Model 1928-C

Optical Power Meter

User's Manual

Newport®

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EU Declaration of Conformity

We declare that the accompanying product, identified with the CE mark, complies with the requirements of the Electromagnetic Compatibility Directive, 2004/108/EC and the Low Voltage Directive 73/23/EEC.

Model Number: 1928-C

Year CE mark affixed: 2009

Type of Equipment: Electrical equipment for measurement, control and laboratory use in industrial locations.

Manufacturer: Newport Corporation
1791 Deere Avenue
Irvine, CA 92606

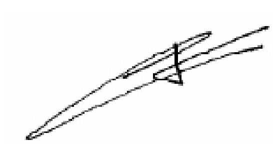
Standards Applied:

Compliance was demonstrated to the following standards to the extent applicable:

BS EN61326-1: 2006 “Electrical equipment for measurement, control and laboratory use – EMC requirements”

This equipment meets the CISPR 11:2006+A2 Class A Group 1 radiated and conducted emission limits.

BS EN 61010-1:2001, 2nd Edition “Safety requirements for electrical equipment for measurement, control and laboratory use”



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Firmware and User Manual Updates

Dear Customer,

In an effort to keep the 1928-C Optical Power Meter optimized for your applications, Newport will on occasion update existing, and add new features to this instrument.

To utilize this new functionality will require an update to the instrument's firmware, which can be easily accomplished by the user, as described in this User Manual. As required, Newport will also generate a new version of this User Manual, reflecting updates to the instrument.

Please check the Newport website (www.Newport.com) for newer versions of the firmware and the User Manual, which can be downloaded as a PDF file. Call your local Newport application specialist if you need support with locating or downloading these files.

Enjoy your new instrument!

Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport’s published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever first occurs.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Newport’s written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

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First printing 2009

This manual has been provided for information only and product specifications are subject to change without notice. Any change will be reflected in future printings.

Newport Corporation
1791 Deere Avenue
Irvine, CA, 92606
USA

Part No. 90022689, Rev. B

Firmware version 1.1.0

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Service Information

This section contains information regarding factory service for the source. The user should not attempt any maintenance or service of the system or optional equipment beyond the procedures outlined in this manual. Any problem that cannot be resolved should be referred to Newport Corporation.

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Newport Corporation Calling Procedure

If there are any defects in material or workmanship or a failure to meet specifications, promptly notify Newport's Returns Department by calling 1-800-222-6440 or by visiting our website at www.newport.com/returns within the warranty period to obtain a **Return Material Authorization Number (RMA#)**. Return the product to Newport Corporation, freight prepaid, clearly marked with the RMA# and we will either repair or replace it at our discretion. Newport is not responsible for damage occurring in transit and is not obligated to accept products returned without an RMA#.

E-mail: rma.service@newport.com

When calling Newport Corporation, please provide the customer care representative with the following information:

- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system non-operational?
- Can you identify anything that was different before this problem occurred?

IMPORTANT NOTE

Before plugging the instrument into a PC via a USB communication port, please make sure that the USB Drivers are installed. Run Setup.exe from the Software CD that came with your product. The installation program will configure the PC with the 1928-C USB drivers.

Table of Contents

List of Figures

List of Tables

1 Safety Precautions

1.1 Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the 1928-C Optical Power Meter where safety-related issues occur.

1.1.1 General Warning or Caution

Figure 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.

1.1.2 Electric Shock

Figure 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.

1.1.3 Protective Conductor Terminal

Figure 3 Protective Conductor Terminal Symbol

The protective conductor terminal symbol in the above figure identifies the location of the bonding terminal, which is bonded to conductive accessible parts of the enclosure for safety purposes.

1.1.4 European Union CE Mark

CE

Figure 4 CE Mark

The presence of the CE Mark on Newport Corporation equipment means that it has been designed, tested and certified as complying with all applicable European Union (CE) regulations and recommendations.

1.1.5 Alternating voltage symbol

~

Figure 5 Alternating Voltage Symbol

This international symbol implies an alternating voltage or current.

1.1.6 ON

I

Figure 6 On Symbol

The symbol in the figure above represents a power switch position on the Model 1928-C Optical Power Meter. This symbol represents a Power On condition.

1.1.7 OFF

O

Figure 7 Off Symbol

The symbol in the figure above represents a power switch position on the Model 1928-C Optical Power Meter. This symbol represents a Power Off condition.

1.1.8 Fuses

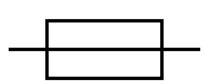

Figure 8 Fuse Symbol

The fuse symbol in the figure above identifies the fuse location on the Model 1928-C Optical Power Meter.

1.1.9 Frame or Chassis

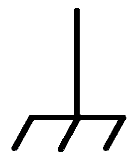

Figure 9 Frame or Chassis Terminal Symbol

The symbol in the figure above appears on the 1928-C Optical Power Meter. This symbol identifies the frame or chassis terminal

1.1.10 USB Connector Symbol

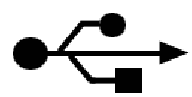

Figure 10 USB connector Symbol

The USB connector symbol in the above figure identifies the location of the USB communications connector.

1.1.11 Waste Electrical and Electronic Equipment (WEEE)

Figure 11 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. See Section 16 for instructions on how to disassemble the equipment for recycling purposes.

1.2 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.

1.2.1 General Warnings

Observe these general warnings when operating or servicing 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.
- Lockout all electrical power sources before servicing the equipment.
- To avoid fire hazard, use only the specified fuse(s) with the correct type number, voltage and current ratings as referenced in the appropriate locations in the service instructions or on the equipment. Only qualified service personnel should replace fuses.
- To avoid explosion, do not operate this equipment in an explosive atmosphere.
- Qualified service personnel should perform safety checks after any service.

1.2.2 General Cautions

Observe these cautions when operating or servicing this equipment:

- If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.
- To prevent damage to equipment when replacing fuses, locate and correct the problem that caused the fuse to blow before re-applying power.
- Do not block ventilation openings.
- Do not position this product in such a manner that would make it difficult to disconnect the power cord.
- Use only the specified replacement parts.
- 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 1928-C Optical Power Meter.
- 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.

1.2.3 Summary of Warnings and Cautions

The following general warning and cautions are applicable to this instrument:

WARNING

Before operating the Model 1928-C Optical Power Meter, please read and understand all of Section 1.

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.

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

WARNING

Before cleaning the enclosure of the Model 1928-C Optical Power

	Meter, the AC power cord must be disconnected from the wall socket.

⚠	**CAUTION** **There are no user serviceable parts inside the Model 1928-C Optical Power Meter. Work performed by persons not authorized by Newport Corporation will void the warranty. For instructions on obtaining warranty repair or service, please refer to Section 11.**

1.3 Location of Labels

1.3.1 Rear Panel

Markings on the rear panel identify the instrument compliance with different standards and regulations. The labels are located in the middle of the rear panel.

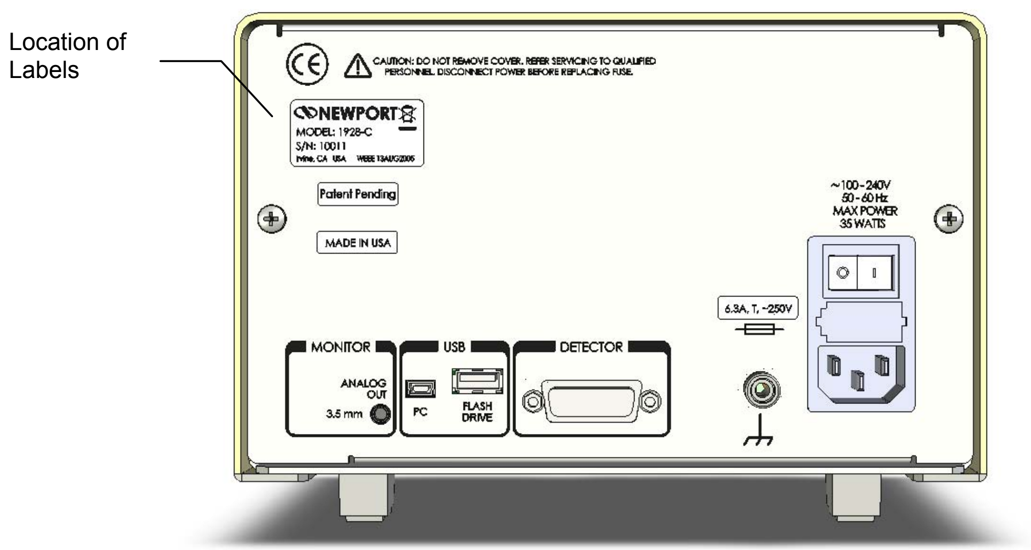

Figure 12 Locations of labels on the rear panel

2 General Information

2.1 Introduction

The 1928-C Optical Power Meter is designed to provide a powerful combination of features to measure optical power and energy of near-monochromatic or monochromatic sources. The instrument is powered by an AC wall-plug.

