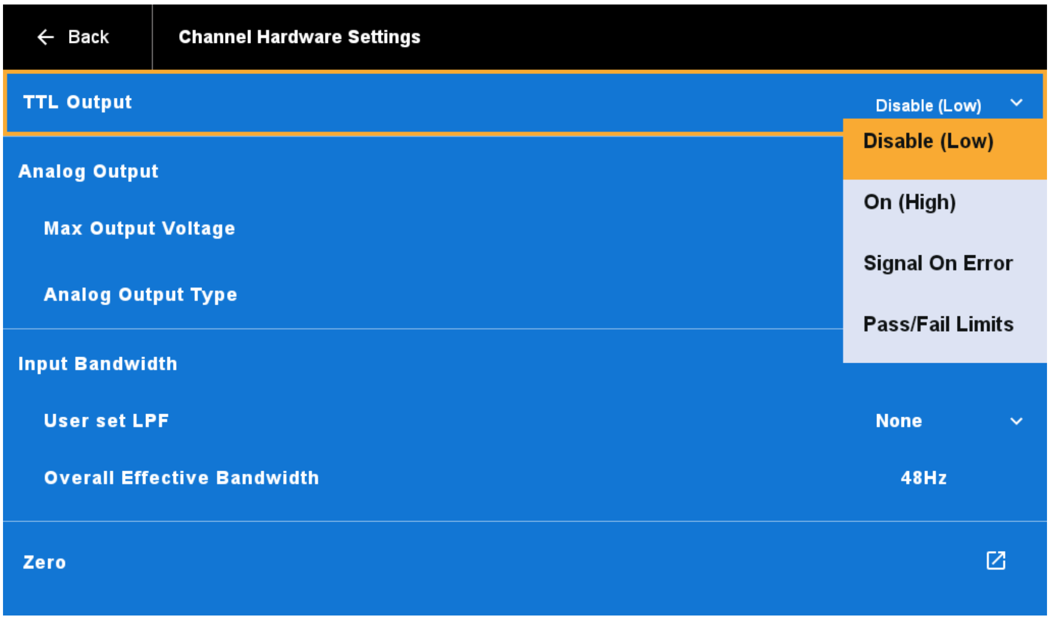


Figure 5-12 Channel Hardware Settings Screen

5.2.7 External Trigger

The x940 includes External Trigger BNC connectors.

Each TRIG IN input can be utilised individually when using the dual channel 2940-R meter.

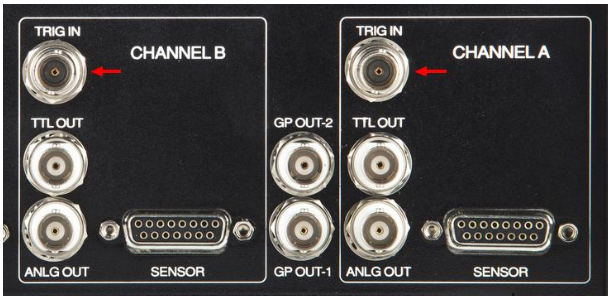


Figure 5-13 x940 Rear View with TRIG IN highlighted

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 only for Pyroelectric sensors only.

In this mode, the x940 measures pulses that happen within a user-defined window of time after the External Trigger goes to high. After that period of time, the level of the Trigger input is ignored until it goes low and is therefore re-armed to trigger a new measurement window. The user defined window can be up to 50mS.

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

Trigger on Falling Edge:

This trigger mode applies only for Pyroelectric sensors only.

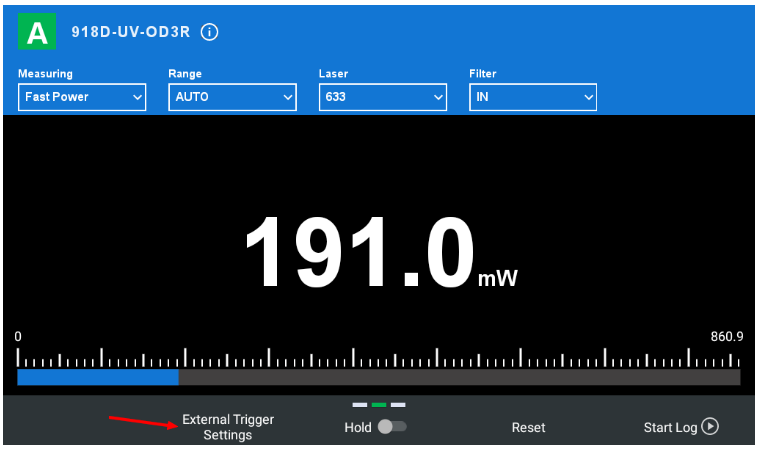
In this mode, the x940 measures pulses that happen within a user-defined window of time after the External Trigger goes to low. After that period of time, the level of the Trigger input is ignored until it goes high and is therefore re-armed to trigger a new measurement window. The user defined window can be up to 50mS.

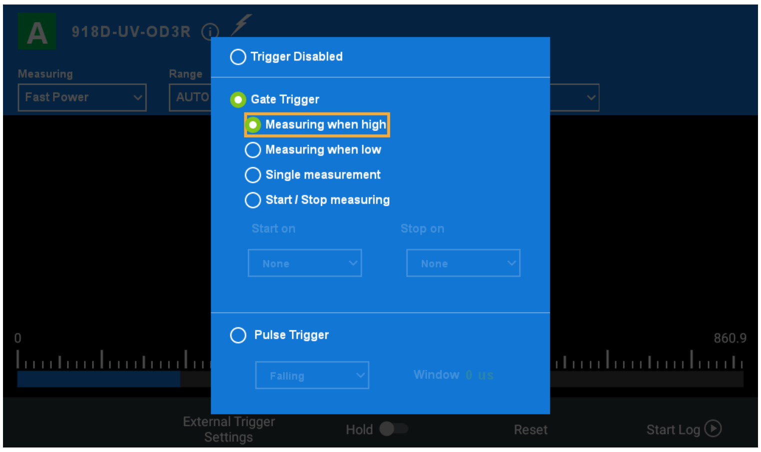
In this mode, it is possible to measure missing pulses. A missing pulse is defined as a trigger happening yet the sensor does not report a pulse.

To set the external trigger:

1. Roll through the bottom bar until you can select **External Trigger Settings.**
2. Select 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 selecting the current number, using the keypad displayed to enter a value, and then select Apply.
3. Select the Gate Trigger for High, Low, Single, Start/Stop Triggering





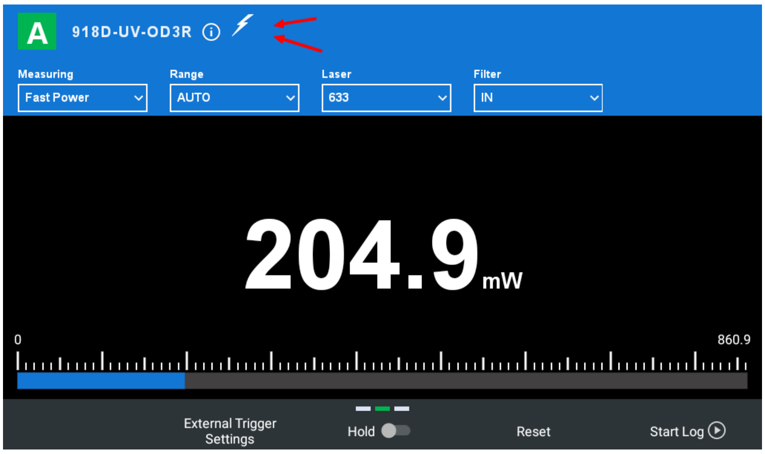


Table 1-1 External Trigger Input Modes

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

5.2.8 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 x940. When the connection is made with the PC application, the x940 touch screen and keys are locked to prevent conflict with the PC application, and “Touch Response and Keys are Locked” is displayed at the top of the x940 screen.

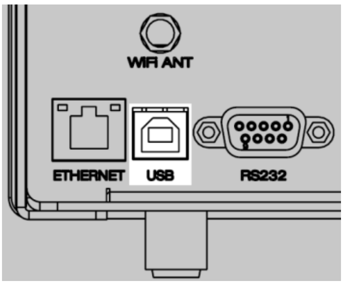


Figure 5-14 x940 Rear View with USB socket highlighted

5.2.9 USB Flash Drive Socket

The USB socket on the front panel 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 5-15 x940 Front View of USB Flash drive Socket

When removing the external storage device from the x940, first select the ‘eject’ triangle icon on the Instrument I/O Settings screen and then wait a few moments for the flash drive to disconnect before removing. See Figure 5-16

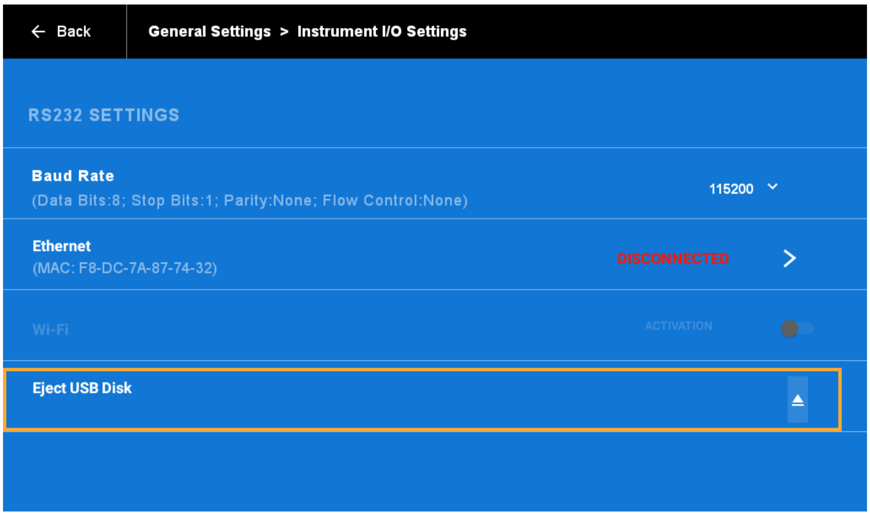


Figure 5-16 x940 Screen with USB Flash Drive release icon highlighted

5.2.10 Loudspeaker

The loudspeaker allows the x940 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.

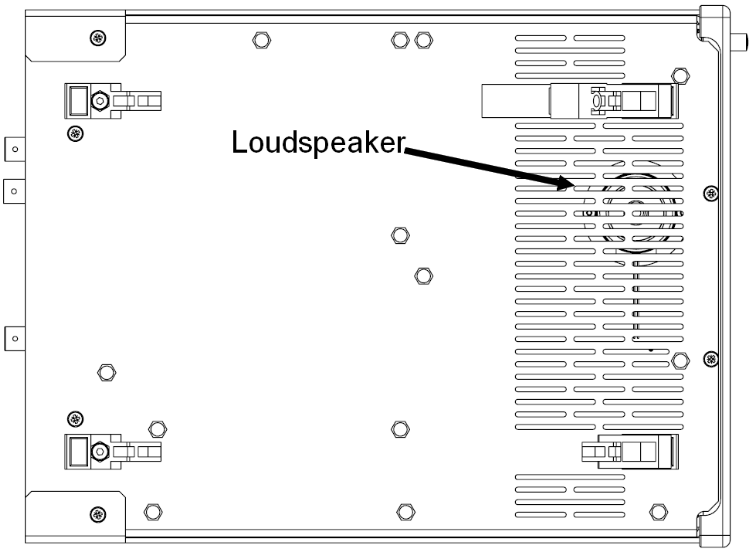


Figure 5-17 x940 Bottom Panel with speaker highlighted

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.

5.2.11 WiFi Antenna Socket

For future use

5.2.12 Ethernet Communication

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 x940. When the connection is made with the PC application, the x940 touch screen and keys are locked to prevent conflict with the PC application.

5.3 Zero Adjustment

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 x940 run for at least 10 minutes before performing zero adjustment.
3. Select **Instrument Settings.**
4. From the **Instrument Settings** screen, select **Zero**.

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

Zeroing the meter with the sensor attached

For the most accurate calibration, you can also zero the sensor against the x940 it is being used with, however the sensor should be covered.

1. Make sure the sensor is in a quiet environment and not subject to laser radiation, light * or heat**.
2. Roll through the bottom bar until you can select **General Settings**.
3. Select **Instrument Settings**.
4. On the Instrument Settings screen, select **Zero**.
5. In the **Zeroing Instrument** dialog, select **Start**. Zeroing takes about 30 seconds. Wait until "Zeroing completed successfully" is displayed.
6. Select **Save** to save the zero values. Select **Exit**.

*When zeroing with **photodiode sensors**, make sure to 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.