Use of the extensive measurement modes and features has been simplified with an intuitive menu driven structure that provides quick access to all modes, features and settings. Some of the prominent specifications and features that will simplify your calibrated measurement applications are the following:

- Compatibility with Photodiode, Thermopile and Pyroelectric detectors. (Low-Power (Semiconductor) Family, High-Power (Thermopile) Family, Energy (Pyroelectric) Family, PMT, GaN, PbS, PbSe, and HgCdZnTe)
- Measurement rate up to 4 kHz with internal signal sampling rate of 250 kHz.
- Multiple measurement modes for power and energy measurements: Single, Continuous, Integrated, and Peak-to-Peak.
- Software suite, including LabVIEW drivers and Windows application.
- 250,000 internal data point storage.
- External USB flash-memory compatibility.
- USB Device interface.

The full color TFT 4” LCD renders excellent visibility both with the naked eye and laser goggles for single screen rendering of plotted and enumerated results. Measurements can be displayed in Watts, Joules, Amperes, Volts, dBm, dB, Sun or relative units, either directly or as relative ratio measurements from present or stored values. Statistical capabilities include the computation of Min, Max, Max-Min, Mean and Standard Deviation. Additional features such as digital and analog filtering, and data storage of up to 250,000 readings per channel are also offered.

Newport’s experience with calibration, together with N.I.S.T. calibration traceability and high precision Optical Power Meters provide users with accurate measurements and exceptional inter-instrument correlation. In R&D, QA/QC, and manufacturing environments, the 1928-C Optical Power Meters enable users to benefit from high correlation between multiple locations at a price-to-performance ratio second to none. Among all the other practical tools provided, remote controlling with a computer and synchronization to other instruments are simplified with the inclusion of LabVIEW drivers, tools to develop in the .NET environment and a high-speed software utility that fully utilizes the optical power meter's ability to sample at 250 kHz and transfer data via a Full-Speed USB interface (11 Mbps).

2.2 Calibration

Calibration of the optical power meter is done at the factory by defining a slope and offset, for all ranges as determined for each detector type.

Newport recommends annual factory re-calibration to ensure the continued accuracy of the instrument measurements.

Please refer to the "Maintenance and Troubleshooting" section for contact information for re-calibration of your optical power meter.

2.3 Specifications

2.3.1 Physical Specifications:

Dimensions:	5.24 x 8.5 x 8.07 inch (133 x 216 x 205 mm)
Weight:	max. 5.5 lb
Enclosure:	Metal case, painted
Connectors:	Optical Detector 15-Pin D-Sub, Analog Output 3.5 mm Jack, USB-A Host, mini-B USB Device, AC Input IEC/EN 60320-1/C14 receptacle.
Power:	100/120/220/240VAC ± 10%, 50/60 Hz, 35 Watts (autoranging)
Display:	Graphical LCD ¼ VGA, 4 inch diagonal
Display Update Rate:	up to 20 Hz for selected graphical modes
Operating Environment:	5°C to 40°C; < 70% RH non-condensing
Storage Environment:	-20°C to 60°C; < 90% RH non-condensing
Altitude	< 3000m
Installation Category	II
Pollution Degree	2
Use Location	Indoor use only.

2.3.2 Electrical Specifications

DC Current Measurement (Low-Power, Semiconductor Photodiode)

Signal Range[2,3]	0	1	2	3	4
Full-Scale Current	2.50 µA	25.0 µA	250 µA	2.50 mA	25 mA
Resolution (Filtered)[1]	10 pA	100 pA	1.00 nA	10.0 nA	100 nA
Bandwidth[6] (Unfiltered)	480 Hz	4 kHz	43 kHz	170 kHz	500 kHz
Accuracy (Filtered)[1]	0.2%	0.2%	0.2%	0.2%	0.2%
Accuracy (Maximum Measurement Rate=4 kHz)	1.0%	1.0%	1.0%	1.0%	1.0%
Signal to Noise Ratio[1]	120 dB	120 dB	120 dB	120 dB	120 dB

Peak-Peak Current Measurement (Low-Power, Semiconductor Photodiode)

Signal Range[2,3]	0	1	2	3	4
Full-Scale Current	2.50 µA	25.0 µA	250 µA	2.50 mA	25 mA
Resolution	76.3 pA	763 pA	7.63 nA	76.3 nA	763 nA
Accuracy	1.0%	1.0%	1.0%	1.0%	1.0%
Bandwidth[6]	480 Hz	4 kHz	43 kHz	170 kHz	500 kHz
Maximum Pulse Repetition Rate[4]	480 Hz	4 kHz	4 kHz	4 kHz	4 kHz

D.C. Voltage Measurement (Thermopile)

Signal Range[2,3]	0	1	2	3	4	5
Full-Scale Voltage	2.5mV	25.0 mV	250 mV	2.50 V	25.0 V	130 V
Resolution	76.3 nV	763 nV	7.63 µV	76.3 µV	763 µV	3.96 mV
Accuracy (Filtered)[1]	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Accuracy (Maximum Measurement Rate=2 kHz)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Bandwidth[6]	600 kHz	1000 kHz	1000 kHz	1000 kHz	400 kHz	1000 kHz
Signal to Noise Ratio[1]	100dB	120dB	130dB	130dB	130dB	120dB

Pulse Voltage Measurement (Energy, Pyroelectric)

Signal Range[2,3]	0	1	2	3	4	5
Full-Scale Current	2.5mV	25.0 mV	250 mV	2.50 V	25.0 V	130 V
Resolution	76.3 nV	763 nV	7.63 µV	76.3 µV	763 µV	3.96 mV
Accuracy	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Bandwidth[6]	600 kHz	1000 kHz	1000 kHz	1000 kHz	400 kHz	1000 kHz
Maximum Pulse Repetition Rate[5]	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz

RMS Measurement

Maximum Pulse Repetition Rate	2 kHz	4 kHz
Accuracy	1.0%	2.0 %

Analog Output

Output Range	0	1	2
Full Scale Voltage (Load > 100 kΩ)	1 V	2 V	5 V
Accuracy	1.0 %	1.0 %	1.0 %
Linearity	0.3%	0.3%	0.3%

Trigger Level

Programmable Level	0…100 % Full Scale
Resolution	0.39 % Full Scale

[1] With 5Hz filter on and Digital Filter of 10000 samples on.
[2] Listed signal ranges specify meter capability. Available signal ranges are detector dependent.
[3] Maximum measurable signal is detector dependent.
[4] While the maximum repetition range may equal the bandwidth, it really depends on the signal duty-cycle or the signal shape.
[5] The Maximum Repetition Rate refers to the meter pulse-by-pulse measuring capability. Due to its high bandwidth, the 1928-C can take in signals with higher repetitive rates and outputs them undistorted at the Analog Output.
[6] The instrument bandwidth is determined by the detector used. Please refer to Newport Corporation's complete offering on detector type. The specified bandwidth is measured from the instrument input (detector) to the Analog Output BNC.

2.4 Unpacking and Handling

It is recommended that the 1928-C Optical Power Meter be unpacked in a lab environment or work site. Unpack the system carefully; small parts and cables are included with the instrument. Inspect the box carefully for loose parts before disposing of the packaging. You are urged to save the packaging material in case you need to ship your equipment in the future.

2.5 Inspection for Damage

The 1928-C Optical Power Meter is carefully packaged at the factory to minimize the possibility of damage during shipping. Inspect the box for external signs of damage or mishandling. Inspect the contents for damage. If there is visible damage to the instrument or accessories upon receipt, inform the shipping company and Newport Corporation immediately.

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.

2.6 Available Options and Accessories

Newport Corporation also supplies temperature controlled mounts, lenses, and other accessories. Please consult with your representative for additional information.

2.7 Parts List

The following is a list of parts included with the 1928-C Optical Power Meter:

1. A CD-ROM containing the User's Manual, Software Drivers and Utilities. (A PDF version of the manual can also be downloaded from the Newport website at www.newport.com).
2. Power cord

If you are missing any of these items or have questions about the items you have received, please contact Newport Corporation.

2.8 Choosing and Preparing a Suitable Work Surface

The 1928-C Optical Power Meter may be placed on any reasonably firm table or bench during operation. The front legs of the unit can be pulled out to tilt the unit at an angle, if desired.

Provide adequate distance between the 1928-C Optical Power Meter and adjacent walls for ventilation purposes. Approximately 2-inch spacing for all surfaces is adequate.

2.9 Electrical Requirements

Before attempting to power up the unit for the first time, the following precautions must be followed:

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

- Have a qualified electrician verify the wall socket that will be used is properly polarized and properly grounded.
- Verify the correct rated fuses are installed according to the fuse marking on the rear panel.

2.10 Power Supply

AC power is supplied through the rear panel input power connector that provides in-line transient protection and RF filtering. The input power connector contains the fuses for operation at 100VAC, 120VAC, 220VAC or 240VAC.

CAUTION

Do not operate with a line voltage that is not within 90-264 VAC.

3 System Overview

3.1 Startup Procedure

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

Provided that the Optical Power Meter has been installed in an appropriate environment and its external power supply power cord is connected to a working electrical outlet, power-up the Optical Power Meter by pressing the power button on the back panel.

For the highest precision and accuracy, the 1928-C Optical Power Meter should be allowed to warm up for one hour before being used for measurements.

3.2 Front Panel Layout

Figure 13 Front Panel Layout

3.2.1 Front Panel Elements

The front panel of the 1928-C features the following elements:

- A faceplate with a 4” active color liquid crystal display
- Setup/Enter and Esc keys
- Rubberized horizontal (left/right) and vertical (up/down) arrow keys
- Four rubberized blank keys below the display (referred to as “soft keys” later in the manual, as their function depends on the text on the screen above the key.) The leftmost key is also the Standby key.
- Six rubberized buttons with dedicated functions – Range, Mode, Hold, Filter, Lambda (λ), and Zero.

3.2.2 Understanding the Main Screen

The main screen is displayed after startup (Figure 13). The middle portion of the main screen is a real-time display of power measured in last used units, and the lower half of the main screen is a row of four labels for actions that the keys below them will activate.

When an annunciator label is visible, its function is enabled. If the annunciator appears on the display as an unlabeled key, the function it represents is currently disabled. Annunciators loosely correspond to keypad keys, which are used either alone or in combination with the navigation and selection keys to control annunciator functions.

3.3 Rear Panel Layout

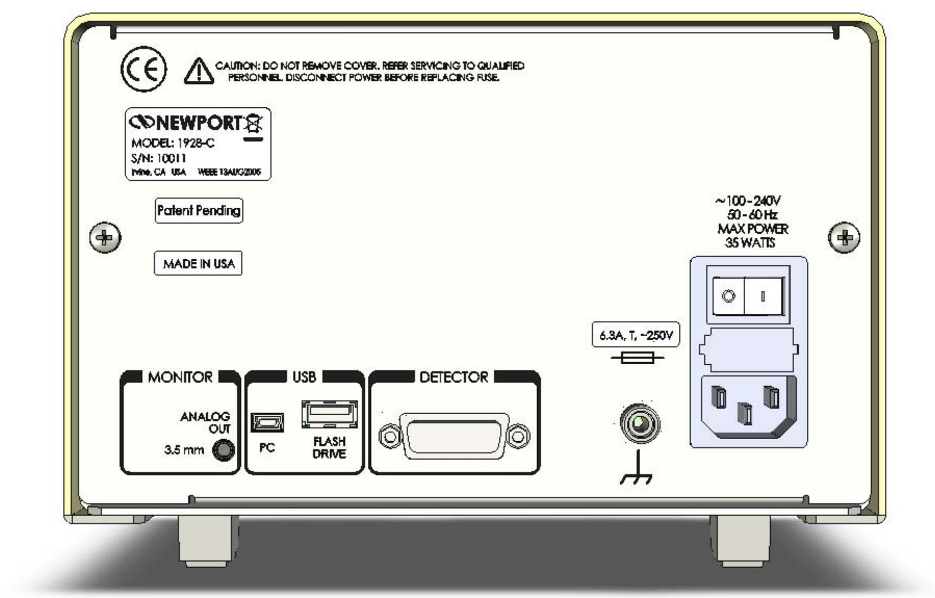

Figure 14 Rear panel

3.3.1 Rear Panel Elements

The rear panel of the 1928-C features the following elements (Figure 14):

Main Power Switch

The Main Power Switch is located on the rear panel. It is part of the AC power input connector. When the power is on, the meter can go in Standby mode by pushing the Standby key on the front panel.

Input Connectors

The input connectors are on the rear panel. The 1928-C power meter supports input from external detectors through DB15 detector connectors.

Output Connectors

The power meter 1928-C supports an analog output. This is a 3.5 mm Jack Output and enables direct monitoring of a detector through an oscilloscope or voltmeter. The monitoring channel is analog. Because of that, the signal is visualized in real time.

Mini USB Connector labeled PC

This connector is used for sending remote commands to the Optical Power Meter from a PC. The connection to a computer is done via a USB cable Type "A" Male Connector to Type "Mini-B" Male Connector.

USB “A” connector labeled FLASH DRIVE

This connector is used for saving the data on a USB flash drive and for firmware upgrades.

CAUTION

There are no user-serviceable parts inside the Optical Power Meter.

Work performed inside the Optical Power Meter by persons not authorized by Newport may void the warranty.

WARNING

To avoid electrical shock hazard, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

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4 System Operation

4.1 Front Panel Power Standby Key

4.1.1 Standby Key

Figure 15 Standby Key

The 1928-C Optical Power Meter can be placed in Standby mode by pressing the Standby soft key located on its front panel. It is the leftmost soft key in the main measurement view. When this key is pressed, the unit displays a message stating, "Entering Standby Mode…" for a few seconds before actually entering this mode. Once the unit is in Standby mode, all its functions including display are turned OFF. The unit can exit this mode and resume all functions either by pressing any key on its front panel or by sending commands to it from a host PC via USB communication interface.

4.2 Front Panel Keys

The front panel keys are organized in four groups (see Figure 16).

- Navigation Keys
- Escape (ESC) Key
- Reconfigurable Keys (also called Soft Keys).
- Dedicated Keys

Figure 16 Front Panel keys

4.2.1 Setup/Enter Key

The Setup/Enter key is placed to the right of the display (Figure 17). This key has dual functionality. From the main screen (Figure 18) press this key to display the Measurement Settings screen (Figure 19). Also, use this key while any secondary menu is displayed to complete entering data, or to exit the current secondary screen.

Figure 17 Navigation/Selection and Setup/Enter keys

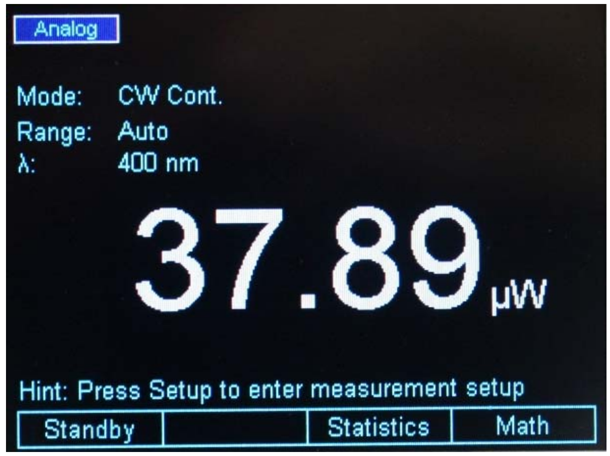


Figure 18 Main screen

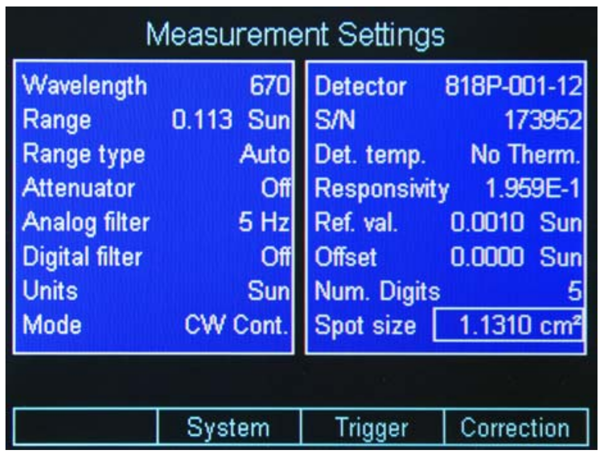


Figure 19 Measurement Settings screen

Refer to Section 4.3 for more information about the measurement settings.

4.2.2 Esc Key

The Esc key (Figure 16 and Figure 17) is used to cancel the current action. When in a secondary screen or menu, it will close the current screen or menu and the instrument will return to the main screen (Figure 18).

4.2.3 Navigation and Selection Keys

Navigation through and selection of data in the display is done with the top right group of four arrows keys and with the Setup/Enter key (Figure 17).

If the instrument is in Setup mode or in any configuration screens, pressing the arrow keys will select different setup modes as displayed by the current screen.

4.2.4 Soft Keys

Below the screen are a group of four keys (Figure 20). Their function varies, depending on the measurement mode or the setup screen. They are designed to provide context sensitive functionality to the user. The label displayed above each key indicates their function.

Figure 20 Soft keys

4.2.5 Dedicated Keys

Six dedicated function keys are at the bottom right portion of the front panel (Figure 21). Each of these keys can be used for quick access to the given function.

Figure 21 Dedicated keys

Range

Pressing this key reconfigures the Soft keys at the bottom of the screen as in Figure 22.

From this screen the user has two options.

- One is to toggle Auto/Manual Range mode. This is accomplished by pressing the left-most Soft key.