5.4 Offset

The **Offset** function available on the bottom bar can be used to temporarily subtract the background and set the current reading to zero.

5.4.1 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 x940 shows a non-zero power reading even when there is no laser: you can subtract the background using the Offset function. For example, the x940 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 x940 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 5-18 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.

5.4.2 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.

5.4.3 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.

5.4.4 Measuring Loss Using the dB Offset Function

Since dBm is a logarithmic measurement, the ratio between two measurements is the difference between the dBm measurements. For instance, say you want to measure the loss in a fiber optic cable where the measurement before the cable is 1mW = 0dBm and the measurement after the cable is 0.1mW = -10dBm. The ratio is then 1:10 = 0.1 and the dB loss is 0 – (-10) = 10dB.

The dB offset function enables you to measure this easily.

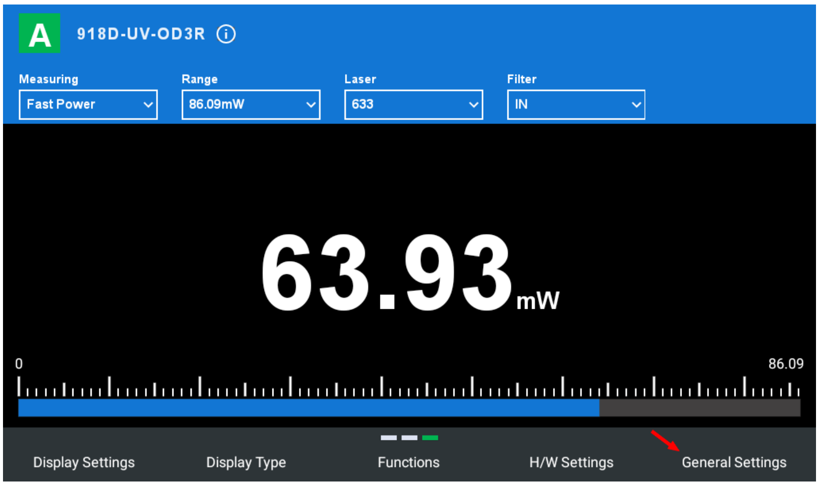
To measure loss using the dB Offset function:

1. When measuring the reference value, select **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, select **Offset** and subtract the zero offset. Then follow steps 1 and 2 above. The zero offset subtracted when **Offset** was selected is saved in the dBm scale and you can now use the dB Offset setting to measure the true ratio without zero offset problems.

5.5 Using the General Settings Menu

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



(When no sensor is connected, the x940 General Settings menu is displayed upon power-up.)

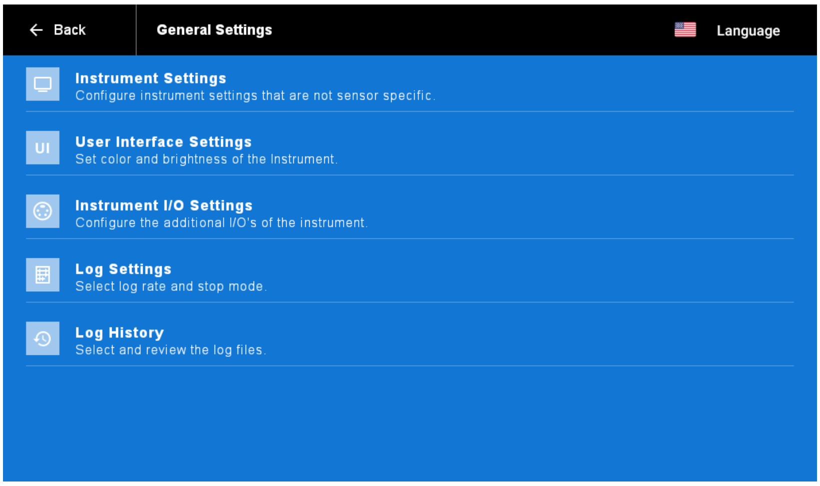


Figure 5-19 General Settings Menu

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

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

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

Sub-topics in this section include:

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

5.5.1 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, the line frequency, and the Range Type.

The x940 automatically saves all current settings for the next time the meter is turned on.

Figure 5-20 Instrument Settings Screen

Real-Time Clock

The x940 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, select 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. Select **OK** to exit.

To set the time

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

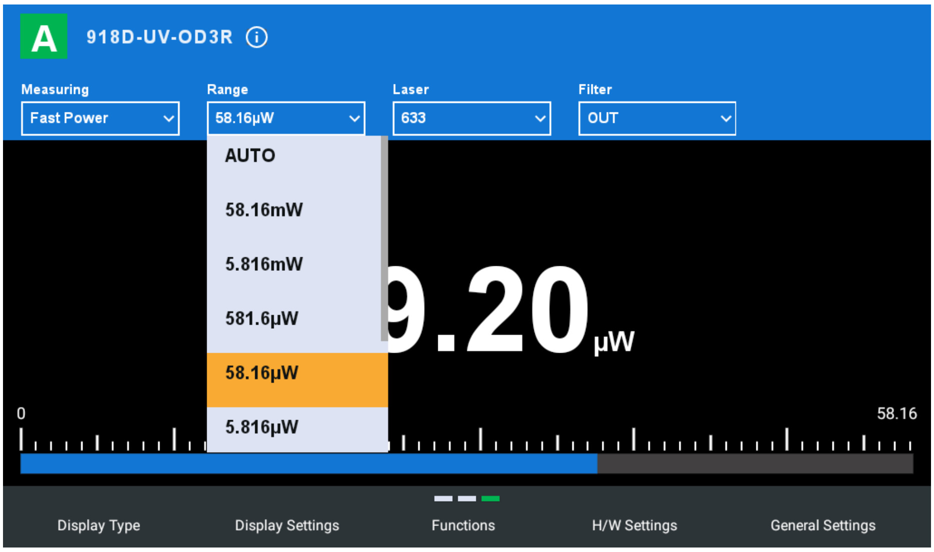
Range Type

1. **Physical**

In this mode the internal hardware Amps Scales translate directly into user selectable Power Ranges.

The resulting full scale of the selectable Power Ranges will then have values which are non-rounded numbers.

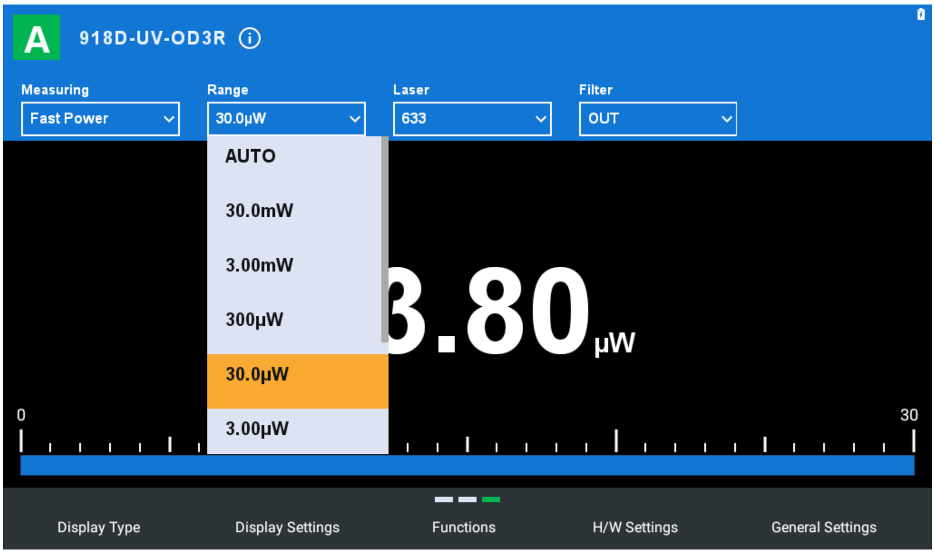
HOWEVER, the advantage of this mode is that the Raw Analog Output full-scale (volts) will be equivalent to the chosen Power Range full-scale.



2. **Logical**

In this mode the Power Ranges are fixed “virtual” power ranges with nice round numbers, and are not linked directly to the internal hardware Amps Scales. Instead they are “mapped” by the firmware depending on the required max amps for each case.

Due to the indirect per case mapping of the Logical Power Ranges to the hardware Analog Scales, the Raw Analog Output full-scale is not exactly equivalent to the chosen Power Range full-scale. However the Digital Analog Output full-scale is equivalent to the chosen Power Range full-scale



Zeroing

1. Select Zero at the bottom of the screen.
2. The Zeroing Instrument dialog is displayed. Select Start.
3. Zeroing takes about 30 seconds. Wait until “Zeroing completed successfully” appears.
6. Select Save to save Zero values and then select Exit.

5.5.2 User Interface Settings

This screen enables setting the color scheme and brightness of the x940 display, the interface language, and configuration of audio warning.

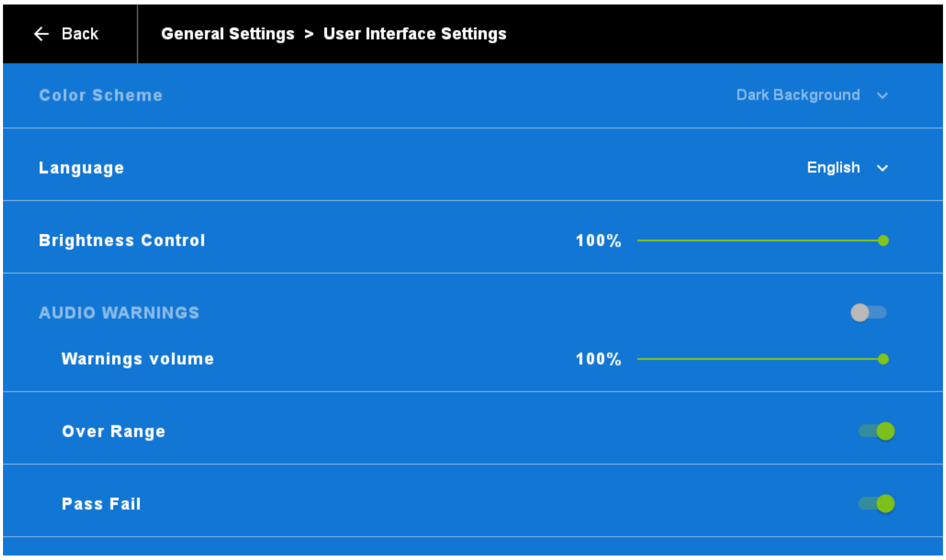


Figure 5-21 User Interface Settings Screen

Color Scheme

You can configure the x940 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 **General Settings** screen, select **User Interface Settings**.
2. On the **Color Scheme** line, select the current color scheme and then select 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 **General Settings** screen, select **User Interface Settings**.
2. On the **Color Scheme** line, 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

Brightness Control

To adjust the display brightness:

1. From the **General Settings** screen, select **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 **General Settings** screen, select **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 **General Settings** screen, select **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 **General Settings** screen, select **User Interface Settings**.
2. On the **Over Range** line, select 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 **General Settings** screen, select **User Interface Settings**.
2. On the **Pass Fail** line, select 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 **General Settings** screen, select **User Interface Settings**.
2. On the **Screen Touch** line, select 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 General Settings menu.

Languages presently supported are:

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

5.5.3 Instrument I/O Settings

You can configure additional I/O settings for x940 from the Instrument I/O Settings screen

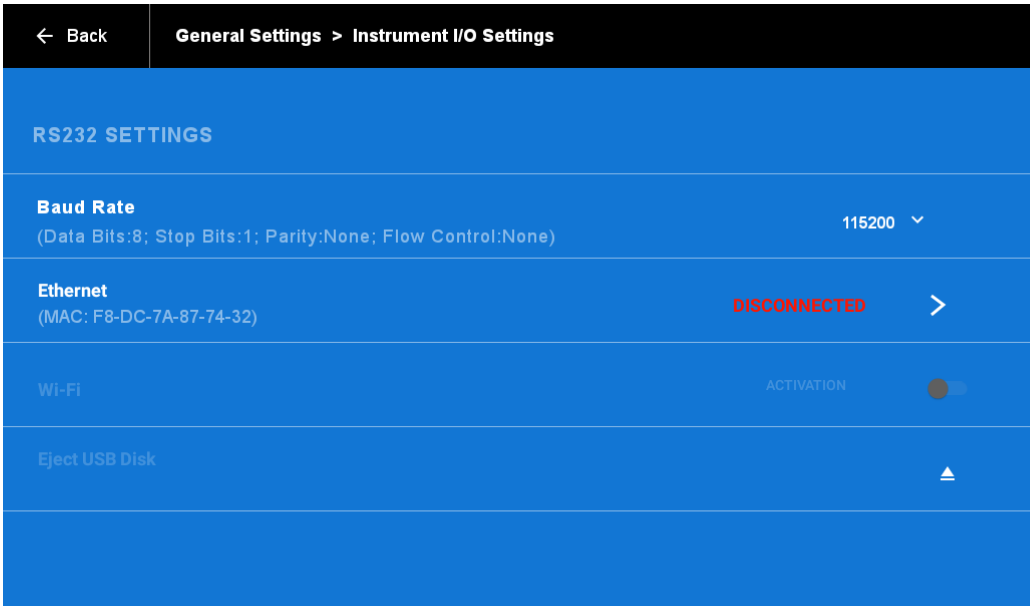


Figure 5-22 Instrument I/O Settings Screen

RS232 Baud Rate

You can set the baud rate for communication through the x940 serial COM port. For further information see RS232.