  If the meter current configuration is Manual mode the left-most Soft key is labeled Auto to allow the user to change the Range selection in Auto Range Mode. This can be seen in Figure 22, where the range is 110.0 µW indicating a manual mode.

  If the instrument is in Auto Range Mode, the left most key is labeled Manual. The user may return to the main screen by pressing the ESC key (see Figure 23).

- The other option is to press the right-most Soft key, which is labeled Config. This action displays the Range Configuration screen. Here the user can select a certain range or even Auto Range with the Navigation/Enter keys. The number of ranges depends on the detector used (see Section 2.3.2). Once a range is selected the instrument returns to the main screen. While in Range Configuration screen, the user may cancel the selection by hitting the ESC key.

Figure 22 Manual Range mode

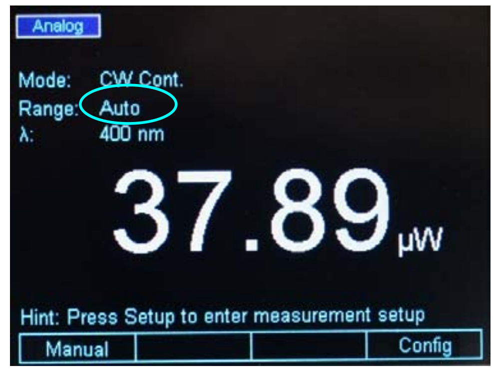


Figure 23 Auto Range mode

Figure 24 This screen is displayed after pressing the Config soft key

Mode

The Mode key displays a screen as in Figure 25. Using Navigation/Enter keys, the user can select different measurement modes or display modes according to his/her application. The ESC key cancels the selection and brings the instrument back to the main screen.

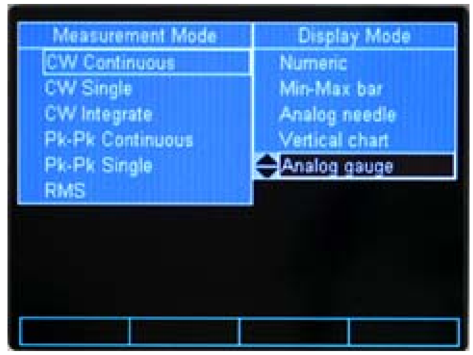


Figure 25 Mode selection screen

Hold

The Hold key toggles between holding the current measurement and updating regularly. When in Hold mode the numeric display freezes and the upper left corner of the display reads Hold (see Figure 26).
The display starts updating when the Hold key is pressed again. The ESC key has no effect on Hold status.

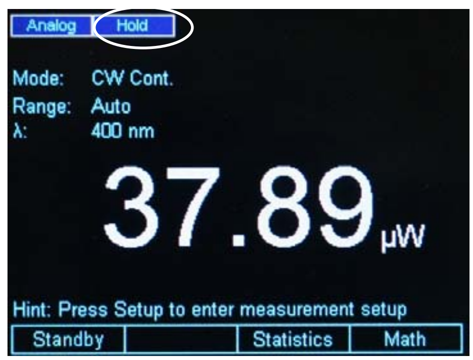


Figure 26 Measurement is on hold

Filter

The Filter key allows the user to apply Analog and/or Digital filters to the detector signal. Pressing this key reconfigures the Soft keys at the bottom of the screen as in Figure 27. Counting from left to right, the first key applies only the analog filter to the detector signal, the second applies only the digital filter, and the third applies both filters. When the filters are selected, the corresponding label above the soft key has a highlighted background and the filter name is displayed in the upper left corner.

Figure 27 Filter selection screen

The fourth Soft key is used for filter configuration. When selected, a screen as in Figure 28 is displayed. Using the Navigation/Enter keys the user can select the desired analog and digital filters. If Enter key is pressed after making the selection, the new analog and digital filter settings are applied, and the instrument goes back to the main screen. If ESC key is pressed instead, the new settings are ignored and the instrument goes back to the main screen.

Figure 28 Filter configuration screen

The digital filter values can be edited (Figure 29). When one of the digital filter values is selected, the right most soft key becomes Edit Value. Pressing this Soft key displays a cursor on top of the first digit of the edited filter value. The Navigation Up/Down keys modify the digit, while the Left/Right keys move the cursor to the next digit. When finished, press the Enter key to store the new digital filter value and press Enter again to select the new value and exit the Filter configuration screen.

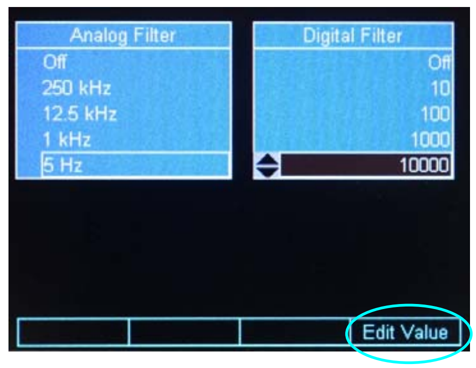


Figure 29 Digital Filter editing

Lambda (λ) Key

The Lambda (λ) key displays the Default and Custom Wavelengths screen (Figure 30). This screen allows the user to choose a default wavelength or a custom wavelength for the measurement in progress. See Section 4.5 for more details.

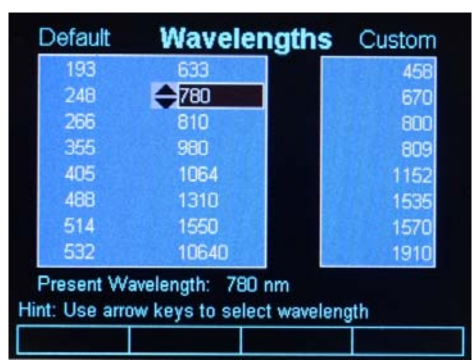


Figure 30 Wavelengths screen

Set Zero Offset (Zero Key)

The Zero Offset key, or short, Zero key is used to temporarily zero the instrument for the measurement in progress. When the user presses this key, the instrument takes the displayed numeric value as offset and subtracts it from all the subsequent measurements. When the instrument is zeroed the offset value is displayed on the main screen above the numeric value (see Figure 31).

The Zero key toggles the offset on or off. The ESC key has no effect on the Zero function.

Figure 31 Zero Selection

4.3 Measurement Settings

The Measurement Settings screen has dual functionality:

- One is the convenience the user has to change all the measurement settings within one screen.
- The other is information presented to the user about the detector used.

From the main measurement screen, pressing the Setup/Enter key causes the 1928-C to display the Measurement Settings screen as in Figure 32.

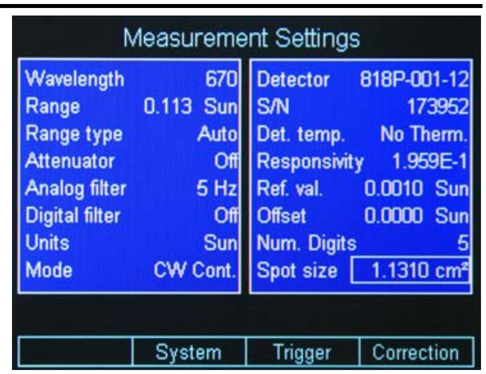


Figure 32 Measurement Settings screen

4.3.1 Changing the Measurement Settings

Within the Measurement Settings screen the user can select the Wavelength, Range, Range Type, Detector Attenuator Status, Analog Filter, Digital Filter, Measurement Units, Measurement Mode, Spot Size and the Number of Digits displayed.

4.3.1.1 Wavelength Selection

With the Navigation/Selection keys bring the cursor on top of the Wavelength field. Hit the Enter key. A drop-down menu appears with the custom wavelength values (see Section 4.5 for more information about the wavelength custom values). Select the desired wavelength and hit Enter.

4.3.1.2 Range Selection and Range Type (Rng. type)

The Range field has dual functionality:

- One is to display the current selected range whether it was selected by the user, in Manual Range Mode, or by the system, in Auto Range Mode.
- The other is to allow the user to change the range.

With the Navigation/Selection keys bring the cursor on top of the Range field. Hit the Enter key. A drop-down menu appears with the available ranges in the selected units. Select the desired range and hit Enter.

If the unit was in Auto Range mode, once a range is selected here, it will switch the system to Manual Range Mode. To bring it back to Auto Range Mode, navigate to Range Type (Rng. type) and change the range to Auto Range Mode. Also, the user has another option to bring the Optical Power Meter back into the Auto Range Mode. This can be done from the default screen where the user can change the Range to Auto Range Mode with the Range Dedicated key (see Section 4.2.5).

4.3.1.3 Attenuator On/Off

If the detector is equipped with an integrated attenuator (e.g. 918D Series), the 1928-C detects its status (ON or OFF) and displays it in the Attenuator field.

The user has the option to manually set the attenuator to ON or OFF for detectors that have attenuators that can be manually mounted on the detector (e.g. 818 Series).

To change the attenuator status, bring the cursor on top of the Attenuator field. Hit the Enter key. A drop-down menu appears with the ON/OFF option. Select the setting and hit Enter.