Ethernet Connectivity

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

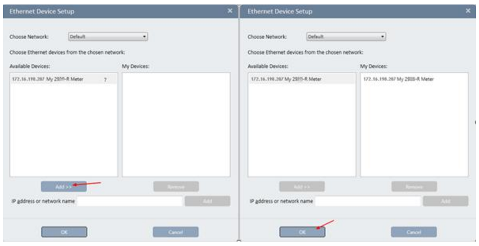
When the meter is not connected via Ethernet, ‘Disconnected’ will appear in red.

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 following example 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.

5.5.4 Log Settings

This screen is described in the Chapter for Log Settings.

5.5.5 Log History

This screen is described in the Chapter for Log History

5.6 Configuring Measurements

The Quick Reference contains a quick introduction to using the x940 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.

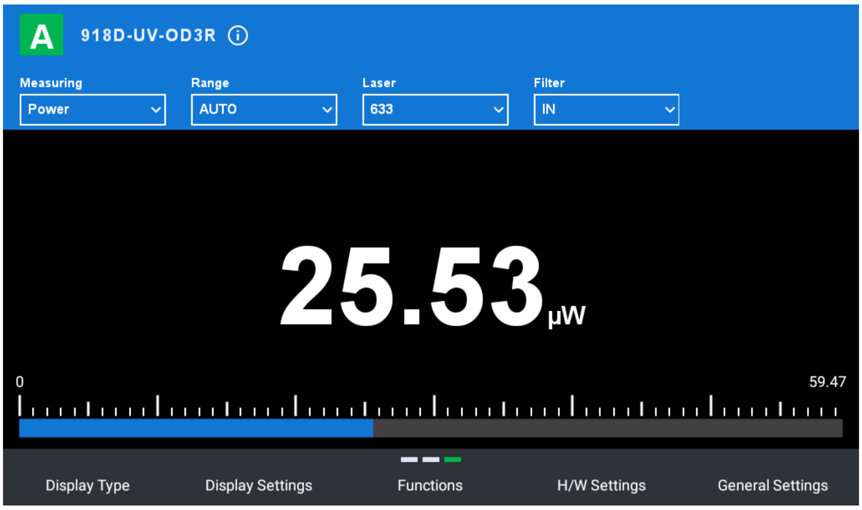


Figure 5-23 Photodiode sensor measurement screen with sensor parameters highlighted

The measurement screen comprises the following:

- On the top line is the channel identifier, A or B, which would also indicate whether a function is configured for that channel, and next is the sensor's name and a selectable ***i*** in a circle that can display the sensor serial number and calibration date.
- On the second line are the sensor parameter settings. The sensor parameters, including Measuring Mode, Range, Laser, Filter, are configured by selecting the parameter, and then the value is selected from the drop down list.
- Large numeric display.
- On the bottom of the screen is a swipe-able **Bar**, which includes **Offset** and **Zoom**, **External Trigger Settings, Hold, Reset, Start Log, Display Type, Display Settings, Functions, H/W Settings, General Settings.**

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

FUNCTIONS

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

H/W SETTINGS

Selecting **H/W Settings** produces the Channel Hardware Settings Screen.

Channel Hardware Settings Screen

The **Channel Hardware Settings** menu enables configuration of the TTL Output, Analog Output, and, Second Stage Analog Filter features as well as Zeroing.

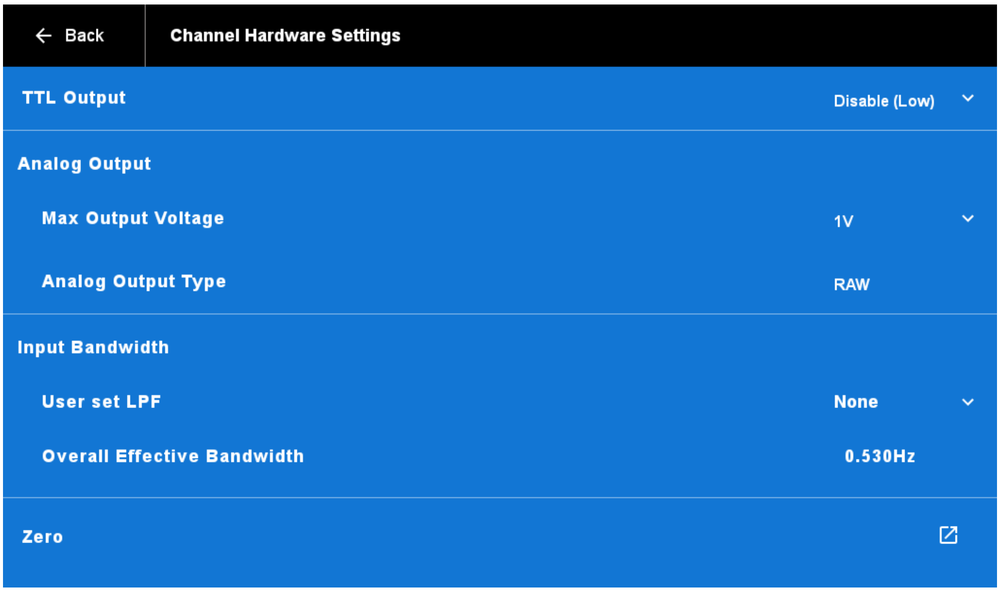


Figure 5-24 Channel Hardware Settings Screen

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 x940 provides an analog voltage output via a BNC socket on the rear panel marked ANLG (see Figure 5-8). 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.

5.7 Using PMManager

You can connect x940 to the PMManager application on a PC for complete remote control from a PC. While the x940 is connected to PMManager in this way, the PC acts as a full-featured display, and the x940 is locked; the notice “Touch Response Locked” is displayed on the screen.

To connect x940 to PMManager

- Connect the supplied USB cable from the PC to the USB back panel socket on the x940.
- Alternatively, connect a network cable to the Ethernet back panel socket on the x940.

6 Points to Consider

Before using the x940 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 x940 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 x940 meter, and the data logging and math processing capabilities that make the x940 meter the complete answer to your measurement needs.

7 Thermal Sensors

For a list of the available thermal sensor models that can be used with the x940, see chapter 15 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 15 Sensor Specifications.

If the sensor is a water-cooled type, ensure that the cooling water is flowing at an adequate rate (see Table 7-1 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 7-1 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 x940. Energy of a single pulse is measured on the x940 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 x940 can be set to various settings while operating, and it automatically saves the settings for the next power-up. This way the x940 is in the desired configuration when turned on the next time.

On power-up, the x940 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 x940 with Thermal Absorber Sensors
- Measuring Laser Power with Thermal Sensors
- Measuring Laser Energy with Thermal Sensors
- Measuring Laser Pulsed Power with Thermal Sensors

7.1 Operation of x940 with Thermal Absorber Sensors

To use x940 with thermal sensors:

1. Connect the thermal sensor to the x940 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 x940 reconfigures itself to work with the attached sensor.

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

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

Note: The x940 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 15 Sensor Specifications, as there is a risk of damaging the absorber.

7.2 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. Measurement parameters are updated in the measurement screen.

To measure laser power using thermal sensors:

1. Set **Measuring Mode** to **Power**.
2. Set **Range** to **AUTO** or to one of the manual ranges, as follows:
   - **AUTO**: Select autoranging when the laser power is unknown or varies widely. In autorange, you do not have to change 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 x940 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.

7.3 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.

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 x940 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 x940 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.

7.3.1 Measuring Pulses of Very Low Energy

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

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

  Average Energy per pulse = Average power / Pulse Repetition Rate

- A train of a known number of pulses can be fired, and the total energy measured in Energy mode. This train should not exceed 5 seconds in duration. The energy per pulse can be calculated by:

  Average Energy per pulse = Total Energy / Number of Pulses

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

7.3.2 Measuring Energy of Rapidly Repeating Pulses

With a typical thermal sensor, the x940 only measures individual pulses every five seconds or so. You can also calculate the average energy of rapidly repeating pulses by measuring average power on the power setting and using the formula:

Average Energy per Pulse = Average Power / Pulse Repetition Rate

7.4 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, select **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 x940 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 x940 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.

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

7.4.1 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.

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 15 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 x940 meter amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the x940, the noise level is very low, and the photodiode sensors with the x940 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 x940 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 EEPROM. 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 15 Sensor Specifications.

The following Subtopics in this Chapter include:

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

8.1 Operation of x940 with Photodiode Sensors

To use x940 with photodiode sensors:

1. Connect the photodiode sensor to the x940 meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor** on the back panel of the x940 meter. x940 reconfigures itself to work with the attached sensor.

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

2. Select the current value of the sensor parameter you want to change, and then select the relevant value.

3. Repeat for all parameters to be modified.

Note: The x940 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 15 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 x940 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 x940 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.

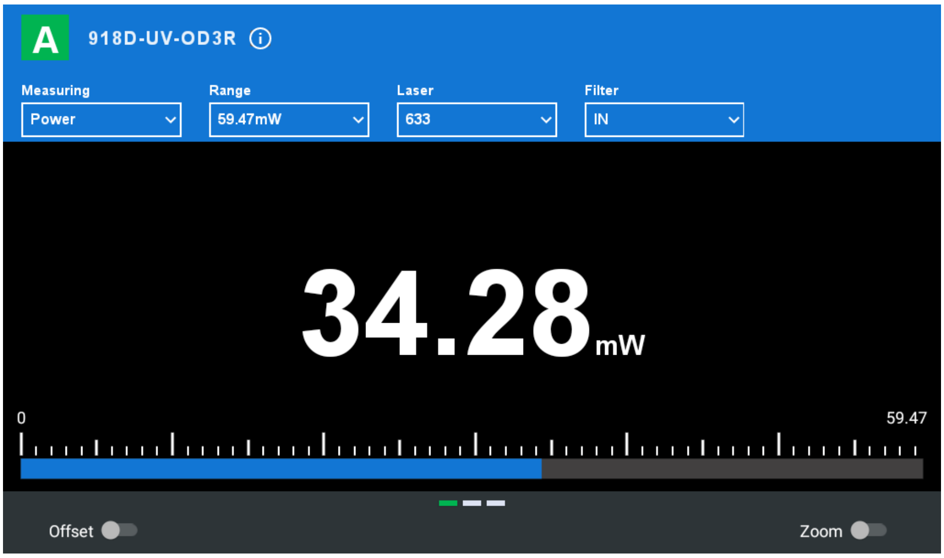


Figure 8-1 Photodiode Power Bar Graph

8.3 Averaging and Measuring Very Low Power Measurements

In standard Power measurement mode, the power is measured 15 times per second. In Fast Power mode, the power is measured 10,000 times a second. If the laser power is fluctuating, the x940 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, and if there is a zero offset coming from the detector as well as noise fluctuations, you can measure these low values by using the average function and selecting offset to eliminate the detector zero offset.

To measure very low powers:

1. In **Functions**, 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, x940 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. Select to set the Stop Mode to **Manual** or **Timeout** period on bottom bar of the screen.
4. Select the **Start** icon on the bottom bar 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, select the stop icon on the bottom bar of the screen.
6. To reset the reading to zero before another reading, select **Reset** on the bottom bar of the screen.
7. To return to the main power measurement screen, set **Measuring Mode** to **Power**.