4.3.1.4 Analog and Digital Filter Selection

With the Navigation/Selection keys bring the cursor on top of the Analog or Digital field. Hit the Enter key. A drop-down menu appears with the available filter settings. Select the desired filter and hit Enter.

The Analog and Digital filter configuration can be accessed any time with the Filter dedicated key. Refer to Section 4.2.5 for details.

4.3.1.5 Units Selection

With the Navigation/Selection keys bring the cursor on top of the Units field. Hit the Enter key. A drop-down menu appears with the available units. Select the desired units and hit Enter.

4.3.1.6 Mode Selection

This setting allows the user to change the measurement mode. The available modes are as follows:

- Continuous Wave Continuous Run (CW Cont.)

- Continuous Wave Single Shot (CW Single)
- Continuous Wave Integral (CW Integ.)
- Peak-to-Peak Continuous Run (Pk-Pk Cont.)
- Peak-to-Peak Single Shot (Pk-Pk Single)
- Pulse Mode Continuous Run (Pulse Cont.)
- Pulse Mode Single Shot (Pulse Single)
- RMS Measurements (RMS)

Refer to Section 5, Performing Basic Measurements, for detailed information regarding these modes.

4.3.1.7 Spot Size

This setting allows users to change the spot size. The default spot size is set to be same as the detector size. The spot size can be modified by navigating the cursor to this setting, and pressing the Setup/Enter key. The value then becomes editable; each digit in the value can be changed by pressing Up/Down arrow keys, and different digits can be selected by pressing Left/Right arrow keys. The desired value can be accepted by pressing Setup/Enter key.

4.3.1.8 Number of Digits Setting

The default number of digits displayed by 1928-C is 4. To change this setting, bring the cursor on top of the Num. Digits field. Hit the Enter key. A drop-down menu appears with the option of 3, 4 or 5 digits. Select the desired number of digits and hit Enter.

4.3.1.9 Offset Field

On the right column of the Measurement Settings the unit displays the Offset stored when the user hits the Zero dedicated key. This value can be cleared or updated if the unit is in the main measurement screen and Zero is pressed (see Section 4.2.5 for more information).

4.3.2 Detector Information

The Measurement Settings screen displays information about the detector used based on the data available in the detector calibration module or detector internal memory.

The available data are the detector model number (Detector), the detector serial number (S/N), the detector temperature (Det. temp.) if the detector has an internal temperature sensor, and the detector responsivity (Responsivity).

4.4 Trigger Setup

The Trigger Setup screen can be accessed from the Measurement Settings (Figure 33). Pressing the Trigger soft key gives the user a few choices to setup the trigger according to the measurement needs.

The 1928-C Optical Power Meter has an advanced Trigger set that allows the user to synchronize the measurements. Synchronization can be achieved with Trigger Start and Trigger Stop which can both be set from the trigger setup screen.

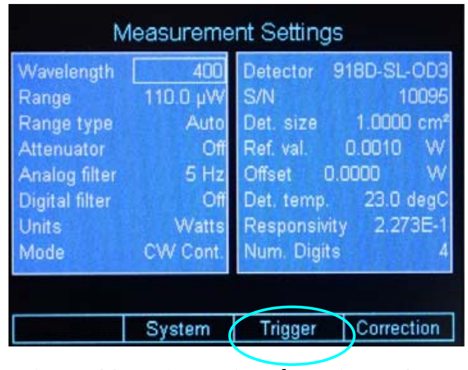


Figure 33 Accessing the Trigger Setup screen

4.4.1 Trigger Start

The Trigger Start is an event that tells the system when to take a measurement or a group of measurements. It can be set in different ways.

- **None**: The system is always triggered.
- **Soft Key**: The system can be triggered with a Soft Key that appears in the main measurement screen.
- **Command**: The system is triggered with an external command, PM:TRIG:STATE (Section 8.3.3).

The Trigger Start can also be set with an external command PM:TRIG:START (Section 8.3.3).

4.4.2 Trigger Stop

The Trigger Stop is an event that tells the system when to stop taking measurements. In the case of a single measurement, a trigger stop event arms the system for the next measurement. It can be set in different ways.

- **None**: The system measures continuously.
- **Soft Key**: The system stops measuring when a Soft Key is pressed. This key appears on the main measurement screen.
- **Command**: The system stops measuring when an external command, PM:TRIG:STOP (Section 8.3.3) is sent via USB.
- **Value**. The system stops measuring when the measured signal crosses a user programmed value in CW Integrate mode.
- **Time**. The system stops measuring when a user programmed time passed between the Start event and the current measurement.

The Trigger Stop can also be set with an external command PM:TRIG:STOP (Section 8.3.3).

4.5 Wavelength Setting

Newport detectors have a calibration module or internal memory which stores the Responsivity versus Wavelength Table. If the Lambda key is pressed, a wavelength screen is displayed with the most common values in nanometers (nm) (see Figure 30 on page 37).

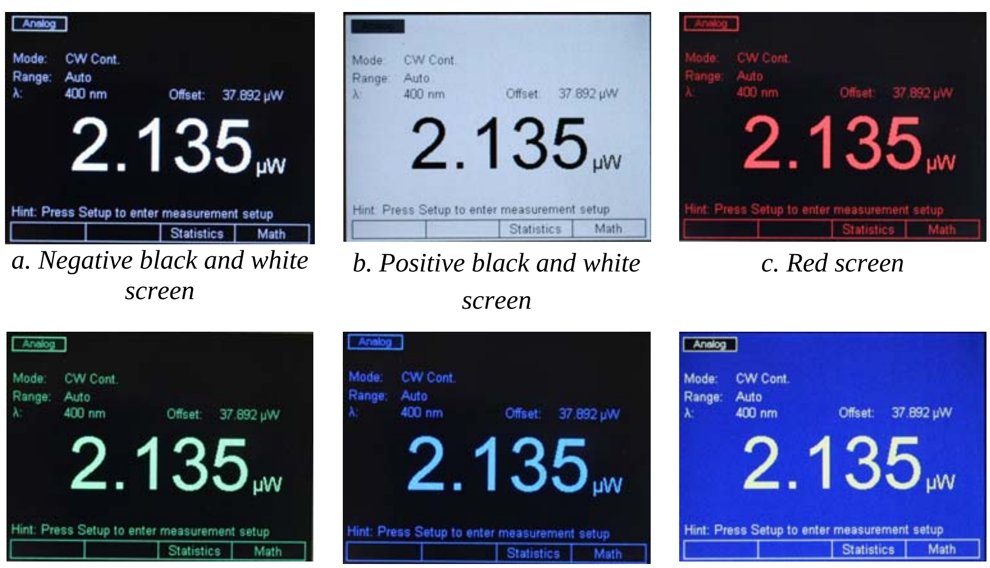
The screen has two columns. The left column displays the common wavelength values used in the industry, while the right column has custom values.

When the user selects one of the predefined wavelengths in the left column, the 1928-C looks up the wavelength in the responsivity table in the detector calibration module. If that exact value is found, the system will use the corresponding responsivity for that particular wavelength. If the value is not found, the system will calculate the responsivity using interpolation.

The right column in the Wavelength screen gives the user the option to set custom wavelengths. To do so, with the Navigation keys bring the cursor on top of one of the numbers. The rightmost Soft key becomes Edit Value. Hit this key to edit the custom number. A white cursor appears on the first digit. Press the Up/Down navigation keys to change the number and the Left/Right keys to move to the next digit. When finished, hit Enter. The new custom wavelength will be stored. Press Esc to return to the main measurement screen

4.6 Display Color

In a laboratory environment, and especially when one uses protective eyewear, it may be desirable to change the meter display color to accommodate the eyewear color. The instrument has predefined color schemes that can be changed any time (Figure 34).



a. Negative black and white screen

b. Positive black and white screen

c. Red screen

d. Green screen

e. Blue screen

f. Color/Blue screen

Figure 34 Predefined color schemes

To change the display colors first press the Enter/Setup key. This will bring the Setup screen and reconfigure the Soft keys (Figure 35).

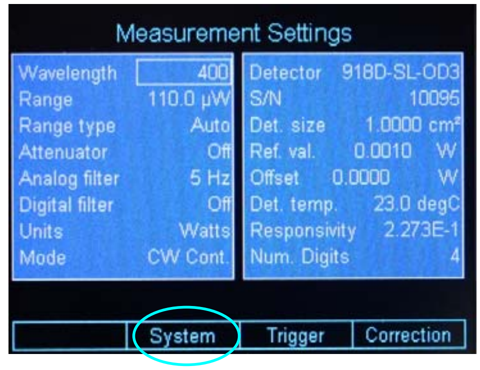


Figure 35 Setup screen

Pressing the System soft key will bring a secondary setup screen. Navigate to the Color Selection to change the screen color (Figure 36). Also, navigate to the Brightness field and hit Enter to change the screen brightness. The default value is 80%. Press the Measure soft key to go back to the Measurement Settings screen, or press ESC to go back to the main measurement screen.