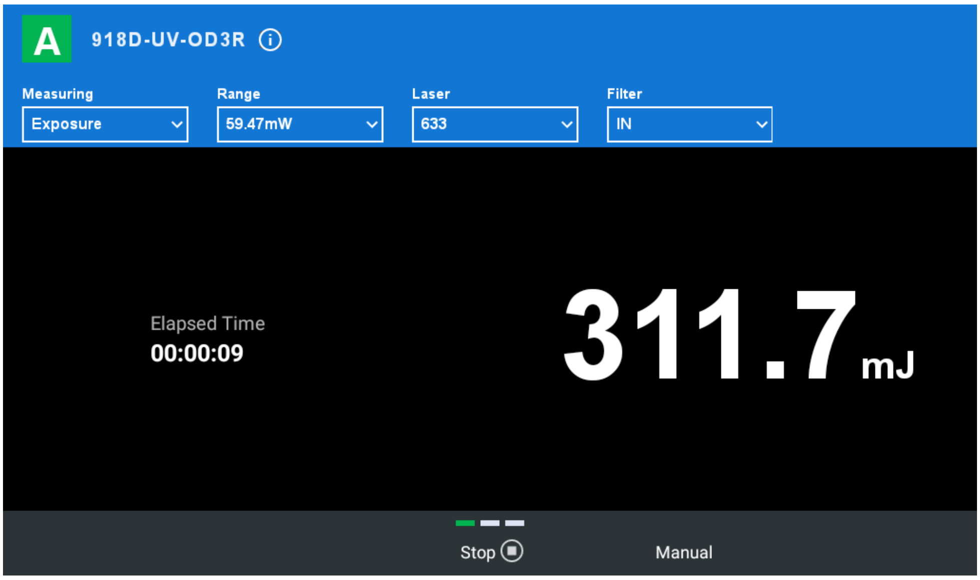


Figure 8-2 Photodiode Exposure Measurement

8.4.1 Exposure Limitations

Function Limitations
When measuring exposure, only **Scale Factor** and **Density** functions are enabled.

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

An additional 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 frequencies 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 frequency of the laser pulse rate. 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 important, 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 measurement is unstable, switch to Low Freq. Power Mode.

5. If the measurement 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 be used in conjunction with logging and analysis, as well as the with the Analog Output.

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 if you wish to record the laser modulation.

9 Graphical Displays

The x940 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 selecting **Hide Sensor Details** and **Hide Sensor Settings** in the **Display Settings**.

When two channels are merged when using the 2940-R dual channel meter (see Dual-Channel Operation), the only display types available 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

9.1 Bargraph

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

Options available for this display:

You can slide the Zoom button at the bottom of the screen to zoom in on a smaller section of the range when readings are fluctuating slightly.

If you notice that background light has impacted the measurement, you can slide the Offset button to remove it from the measurement.

Figure 9-1 Bargraph Display

The bargraph display comprises the following sections:

- On the top line are the sensor's name and serial number and an indication whether a function is configured.
- On the second line are the sensor parameter settings. The sensor parameters, including Measuring Mode, Range, Laser, Filter, are configured by selecting the parameter, and then the value is selected from the drop down list.
- Large numeric display.
- On the bottom of the screen is a swipe-able **Bar**, which includes **Offset** and **Zoom**, **External Trigger Settings, Hold, Reset, Start Log, Display Type, Display Settings, Functions, H/W Settings, General Settings.**

To expand the bargraph scale ±5x of the present reading, slide **Zoom** on the bottom of the screen. Slide **Zoom** back to return the bargraph to full scale. For more details, see Zoom.

To subtract the background and set the current reading to zero, slide **Offset**. Slide **Offset** back to cancel. For more details, see Offset. See also Measuring Loss Using the dB Offset Function.

9.1.1 Zoom

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

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

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

Figure 9-2 Bargraph Display

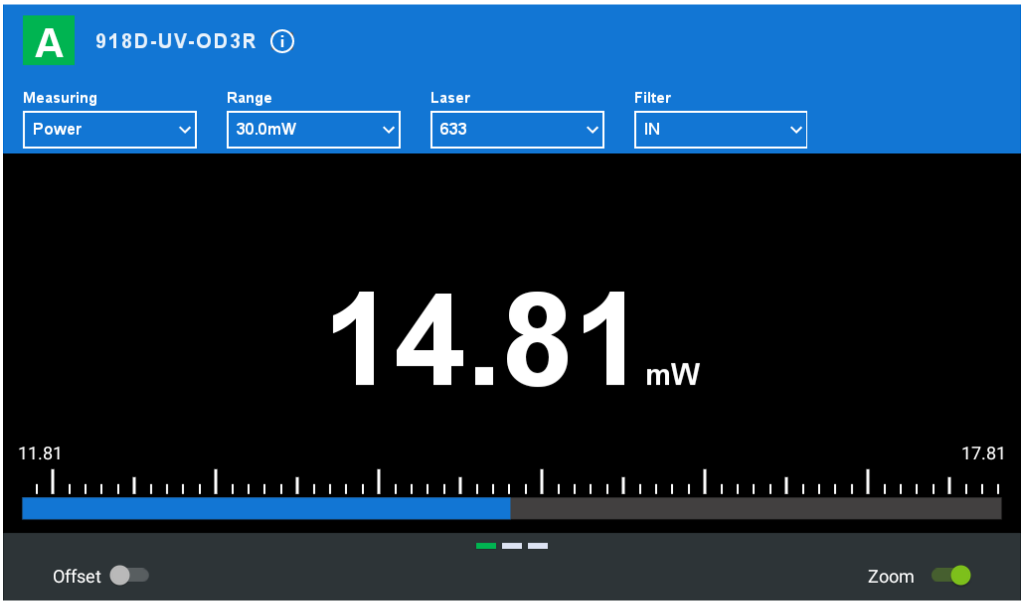


Figure 9-3 Bargraph Display with Zoom

9.2 Analog Needle

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

Options available for this display:

Slide the **Zoom** button at the bottom of the screen to zoom in on a smaller section of the range when readings are fluctuating slightly.

If you notice that noise has impacted the measurement, you can slide the **Offset** button to remove it from the measurement.

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

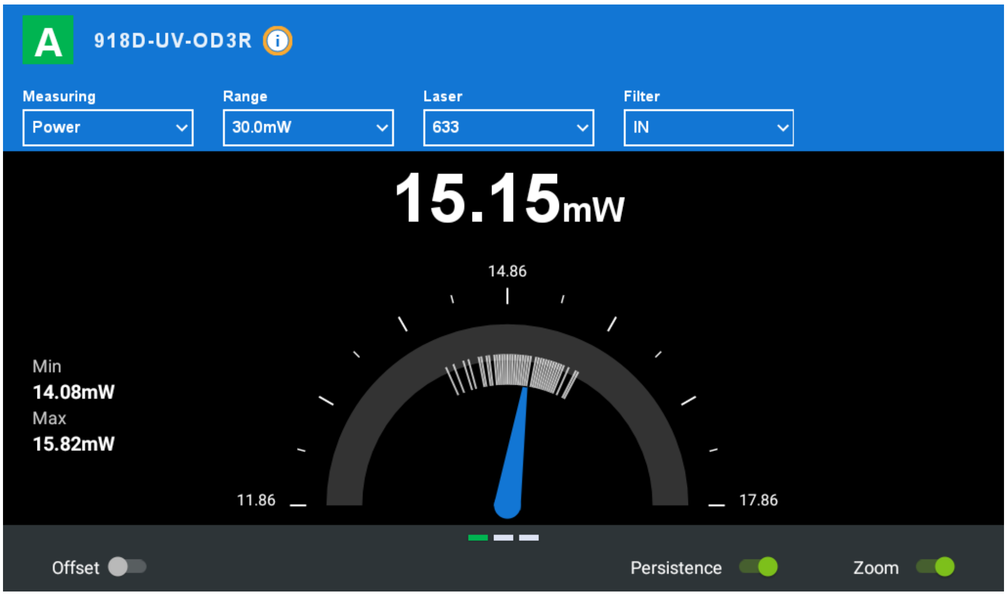


Figure 9-4 Needle Display

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 are on the bottom bar of the screen.

To simulate an analog needle:

1. Select **Display Type** on the bottom bar.
2. Select to select **Needle**.

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

9.2.1 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.

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

9.3 Line Graph

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

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

The line graph has the following touchscreen capabilities: zoom and un-zoom by stretch and pinch the graph with two fingers, after zooming pan the graph up and down by moving your finger up and down on the graph, and double-tap the graph area to reset the pan and zoom.

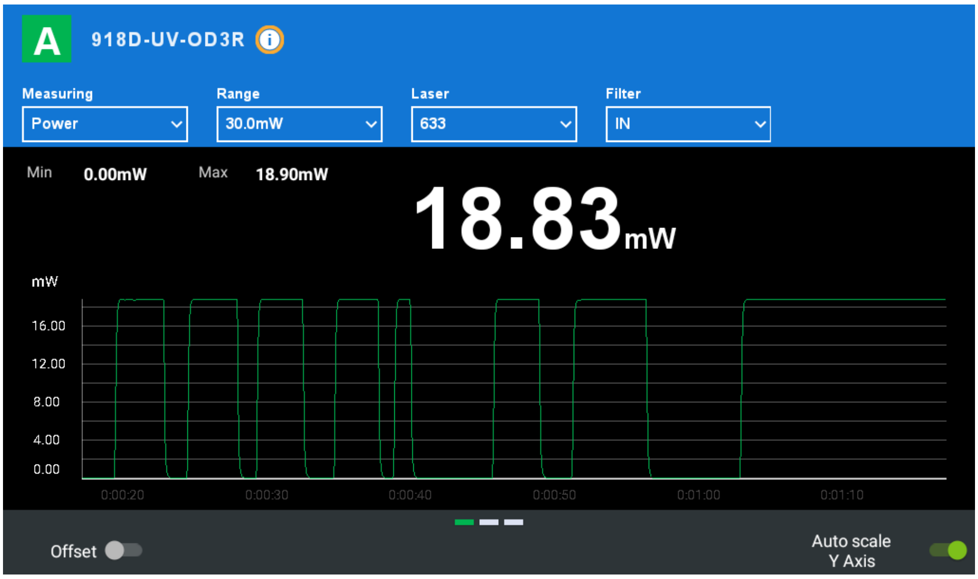


Figure 9-5 Line Graph

Select **Autoscale Y Axis** at the bottom of the screen to scale the axis between the minimum and maximum readings.

Select **Reset** on the bottom bar of the screen to clear the **Min/Max** tracking and to restart the graph.

9.3.1 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.

9.3.2 Reset

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

9.4 Pulse Chart

The Pulse Chart displays a graph of pulses as they occur. The readings are shown as bars with lengths proportional to the measurement. This is useful for technicians performing laser alignment (laser tuning) who want to see a graphical representation of the results of their experimenting, and the maximum laser power attained. This graph is not time-based and is most applicable when the data flow is not necessarily periodic. It is ideal when measuring low frequency lasers. The Pulse Chart can be used with any sensor that measures power or energy. It is mainly used for pulsed lasers with Pyroelectric energy sensors or Thermal sensors in one-shot Energy mode .

The graph has the following touchscreen capabilities: zoom and un-zoom by stretch and pinch the graph with two fingers, after zooming pan the graph up and down by moving your finger up and down on the graph, and double-tap the graph area to reset the pan and zoom.

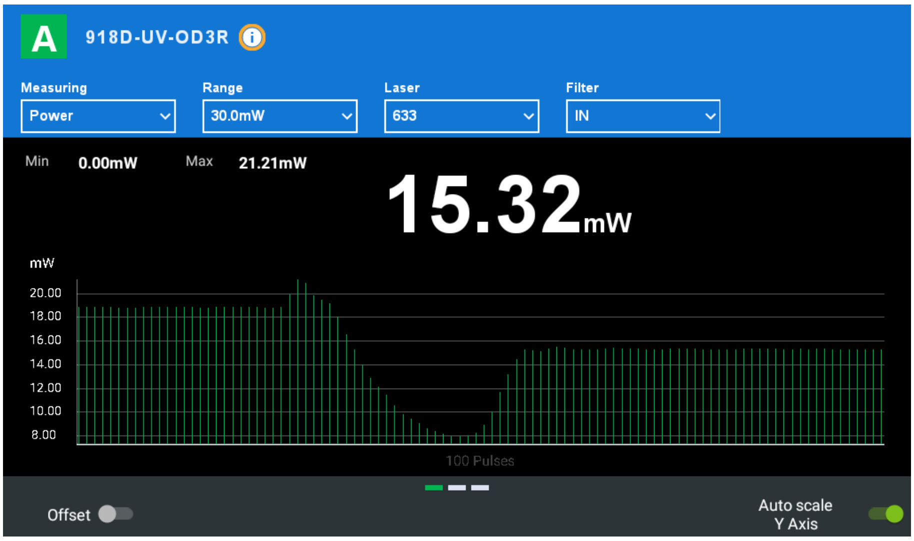


Figure 9-6 Pulse Chart

- 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 are on the bottom bar of the screen.

9.4.1 Autoscale Y-Axis

Select **Autoscale Y Axis** along the bottom of the screen to scale the axis between the minimum and maximum readings.

9.4.2 Reset

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

.

9.5 Pass/Fail

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

If the measurement is out of range, indications of that are displayed on the screen, as well as the sounding of an optional **Audio Warning**. When the measurements are within range, the display is normal.

Figure 9-7 Pass/Fail Under the Lower Limit

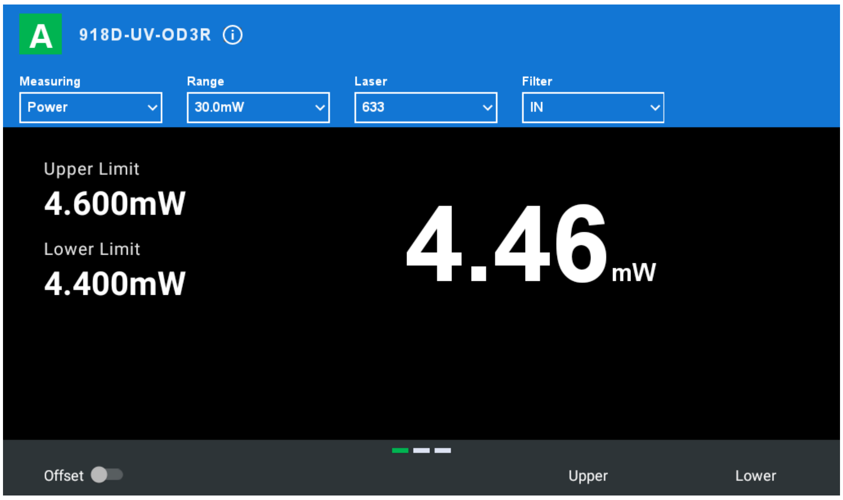


Figure 9-8 Pass/Fail within Limits

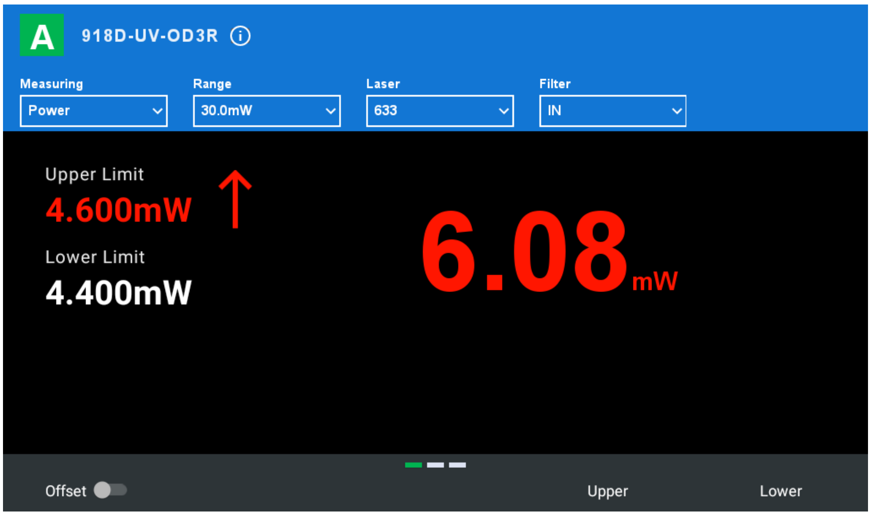


Figure 9-9 Pass/Fail over the Upper Limit

- Out-of-range warning: red numeric display, red arrow shows limit violated.

To set pass/fail tracking:

6. From the **Display Type** dialog, select to select **Pass/Fail**.

   The Pass/Fail screen is displayed.

7. Select **Upper** and **Lower** on the bottom of the screen to set tolerance limits. If the reading is out of range, an appropriate warning is displayed on the screen.

9.5.1 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. Select the **Upper** or **Lower** button at the bottom of the screen. The respective **Set Upper Limit/Set Lower Limit** dialog is displayed.
2. Select 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.) Select **Apply**.

   If the measurement is out of range, there is an indication of on the screen, as well as the sounding of an optional **Audio Warning**.

9.6 Statistics

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

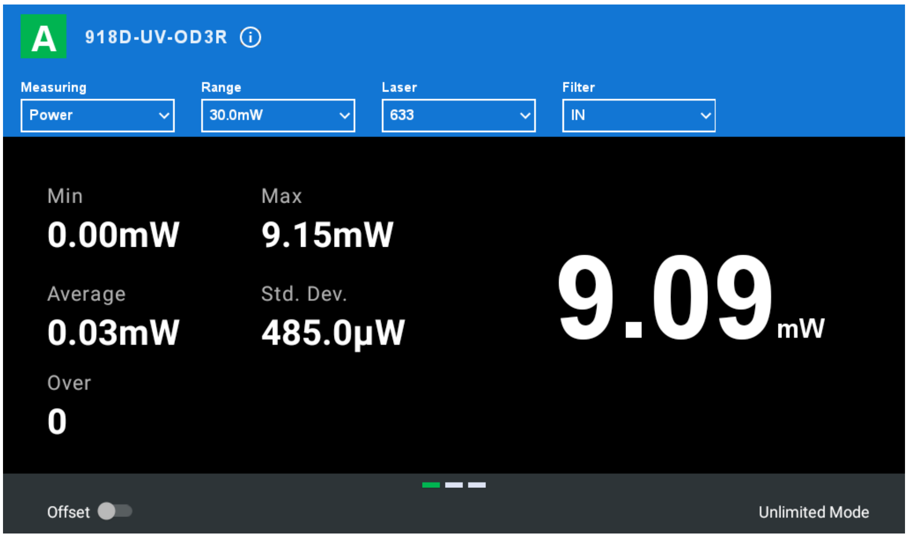


Figure 9-10 Statistics display

The Statistics display comprises the following components:

- Max, Min, Average, Standard Deviation, and Over values on the left-hand side of the main screen.

Displayed are **Maximum**, **Minimum**, **Average**, **Standard Deviation**, **Total** readings, and number **Over** range.

To subtract the background and set the current reading to zero, select **Offset** on the bottom of the screen. Select **Offset** again to cancel. For further details, see Offset.

Select **Reset** on the bottom bar of the screen to clear the statistics.

- Track

10 Functions

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

Topics include:

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

10.1 Display on Main Measurement Screen

If any functions are enabled, then the letter "*f*" is displayed next to the sensor information. In the graphic below from a 2940-R dual-channel meter, Channel A has a function configured, while Channel B does not.

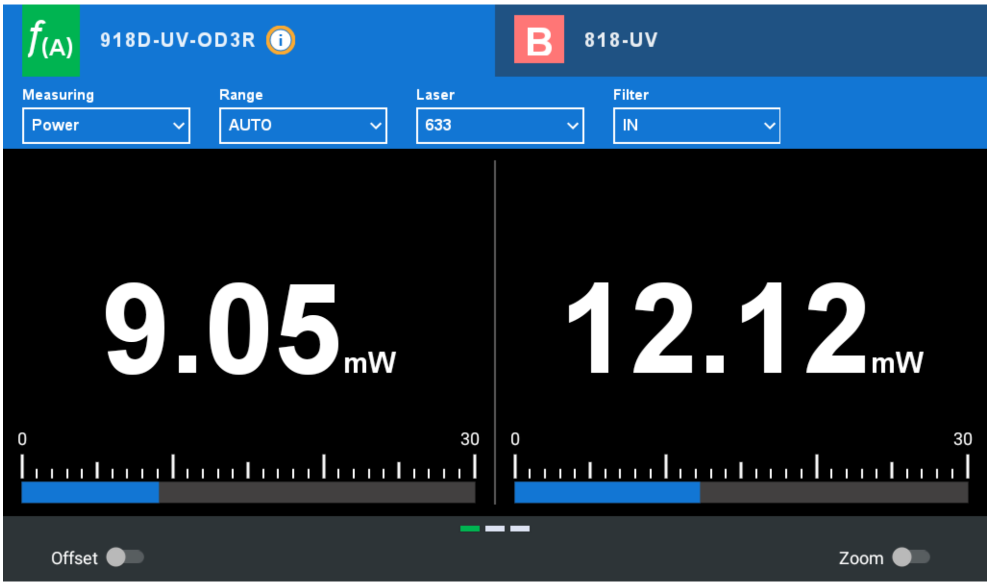


Figure 10-1 Function Indicated for Channel A

10.2 Functions Screen

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

To enter the **Functions** menu select **Functions** from the bottom bar**.**

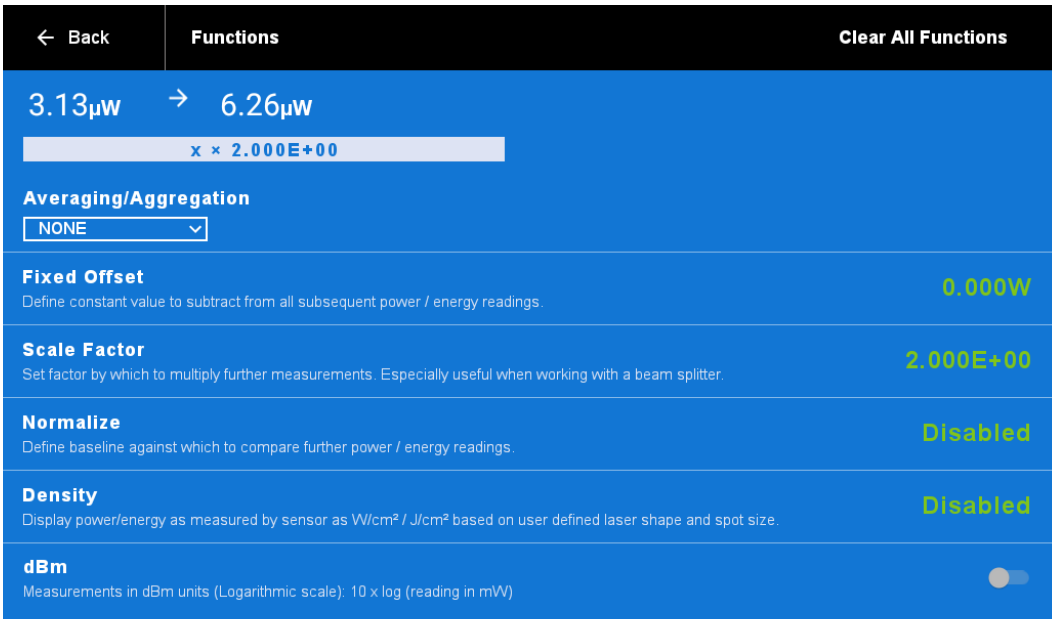


Figure 10-2 Functions Screen

The Functions screen comprises the following:

- The top line contains a return arrow, Channel A/B indication (always Channel A for single channel systems), and Clear All 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

10.3 Average

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

To set a time period for averaging power readings:

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

10.4 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, select to set to **Peak-to-Peak**

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

10.5 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, select to set to **RMS**

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

10.6 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, select 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.

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

10.7 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, select 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.

Select **Apply** to save and exit.

10.8 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, select 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.

Select **Apply** to set the value and exit.

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

10.9 Density

The x940 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/cm^2 or J/cm^2.

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.

10.10 dBm

Provides measurements in dBm units (logarithmic scale)

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

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

10.11 Functions Limitations

- For thermal sensors in single-shot energy mode, Average is disabled.
- For sensors in Exposure mode, Average, Normalize, and Density are disabled.
- If Normalize is active, then Density is disabled. If Density is active, then Normalize is disabled.
- If the dBm is active, then Normalize and Density are disabled.

11 2940-R Dual-Channel Features

If you have the dual-channel 2940-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.

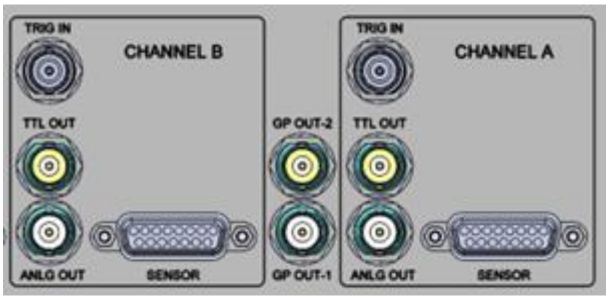


Figure 11-1 x940 Back Panel

11.1 Dual-Channel Operation

When two sensors are attached to the 2940-R, the measurement screen can be divided in two, displaying measurement screens for both sensors. You can configure the sensor parameters for each channel by selecting that channel using the top of the touch screen or pressing the physical channel select button on the 2940-R front panel. Each channel is identified by color, and the Channel Select button illuminates by color according to the selected channel.

The Display Settings menu allows dual-channel features : Merge, Split, and Single as well as Math Channel.