Figure 36 System Settings screen

Pressing the About soft key will bring another screen with information about the unit's firmware version, serial number, calibration date. In addition, the attached detector's data is displayed (Figure 37). From here, one can navigate back to the Measurement Settings or back to the System Settings.

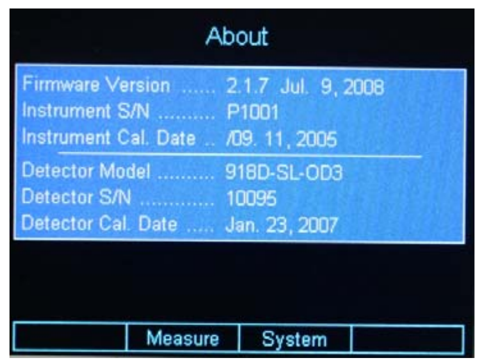


Figure 37 About screen

4.7 USB Address

The USB Address can be changed in the System Settings screen (Figure 36). Navigate to the USB Address and hit Enter. In the drop-down menu select the desired USB address.

4.8 Statistics

The 1928-C can display statistics for the measurement in progress. From the main measurement screen press the Soft key labeled Statistics. The Statistics screen is displayed as in Figure 38.

The left column shows the current statistics setup. The Statistics function has two modes: Fixed and Continuous.

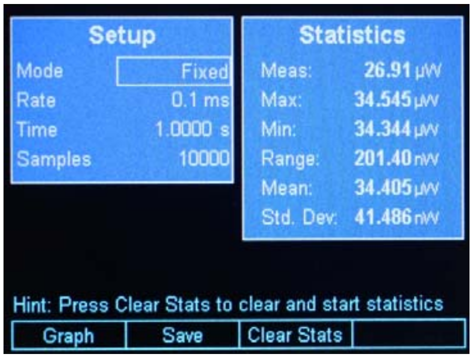


Figure 38 Statistics screen

When in Fixed mode the Statistics engine calculates the minimum (Min), maximum (Max), Range, Mean, Standard Deviation (Std. Dev.) for a fixed number of samples and displays them in the right column.

The number of samples is displayed in the left column on the Samples line. As Figure 38 shows, the number of samples is 10000 with a time interval between samples of 100 µs. This means that, for this example, the statistics values are calculated over 1 second time interval.

Pressing Clear Stats soft key clears current statistics, enables data collection and starts computation of new statistics values. Once the desired number of samples are collected (10000 in this case), the data collection is automatically disabled and statistics computation is stopped. The statistics shown at this point are representative of the collected data collected and available for download. This soft key can be pressed at any time to restart the whole process again.

The data collected can be saved to a flash drive attached to the rear panel of the unit by pressing Save soft key.

The user can change the mode using the Navigation keys. Use the Up/Down navigation keys to highlight the Mode choices. Press the Enter key to view a drop-down menu that allows users to select Fixed or Continuous Mode. Use the Up/Down navigation keys followed by Enter, to change the mode to Continuous.

Pressing Clear Stats soft key in Continuous mode clears current statistics, enables data collection and starts computation of new statistics values. In this mode, the unit does not disable data collection when the number of samples specified is collected. Instead, it continues to collect data and place them in a data buffer on a first-in-first-out (FIFO) basis. The statistics shown are representative of data collected since the time Clear Stats was last pressed. As in Fixed mode, the Clear Stats soft key can be pressed at any time to restart the whole process again.

The Graph soft key (Section 4.8.1) can be used for the visualization of the measured values on a time graph.

The Statistics screen displays also the current measured value at the top of the right column.

4.8.1 Graph

The Graph soft key displays the last 10000 measurements on a time graph (Figure 39). Due to the sample time interval of 100µs, the graph duration is 1 second. The graph width is 270 pixels and, because of that, the system has to decimate the 10000 samples to fit them in this fixed number of pixels. Therefore, the graph might look choppy if the graph zoom is set on 1.

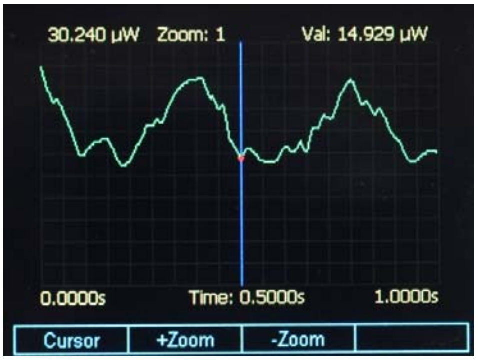


Figure 39 Graph screen

The user can zoom into the graph with the Soft keys +Zoom and –Zoom. As the zoom changes the graph displays a finer picture of the measurements. The zoom value is retained at the top of the screen. Pressing the +Zoom soft key will zoom in the graph 2 times the previous zoom value. Pressing the –Zoom soft key will zoom out ½ times the previous zoom value.

The maximum graph value is displayed in the upper left corner of the display. If the Cursor soft key is pressed, a vertical line (cursor) is displayed. The user can direct the cursor left or right with the Navigation Keys to read the measured values on the graph. The current value is displayed in the upper right corner and marked on the screen with a red dot.

4.9 Math Functions

The Math function is displayed on the math field, at the upper right corner of the main measurement screen (see Figure 40). To display the Math field the user must select the soft key labeled Math on this screen. This in turn displays a math configuration screen (see Figure 41).

Figure 40 Math field

The Math function can be used to add, subtract, multiply or divide the current measurement Ch. A with a reference Ref. A in real time.

Once in the Math configuration screen the user can use the Navigation keys to build a desired mathematical expression. From the first column the user can select the first variable in the expression, from the second column, the operator, and from the third column, the second variable. After making the selections, the user can press Enter key to confirm the choices and to return to the main measurement screen.

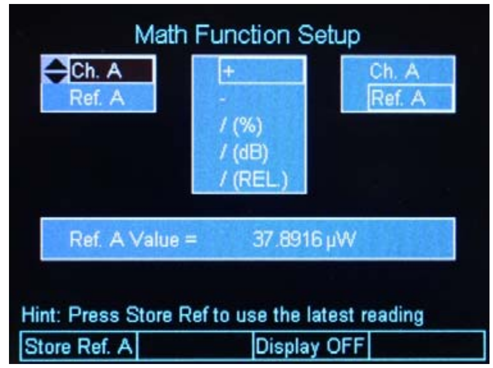


Figure 41 Math configuration screen

The Ref. value is assigned a default value of 0.001 when the system is first turned on. The reference value is stored and displayed in the selected units. The user can change the reference value by navigating to the reference value and units fields and modifying them using the Up/Down/Left/Right keys.

If the displayed units change, then the user needs to update the stored reference value so that the system will store the new units in the reference.

The Math field can be turned off from the math configurations screen. The second Soft key is labeled Display OFF. If this key is pressed the system returns to the main measurement screen and the Math field disappears.

4.10 Measurement Correction Settings

The 1928-C Optical Power Meter provides users the capability to correct actual measurements taken by it through a "Correction Settings" screen. This screen can be accessed by pressing the "Correction" soft-key in "Measurement Settings" screen (Figure 42). The "Measurement Settings" screen, as described earlier, can be accessed by pressing the Setup key from main measurement screen.

The Correction Settings screen (Figure 43) allows users to enter two (2) multiplier values, labeled "Multiplier 1" (M1) and "Multiplier 2" (M2), besides an "Offset" value. The corrected measurement is arrived at using the formula shown below:

Corrected measurement = [(Actual measurement * M1) – Offset] * M2.

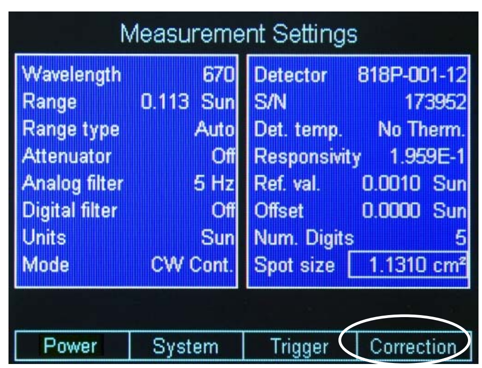


Figure 42 Measurement Settings

The default value for the two multipliers is 1.0, and the offset is 0.0. If any of these three parameters are changed from their default values, the main measurement screen shows the corrected measurement. A new field called "Detector:" appears at the bottom of the main screen that displays the actual measurement without any corrections.

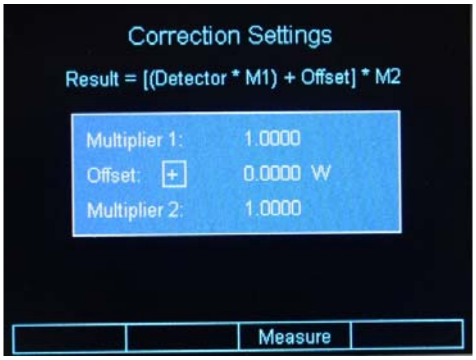


Figure 43 Correction Settings

4.11 Display Modes

The selection of various display modes can be done from the default screen, by pressing the Mode soft key. When the Mode selection screen is displayed (Figure 44), the display mode can be selected from the second column.

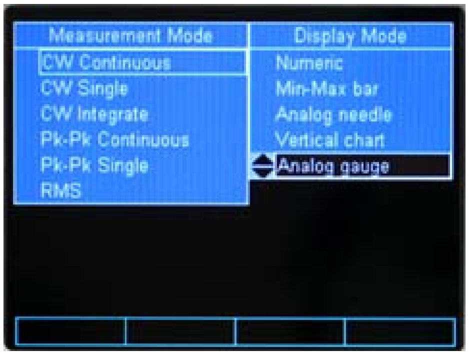


Figure 44 Mode selection screen

4.11.1 Numeric Display

The numeric display is the default display of the 1928-C. The numeric display shows the current measured value.

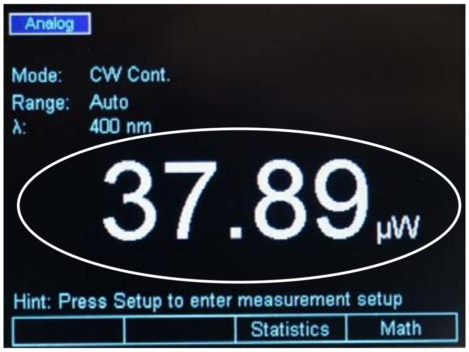


Figure 45 The Numeric display

4.11.2 Min-Max Bar

The Analog Bar display mode shows a bar graph below the numeric display. The bar graph is white and follows the value showed by the numeric display. The minimum and maximum labels displayed just below the bar graph represent the input range the unit is currently set on. For example, if the unit is set on 109.99 µW range, then the bar graph shows the same range of 0 to 109.99 µW. In the middle of the bar graph the displayed number is the middle of the range.

Figure 46 Analog Bar

The major ticks represent 10% of the range, and the minor ticks represent 5% of the range.

If the Soft key labeled Show Max is selected, the maximum value is retained and displayed in the bar graph with red color. The red bar is updated with each measurement, if the current measured value is larger than the largest of the previous measurements. Besides the maximum value being displayed with a red bar, the actual value is displayed above the bar graph where "Max=" shows the value. If the Soft key labeled Show Min is selected, the minimum value is retained and displayed in the bar graph with green color. The green bar is updated with each measurement, if the current measured value is smaller than the smallest of the previous measurements. Besides the minimum value being displayed with a green bar, the actual value is displayed above the bar graph where "Min=" shows the value.

The maximum and minimum bars can be reset with the Reset m/M soft key.

For users who would like to fine adjust a maximum or a minimum, the 1928-C offers the Auto Zoom function. When the Auto Zoom soft key is pressed another bar appears above the Analog Bar. The bar length is 2% of the Analog Bar. It is a display of the region around the end of the analog bar.

Figure 47 Auto Zoom

The Auto Zoom bar displays with white the current measured value, as the Analog Bar does. However its trip is more sensitive, because the maximum trip is +/-1% of the Analog Bar. If the Show Max or Show Min soft keys are pressed, the system behaves the same as with the Analog Bar, displaying with red the maximum value and with green the minimum value. As an example, as Figure 47 shows, the red bar in the Analog Bar is very small, so with the Analog Zoom this bar is extended giving the user the convenience to see better small signal variations.

Pressing the Reset m/M soft key, clears the minimum and maximum bars from both the Analog Bar and the Auto zoom graphs.

4.11.3 Analog Needle

The Analog Needle displays a vertical marker that moves with the displayed numeric value. It is useful for users who look for a maximum or a minimum when adjusting the optical power.

Figure 48 Analog Needle display

4.11.4 Vertical Chart

When the Vertical Chart is selected the numeric display is moved in the upper right corner. The vertical chart scrolls down, representing a snapshot of the last measurements. The chart can be cleared with the Clear soft key. The maximum peak value of the chart is the maximum measurement of the entire chart, since the last clear. Below the chart, there is a line with the chart maximum and minimum in major units. On the same line in the middle, there is information about the chart zoom level, e.g. 2x, and the number of samples processed per chart line, e.g. 10 Avg (Figure 49).

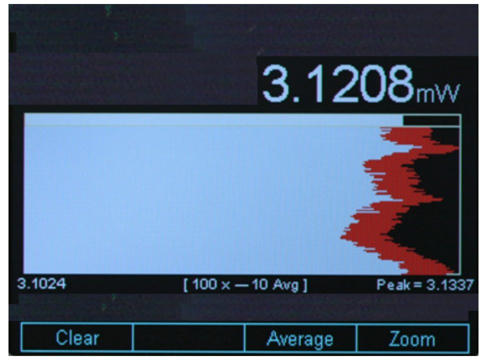


Figure 49 Vertical chart with 10 measurements per line

The chart has 100 lines, each line having a white and red color. When the system fills up a line, it looks at a number of samples defined by the number displayed below the chart.

Figure 50 Vertical chart with 1 measurement per line

Figure 49 shows 100x -- 10 Avg, which means that, while painting a line, the system looks at the previous 10 measurements. It displays with white the minimum value in the 10- measurement list and with red the maximum value in the same list.

The user can change the number of measurements by selecting the Average soft key and then pressing the Right or Left Navigation keys, to increase, respectively decrease the number of measurements. If one measurement is selected, the chart color is white, because the maximum and minimum per line are the same (Figure 50). Due to one measurement display per line, the chart speed increases.

If the Zoom soft key is pressed the user can zoom into the chart with the Up and Down Navigation keys

4.11.5 Analog Gauge

The Analog Gauge display simulates a traditional analog gauge. For enhanced ability to monitor the measurements, this display mode provides users the capabilities of showing a maximum value and zooming in/out around the present measured value. It also supplements the analog gauge simulation with a large numeric display (see **Error! Reference source not found.**) for improved ability to read the measurements.

Figure 51 Analog Gauge Display

If the user applies any correction or zero offset settings, the analog gauge and numeric display show the corrected measurements; the actual detector (uncorrected) measurements and zero offset value are displayed at the right top corner of the screen.

Figure 52 Analog Gauge Display with Maximum Value marker

If the user presses Show Max soft key, a maximum value marker (a thinner and longer needle than the measurement needle) is shown as in Figure 52. The soft keys available now are also modified as shown in this figure. The maximum value captured can be reset by pressing the Reset Max soft key, and this marker can be hidden by pressing the Hide Max soft key. When the maximum value marker is hidden, the soft keys are reconfigured as shown in Figure 51.

Figure 53 Analog Gauge Display at 50x Zoom

The users can zoom in or out around the measurements by pressing the +Zoom and -Zoom soft keys respectively. The default zoom level is 1x. At this zoom level, the analog gauge minimum and maximum settings are 0 and the present range maximum value. When the +Zoom and –Zoom soft keys are pressed, the power meter increases/decreases the analog gauge display resolution by modifying its minimum and maximum values (see Figure 53). The new values are determined based on the present measured value, range maximum value and the zoom level.

4.12 Optical Power Meter Firmware Upgrade Procedure

Firmware Upgrade is an easy, straight-forward process. Simply copy firmware files (PM1928APP.EXE and XMLFILE5.XML) to a WinCE compatible USB Flash Drive and then plug it into the USB connector on the rear panel of the instrument. Then wait a few seconds for the instrument to recognize the USB Flash Drive. The Optical Power Meter will detect the new firmware files and will ask if you want to download the files. Press the “Yes” softkey to start the upgrade process. The Optical Power Meter will instruct you to restart once the upgrade is successful. Disconnect the flash drive from the instrument and restart it by turning it OFF and back ON. The instrument will restart running the new firmware.

New firmware files may be available either through the Newport web site (http://www.newport.com) at the product page or through your local Newport application specialist.

5 Performing Basic Measurements

5.1 Introduction

Many different types of optical measurements are possible using the 1928-C Optical Power Meter. Most of these possible measurements are selected from within the MODE menu. This chapter discusses these measurements.

5.2 Measurement Modes and Units

The 1928-C provides a number of measurement modes for acquiring data. At power on, the meter checks the detector's calibration EEPROM to determine the available measurement modes supported by the detector.

Measurements can be displayed in various units. The detector type and the measurement mode determine the set of units available at any given time. Table 1 illustrates the measurement modes and units available for each detector family. The measurement modes are grouped naturally into three categories: CW, Peak-to-Peak (Pk-Pk), and Pulsed. Each will be discussed in the sections below.

The 1928-C sets the measurement to a detector specific default mode depending on the detector used. All Newport detectors have internal logic or calibration modules. Based on the data stored in detectors, the instrument knows to auto configure itself and sets up the mode, range, filter, rate, etc. The user, in the setup screen, can change the detector specific default mode.