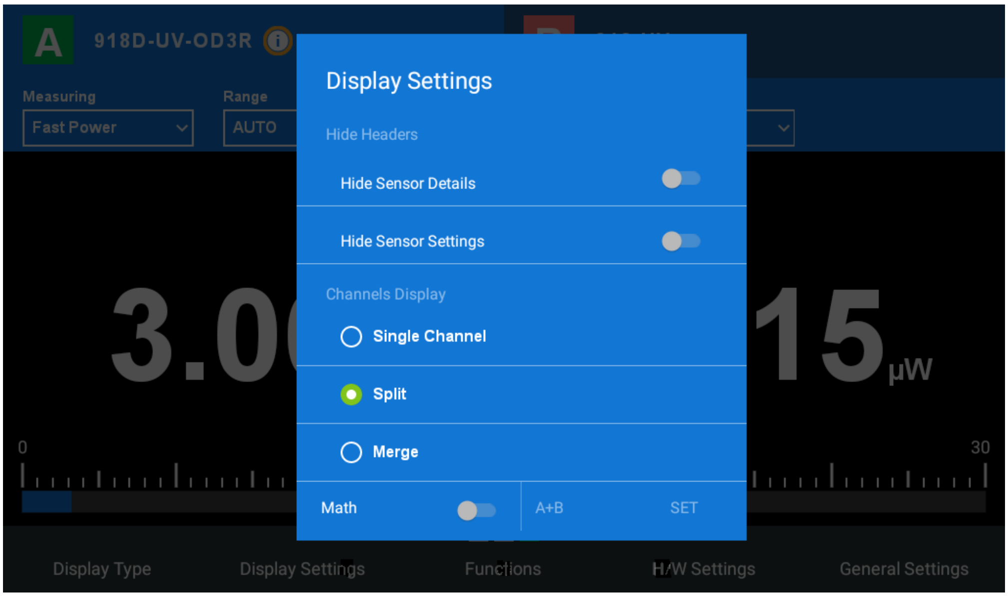


Figure 11-2 Display Settings menu

In Split mode, each channel is shown separately in a split screen.

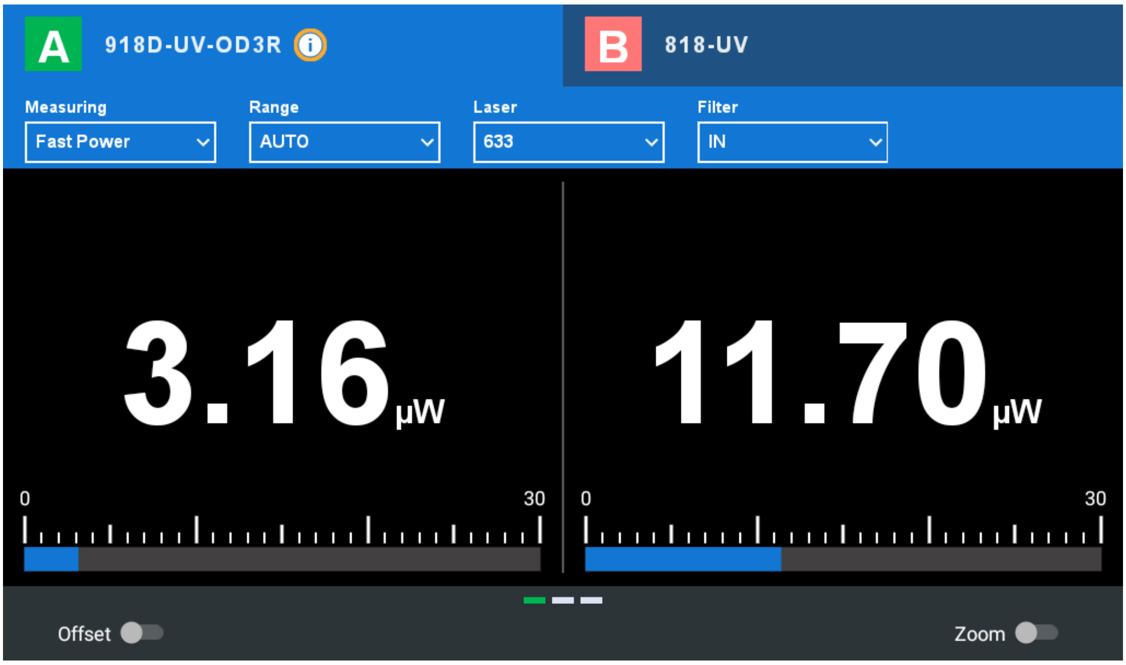


Figure 11-3 Dual Channel Operation in Split Mode

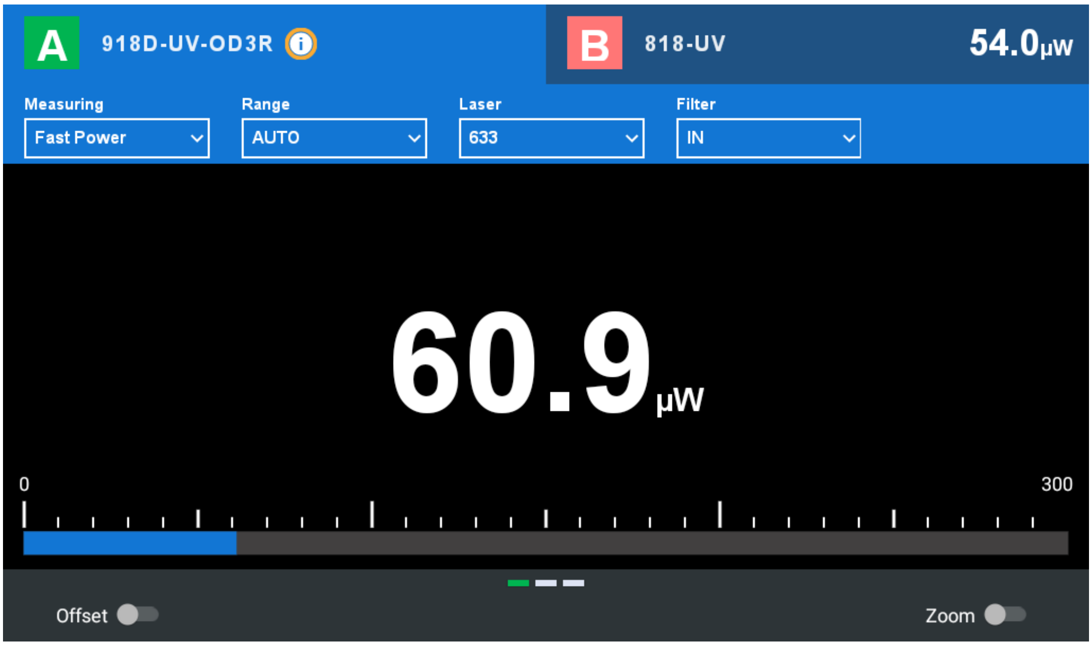


Figure 11-4 Dual Channel Operation with Display set to single channel

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

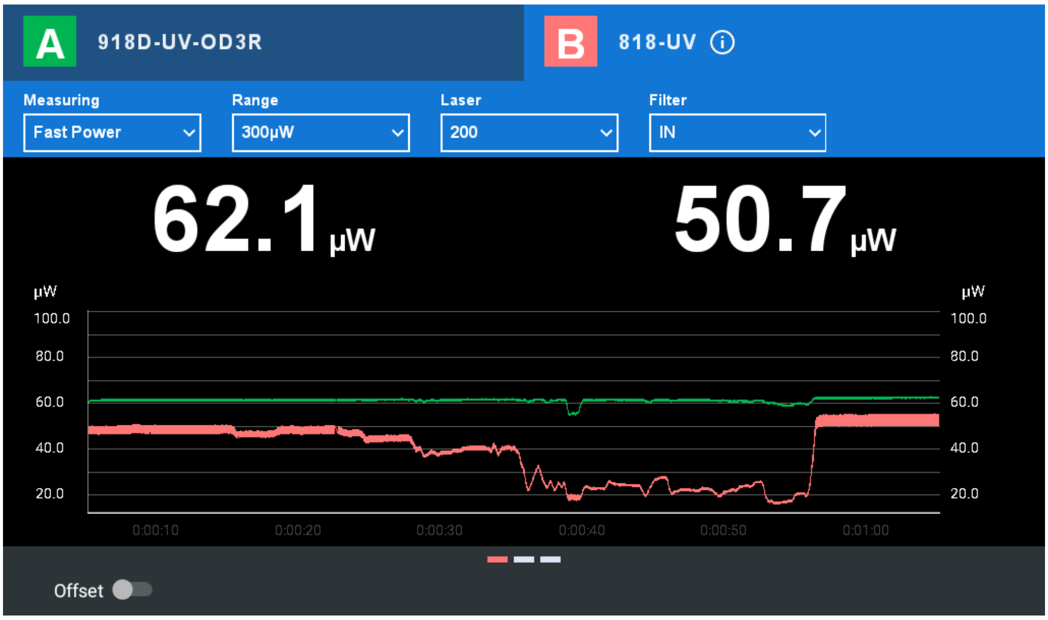


Figure 11-5 Channels A and B Merged

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.

11.2 Math Channel

The dual-channel 2940-R enables comparison of the measurements of the two channels.

The **Math Channel** is activated and its operations set from the **Display Settings**.

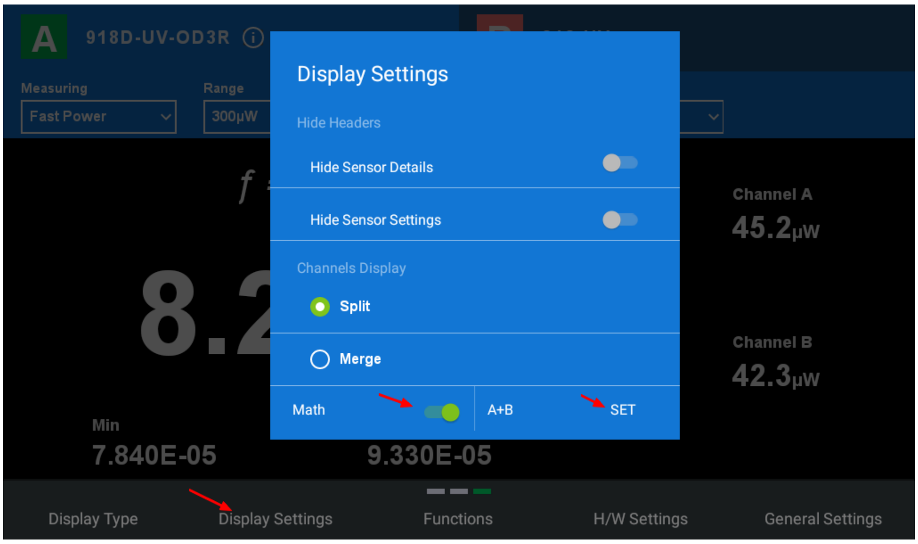


Figure 11-6 Math Channel Activation

The Math Channel displays the comparison. The comparison operation options are:

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

The Math Channel displays the comparison results either numerically or graphically.

The results can also be logged.

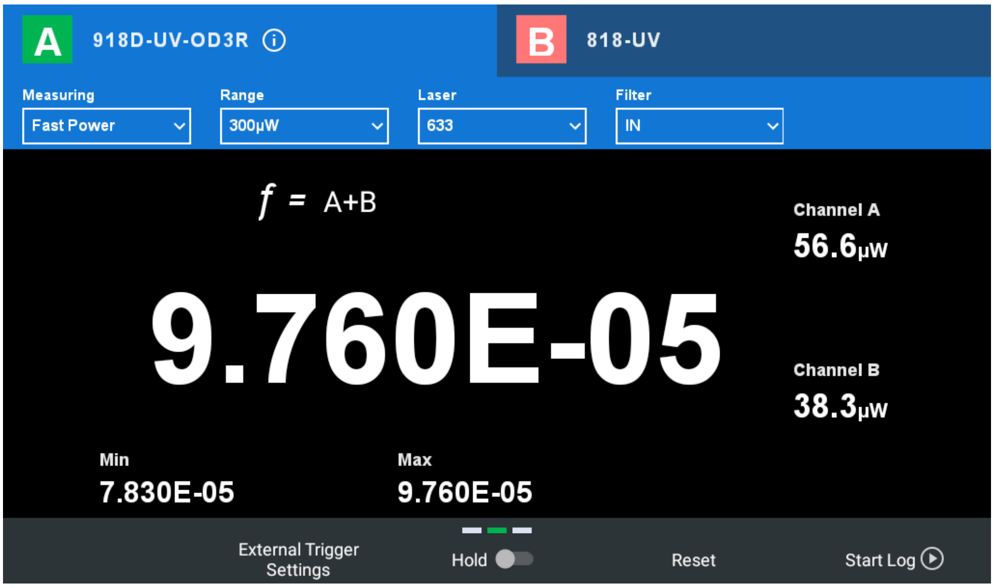


Figure 11-7 Math Channel in Operation (split display)

When two sensors are connected to the x940, the Math Channel can be activated.

The screen then displays three measurements. On the right side, are reduced measurements for the sensors, and on the left side, the Math Function comparison operation.

The f 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 of the screen.

12 Measurement Logging

In addition to displaying measurement results graphically on the screen, you may need to gather a large amount of measurement data and analyze it. The 940 provides the ability to store the logged measurement data and review it, either on the meter, or transfer it to a PC for analysis with Newport's PMManager application, or a Spreadsheet application, or any other PC 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 stored in a USB Flash Drive for later uploading to a PC.

Topics include:

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

12.1 Log Settings

The Log Settings screen is reached via the **General Settings** screen.

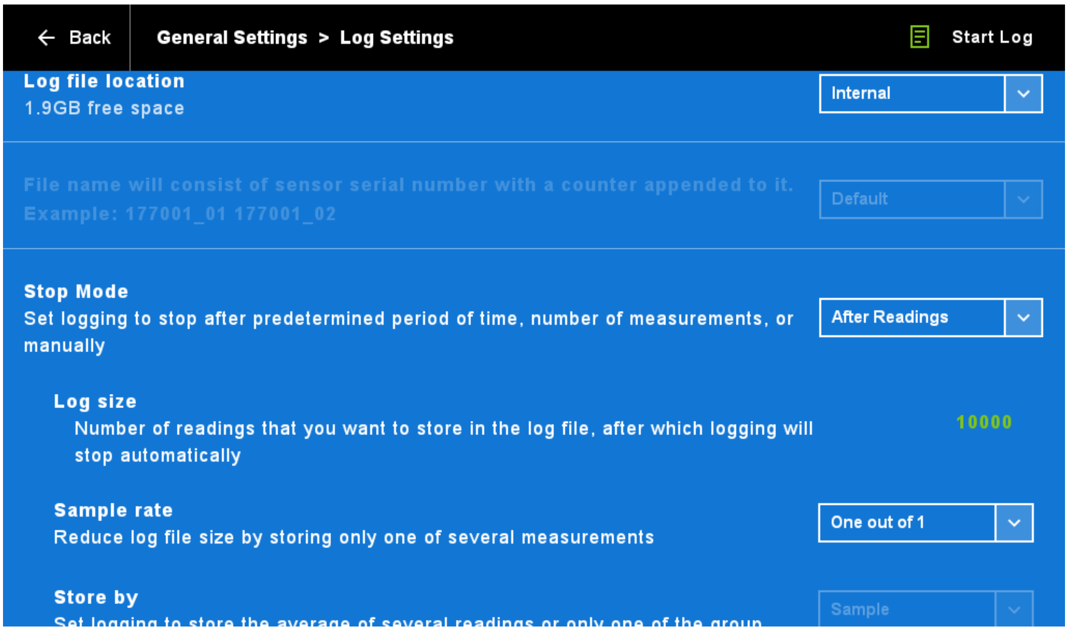


Figure 12-1 Log Settings Screen

To set the log storage location:

➢ In the **Log Settings** screen, go to **Log File Location** and select USB flash drive/Internal storage, as required.

12.2 Setting Logging Parameters for the Various Stop Modes

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

To set the logging parameters for the various Stop modes:

1. In the **Log Settings** screen, on the **Stop Mode** line, select an option.
   - Manual: to stop logging manually.
   - After Time Out: to stop logging after a predetermined period of time.
   - After Readings: to stop logging after a specified number of measurements.

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

12.2.1 Manual Mode

In this Stop Mode, logging does not terminate based on a predefined condition. Rather, it continues until the user selects the **Stop** button on the bottom bar of the display.

To set the Stop Mode to Manual:

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

   Several parameters are displayed.
2. For each parameter, set the relevant options, as required:
   - **Sample Rate:** Enables you to control the number of readings that are added to the log. Options include:

     One out of 1

     One out of 3

     One out of 10

     One out of 30

     One out of 100

     One out of 300

     One out of 1000
   - **Store By:** Set logging to store the average of several readings or only one of the group. (If Sample Rate is set to One out of 1, then this parameter is disabled and grayed out.) Options include:

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

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

12.2.2 After Time Out

In this Stop Mode, logging continues until the **Stop** icon is selected, 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). Select 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) Select the current value to display a dialog to set the interval, in hours:minutes:seconds. Click **OK** to save and exit.
   - **Store By:** Set logging to store the average of several readings or only one of the group. (If **Interval** is set to 00:00:00, then this parameter is disabled and grayed out.) Options include:

     Sample: Logs only the last reading measured.

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

12.2.3 After Readings

In this **Stop Mode**, logging continues until the **Stop** button is selected 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. Select the current number to display the Set Number of Readings until Stop dialog. Type in the number and select **Apply** to save and exit.
   - **Sample Rate.** Enables you to control the number of readings to be added to the log. Select 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

Select a value and exit.

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

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

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

12.3 Start Logging

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

To start logging:

1. In the **Log Settings** screen select **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, and the 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 select this icon at any time to stop the logging.
2. While logging is active, you can select 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. Select the Review Log Data button to display the Log View screen. See Display Log as graph.
5. If **Start Log** is selected, the logging counters are reset, the display is cleared and activated.

Note: x940 does not provide the user with the capability to add notes to a log file.

12.4 Stop Logging

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

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

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

12.5 Log History: Accessing Logged Data

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

To access log files:

1. Select **Log History** in the **General 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 to **highlight it**. The statistical summary of that log appears on the right.

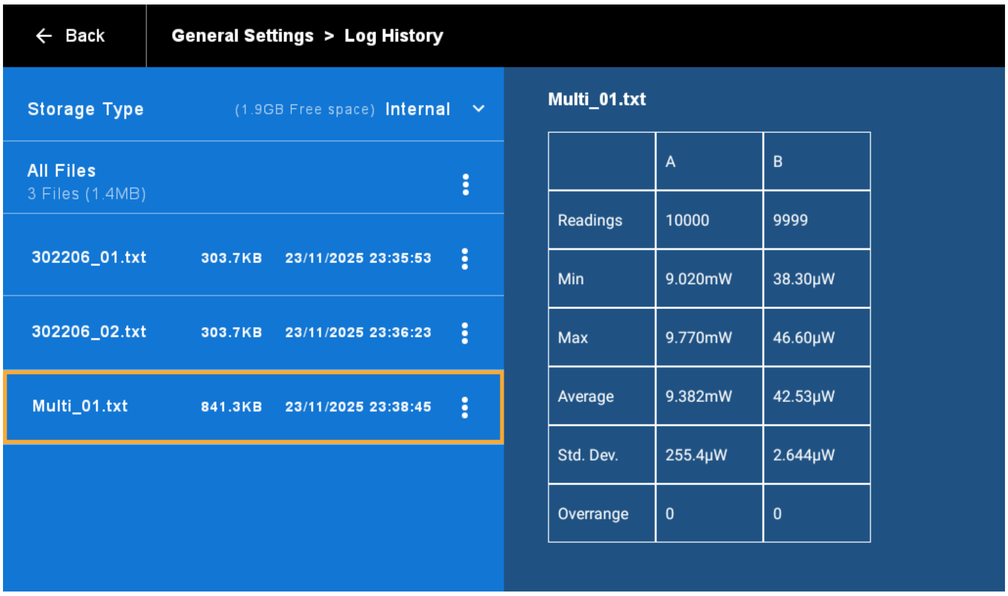


Figure 12-2 List of Log Files saved to internal memory storage

To display logged data:

1. By selecting the 3 dots to the right of the log file, a menu opens and there are two options to display the logged data.
2. Select the Display as Text to view the log file as text.
3. Select the Display as Graph to display the log file as a graph.

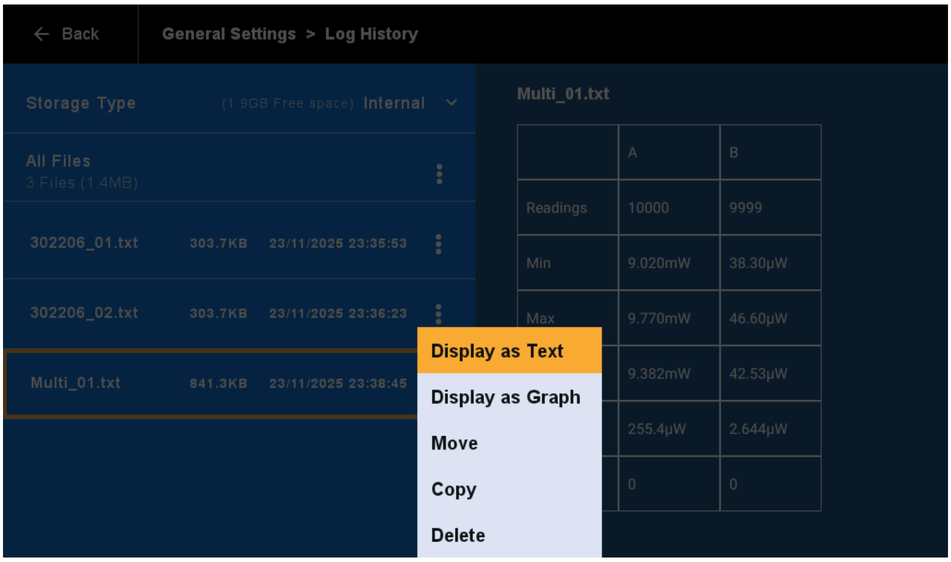


Figure 12-3 Log file options

12.5.1 View Log as Text

You can view logged measurement data in text form.

You can scroll through the file by panning up and down

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

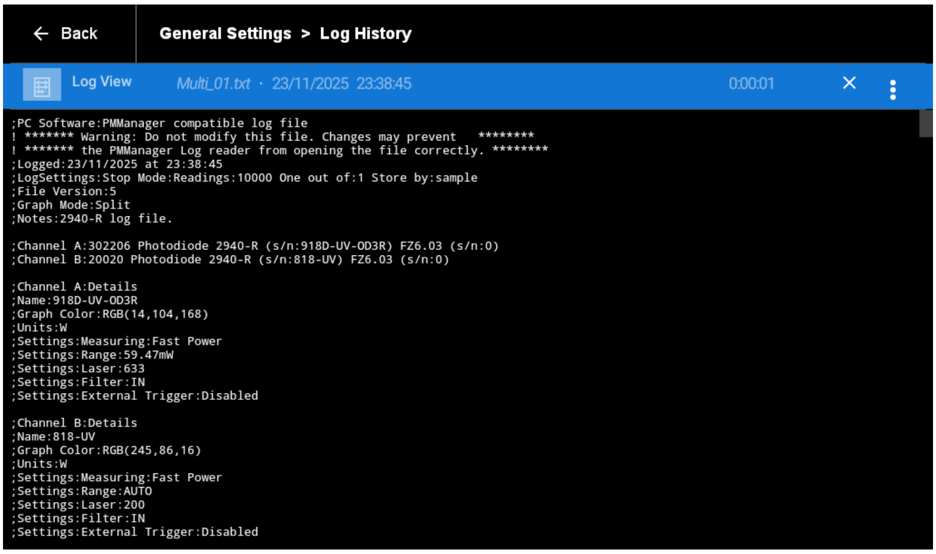


Figure 12-4 Top of log file text

Further down the page is the list of logged measurements.

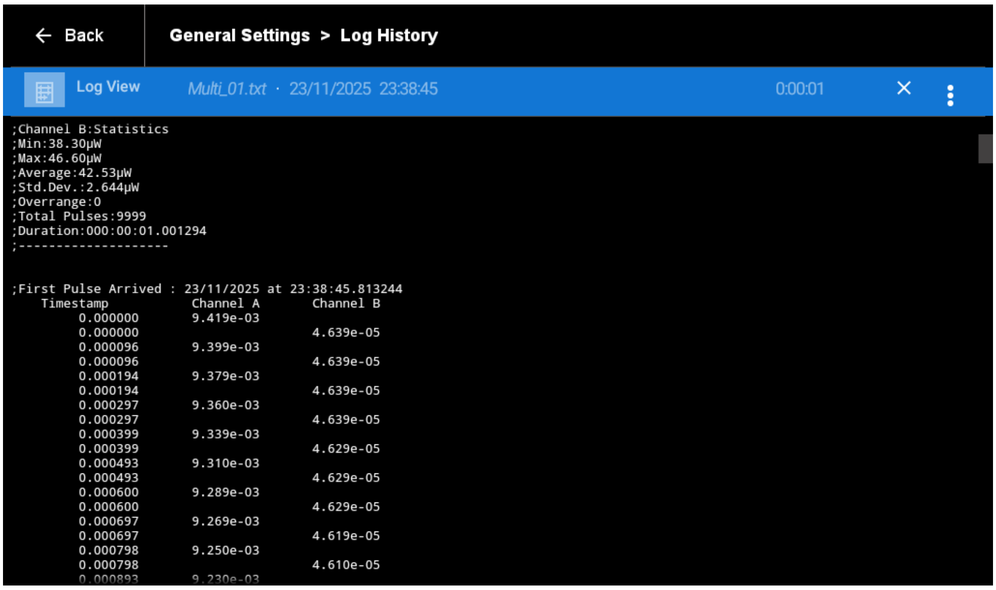


Figure 12-5 Further down in text view

12.5.2 Display Log as graph

You can view logged measurement data as a graph.

Select the 'Display Graph" icon for a particular log file, and it will be displayed.

Figure 12-6 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.

Select the close icon in the upper right-hand corner of the screen to close this view.

12.5.3 Delete, Copy & Move Log Files

From the Log History screen, you can Delete Copy & Move log files as shown below by selecting the 3 dots to the right of the log file:

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 file, select **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 file, select **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, select **Delete** to delete the file from the log history.

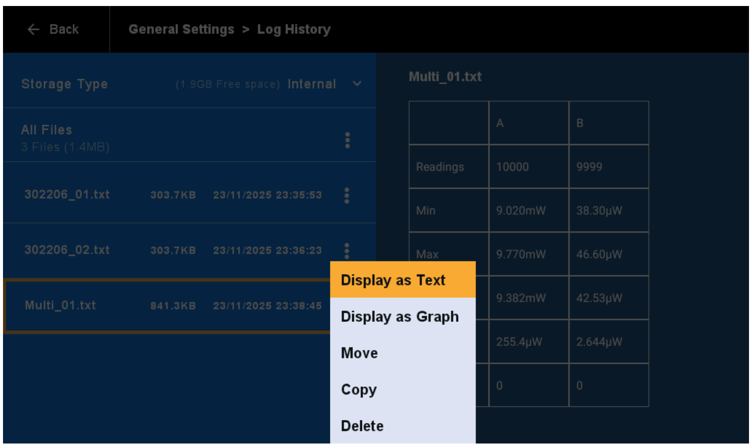


Figure 12-7 Log file options

12.6 How the Various Types of Average Affect Logged Data

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

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

12.7 Viewing the Log File on Your Computer

In addition to reviewing the logged data on x940, 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 x940 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.

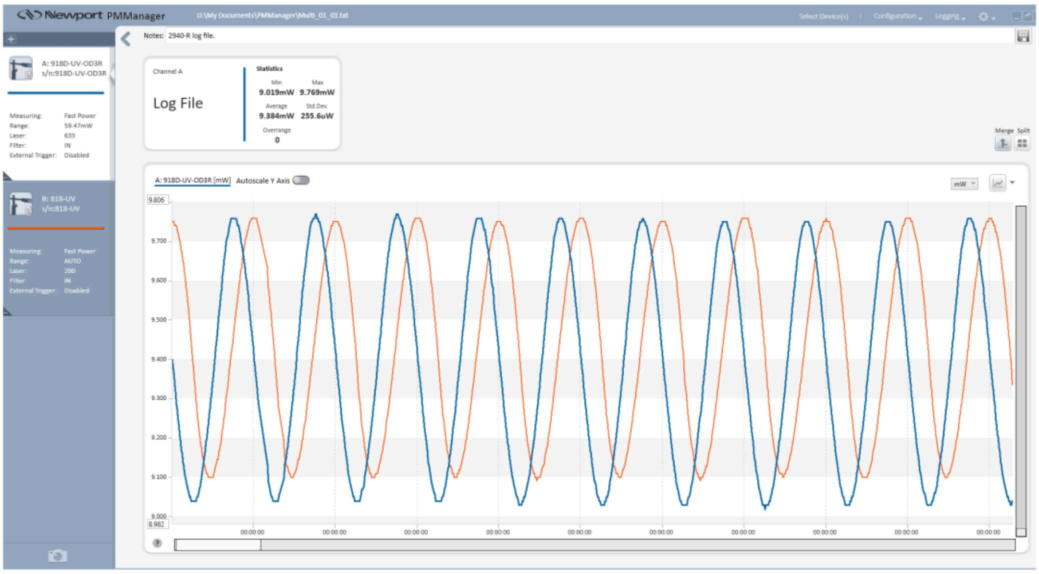


Figure 12-8 Log File in PMManager

13 Error Messages and Troubleshooting

13.1 Error Messages

The x940 displays various error messages when measurements are outside 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 its upper limit, and the detector starts to saturate, the message "sat" (=saturated) is displayed.

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

13.2 Troubleshooting

13.2.1 x940 Meter

Table 13-1 x940 Meter

Problem	Cause/Remedy

13.2.2 Thermal Sensors, Energy Measurements

Table 13-2 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.

13.2.3 Thermal Sensors, Power

Table 13-3 Thermal Sensors, Power

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

14 Meter Specifications

14.1 Electrical Specifications

DC Current Measurement (Low-Power, Semiconductor Photodiode)

Range	0	1	2	3	4	5	6	7
Full Scale Current	2.5nA	25nA	250nA	2.5uA	25uA	250uA	2.5mA	25mA
Resolution[1]	47fA	470fA	4.7pA	47pA	470pA	4.7nA	47nA	470nA
Bandwidth (unfiltered)[1]	1.2Hz	4.8Hz	50Hz	480Hz	4.5kHz	43kHz	160kHz	200kHz
Maximum Peak2Peak Pulse Repetition Rate4 (TBD)	1.2 Hz	4.8 Hz	48 Hz	480Hz	4 kHz	20 kHz	20 kHz	20 kHz
Accuracy	0.4%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
SNR[1]	100dB	100dB	100dB	100dB	100dB	100dB	100dB	100dB
Frequency Measurement (Square Wave Signal)	1Hz-80Hz	1Hz-400Hz	1Hz-4kHz	1Hz-30kHz	1Hz-162kHz	1Hz-380kHz	1Hz-400kHz	1Hz-500kHz
Frequency Measurement (Sine Wave Signal)	1Hz-60Hz	1Hz-270Hz1	1Hz-2.4kHz	1Hz-20kHz	1Hz-140kHz	1Hz-380Hz	1Hz-400kHz	1Hz-500kHz
Frequency Measurement Accuracy			1%	1%	1%	1%	1%	1%

Notes:
1. No filtering

RMS Measurement (TBD)

Maximum Pulse Repetition Rate	2 kHz	10 kHz
Accuracy	1.0 %	2.0 %

Analog to Digital Converter

Resolution, “Fast Power” mode 16-bit
Data rate, “Fast Power” mode 10ksps
Resolution, “Power” mode 23-bit
Data rate, “Power” mode 15sps

Analog Output

Output Range	0	1	2	3
Full Scale Voltage (Load > 100 kΩ)	1 V	2 V	5 V	10 V
Full Scale Voltage (Load = 50 Ω)	0.5 V	1 V	2.5 V	5V
Accuracy	1.0 %	1.0 %	1.0 %	1.0 %
Linearity	0.1%	0.1%	0.1%	0.1%

External Trigger Input

The External Trigger input circuit is intended to be driven with 0v to 5v or 0v to 3.3v logic signals but can accept also “TTL” level signals (0.8v low, 2.0v high). The input circuit contains protection components allowing inputs of up to +/-14v without damage.

Maximum Input Voltage 14v
Minimum Input Voltage -14v
Minimum Input Voltage (high logic) 2.0v
Maximum Input Voltage (low logic) 0.8v

TTL Output

The TTL Output circuit is intended to drive digital logic signals of 0v (low) or 5v (high) into an external load of no more than 10K ohm. Protection components are included to avoid damage if a voltage of up to +/-8v is inadvertently connected to the output. Driving voltages beyond this limit should be avoided.

Output high voltage 5v
Output low voltage 0v
Output impedance 600 ohm
Maximum current drive (output high) 8.3mA (into load externally shorted to ground)
Maximum current sink (output low) -8.3mA (out of load externally shorted to +5v)

14.2 General Meter Specifications

General Specifications	
Detector Compatibility	Thermopile (818P, 919P) Photodiode (918D, 818-xx/DB, 819C/D series,
Detector Connector	15-Pin D-Sub type; 1940-R X 1 or 2940 X 2
Dimensions	221W x 280D x 132H (mm)
Mass	2.9 kg
Display	7" TFT Full color LCD Touchscreen Interface - 1024x600 pixel - Active area 154x91mm Refresh rate 10Hz
LCD Backlight	LED's - Backlight level is user adjustable.
Loudspeaker	1.2 Watt Speaker for Audio Notifications / Warnings
Buttons & knobs	Illuminated rotating knob, soft buttons and power switch button.
Data Storage	2 GB internal memory (Can store ~40,000,000 Measurements) External storage defined by user supplied USB Type-A flash drive via front panel (up to 32GB)
Lithium Coin Cell Battery	3 Volts Model CR2032 for clock backup Non-rechargeable battery. Do not attempt to charge.
Operating Temperature & Relative Humidity	5°C – 40°C, <70% RH
Storage Temperature & Relative Humidity	-20°C to 60°C, <90% RH
Altitude	<3000m
Use location	Indoor use only
Power Supply	~100-240V AC 50-60Hz Max 70 Watts

14.3 Interfaces Specifications

Communications	
Analog Output	BNC Socket (shielded) - 1940-R X 1; 2940 X 2 User selected 0-1 V, 0-2 V, 0-5 V or 0-10 V full-scale (raw and digital) 0.003% resolution, 50Ω impedance ±0.2% (of reading) ±0.3% of full-scale volts
General purpose Analog X, Y	
External Trigger input	BNC socket (shielded) 0 – 5 Volts 1940-R X 1; 2940 X 2
TTL Signal Output	BNC socket (shielded) TTL level voltages 1940-R X 1; 2940 X 2
USB to External Flash Drive	USB A type socket (2.0) For data logging
USB PC Interface	USB 3.0 B type socket (can connect to USB2)
RS232 PC Interface	RS232 9 pin D-sub socket (38400, 8, N, 1) Max baud rate 115200
Ethernet	Ethernet 10Base-T/100Base-TX RJ45 socket Auto-MDIX
Ethernet protocols supported	UDP, DHCP, TCP
Wi-Fi	Antenna socket for future use

14.4 Detector family Specifications

Photodiode-Slow & Fast Mode	
Input Ranges	2.5nA - 25mA full scale in 22 ranges
Dynamic range	10 decades
Photodiode Measurement	Power, Peak-to-Peak Power, Low frequency power, Exposure, Frequency, Amps
Thermal Detector	
Input Ranges	2.5nA - 25mA full scale in 22 ranges
Dynamic range	10 decades
Thermopile Measurement	Power, Single shot energy, Pulsed power, Volts

15 Sensor Specifications

Table 15-1 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/cm²	PD
918D-UV-OD3R	0.2W	30W/cm²	PD
818-SL/IR/UV-DB	2W	30W/cm²	PD
818-UV-DB	0.2W	30W/cm²	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/cm²	BB
919P-010-16	10W	28KW/cm²	BB
919P-020-12	4(20)W	23KW/cm²	BB
919P-030-18	30W	20KW/cm²	BB
919P-050-18HP	50W	0.5KW/cm²	PF-DIF
919P-050-26	50(150)W	12KW/cm²	BB
919P-040-50	35(150)W	12KW/cm²	BB
919P-150-26	150W	12KW/cm²	BB
919P-250-35	250W	10KW/cm²	BB

919P-500-65	500W	7KW/cm²	BB
919P-5KW-50	5000W	2KW/cm²	BB

PD – Photodiode

Int Sph – Integrating Sphere

PF – Volume absorber for short pulses and high average powers

BB – Broadband surface absorber, high power density

BF – Very high damage threshold, long pulses

ES – Extra Slim

Table 15-2 Maximum Energy Densities for Various Absorbers (Single Pulse)

Absorber Type	Max Energy Density J/cm² Pulse Length		
	10ns	1µs	300µs
BB	0.3	0.5	3
PF	1.5	1.5	5

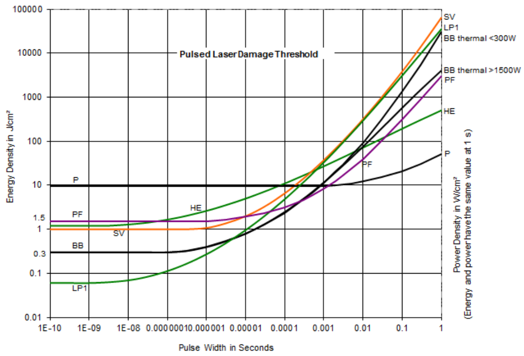


Figure 15-1 Pulsed Laser Damage Threshold for Thermopile Sensors

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

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