The basic measurement techniques for using the 1928-C are covered in the following sections. Refer to Table 1 for a review of the 1928-C's functions and measurement capabilities.

Detector Family	Mode	V	A	W	W/cm^2	J	J/cm^2	dBm	dB	REL / %	Sun
Low-Power (918D-Series)	CW Continuous*		X	X	X			X	X	X	
	CW Single		X	X	X			X	X	X	
	CW Integrate					X	X		X	X	
	Pk-Pk Continuous		X	X	X			X	X	X	
	Pk-Pk Single		X	X	X			X	X	X	
High-Power (818P-Series)	CW Continuous*	X		X	X			X	X	X	X
	CW Single	X		X	X			X	X	X	X
	CW Integrate					X	X		X	X	
Energy (818E-Series)	Pulse Continuous*	X				X	X		X	X	
	Pulse Single	X				X	X		X	X	

Table 1 Available Measurement Modes and Valid Units.

The modes with the symbol “*” are the default measurement modes. The Optical Power Meter enters these modes when it determines the presence of a “new” detector for the first time. The meter will, thereafter, remember the last five connected detectors and enter their last used measurement mode.

Since dB, % and REL are relative measurements, these units are available in the math field only. Use the Math Configuration screen to specify a desired reference value and to select a desired operation.

The following instructions assume familiarity with the meter’s functions. They also include steps to incorporate background correction and assume that the experimental setup under-fills and does not saturate or damage the detector.

5.3 CW Measurements (with 918D or 818P Detectors)

This section describes the procedure for making basic optical power measurements while properly removing the influence of ambient light and other drift effects.

- With a 918D (also 818-XX lower power detectors with proper adapters) or 818P-Series Detector connected to the meter, turn the meter on. Press the Mode key and then select CW Continuous with the Navigation keys. Use the ESC key to return to the Main screen. Set Range to Auto and press the Lambda (λ) key to set the measurement wavelength to the desired value.

- Cover or otherwise block the light source being measured and then press the Zero key to turn the Offset on. This effectively removes any background signal from subsequent measurements.
- Uncover the source so that it illuminates the detector and note the displayed value. This reading is the optical power observed by the detector due to the source.

This process assumes that the ambient signal is not changing between the time when the Zero key is pressed and when the measurement is made. The user should remember that, if he/she can see the detector active area as he/she moves around, then the detector registers this as a changing ambient DC signal!

- For the 918D series detectors (also 818-XX lower power detectors with proper adapters) you can decide whether to use the attenuator for your measurement or deactivate (or physically remove on 818 low power series) the attenuator.
  a. For very low power measurements, below µW range in various ambient light environments, you can elect to use the detector with no physical attenuator in the optical path. This will increase the sensitivity and hence accuracy of the measurement.
  b. In case of higher power measurement, the attenuator should be used to avoid damage or saturation of the detector. The attenuator use is recommended in mW to low Wattage range incident power. Please refer to the specifications of the particular detector to make sure you do not exceed the saturation levels of the detector.

  For the 918D series detectors with integrated (non-removable) attenuators, there is a switch built into the detector head, sensing the position of the attenuator. The Optical Power Meter will then automatically use proper calibration data for presence or absence of the attenuator in front of the photo diode. For models such as 818 low power series detectors which have a removable attenuator, there is no switch built into the detector head, hence the user will have to manually select attenuator option status on the meter to obtain the proper power or signal readings.

5.4 Peak-to-Peak Power Measurements (918D Detectors)

This section describes the procedure for making basic optical peak-to-peak power measurements.

- With a 918D Low Power Detector connected to the meter, turn the meter on. Set the Mode to Pk-Pk Continuous. Set Range to Auto and press the Lambda (λ) key to set the measurement wavelength to the desired value.
- Illuminate the detector and note the displayed value. This reading is the peak-to-peak optical power observed by the detector.
- Accurate peak-to-peak power measurements can be made for pulse repetition rates up to 20 kHz.

5.5 Power Ratio and Power Reference measurements

This section describes how to use the mathematical functions in the Optical Power Meter to obtain a power or signal comparison to a previously saved value. The readout can be displayed as a linear ratio, a percentage or in dB. Refer to Section 4.9 for information on setting the reference values.

- **Example 1** – In order to select dB ratio versus a stored reference value:
  a. While in the Math function screen, select channel A by using the up or down arrow keys. There will remain a black border around the highlighted/selected channel as you leave the column for the next selection.
  b. Move to the next column by using the right arrow key, and select "/(dB)" option.
  c. Move to the last column by using the right arrow key and use the up or down keys to select Ref. A.
  d. Press the Menu/Enter key to accept the selections and exit the Math function screen.
  e. The result of Ch. A/Ref. A in units of dB will appear in the designated window on the screen.
- **Example 2** – In order to get the difference between channel A and a stored reference value:
  a. From the main screen of the meter, select soft key labeled "Math" to enter the math function screen. If you cannot see the label "Math", press the "ESC" key.
  b. Use the direction keys to highlight channel A in the first column
  c. Using the direction keys, navigate to the "-" symbol in the center column.
  d. Using the direction key, move the final column such that Ref. A is highlighted.
  e. Press the Menu/Enter key to retain the settings and exit the screen at the same time.
  f. The result of Ch. A- Ref. A will be displayed in the designated window of the main display screen.

5.6 Pulse Energy Measurements (818E Detectors)

This section describes the procedure for making basic optical pulse energy measurements.

- With an 818E Energy Detector connected to the meter, turn the meter on. Set the Mode to Pulse Continuous. Set the Range to Manual Mode and press the Lambda (λ) key to set the measurement wavelength to the desired value.

- Illuminate the detector and note the displayed value as the meter measures each laser pulse. These readings represent the energies of the incident laser pulses. The meter will display the last pulse energy measured until a new pulse arrives.
- Accurate measurements can be made for pulse repetition rates up to 10 kHz, depending on the limitation of the specific detector in use, of course.

5.7 Signal Integration Measurements (918D or 818P Detectors)

This section describes the procedure for making a basic signal integration measurement while properly removing the influence of ambient light and other drift effects. The 1928-C begins and ends the signal integration every second.

- With a 918D or 818P Detector connected to the meter, turn the meter on. Set the Mode to CW Continuous. Set the Range to Auto and press the Lambda (λ) key to set the measurement wavelength to the desired value.
- Cover or otherwise block the light source being measured, turn Zero on and then set the Mode to CW Integrate. Immediately upon entering the integration mode, the meter will begin to acquire and integrate data. The display value may reflect the integration of noise due to ambient temperature fluctuations (when using the 818P detectors) or light fluctuations (when using the 918D detectors).
- Uncover or trigger the source. The displayed value should now reflect the detector signal integration value.

NOTE

This process assumes that ambient signals are not changing between the moments when the user zeros the display and when the measurement is made.

5.8 Measuring Laser Pulse Energy with an 818P Thermopile Detector (Single Shot)

This application makes use of the 1928-C’ CW Integrate mode (see Section 5.7 above). When an optical pulse with energy $E(\lambda)$ is incident on a thermopile (818P Series), a voltage signal is generated at the detector input as the heat pulse flows out to the cooling fins. The sum of a series of integrated signals (each one second long) resulting from this heat pulse is a measure of the optical pulse energy, see Figure 54.

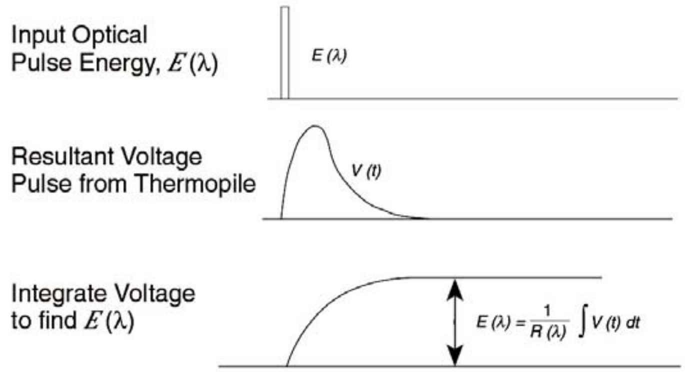


Figure 54 Measuring Laser Pulse Energy via a Thermopile in CW Integrate Mode

A recommended procedure is:

- With an 818P High Power Detector connected to the meter, turn the meter on. Set the Mode to CW Continuous. Set the Range to Auto and press the Lambda (λ) key to set the measurement wavelength to the desired value. Set Zero on and then change Mode to CW Integrate.
- Before the optical pulse arrives, the display may reflect the integral of detector noise due to ambient temperature fluctuations.
- Trigger the laser pulse. The display will display a new integrated energy measurement every second. The readings will start decreasing rapidly after the first couple of measurements due to the decline in heat flow from the relatively slow thermopile detector.
- When the displayed reading drops again to the point of essentially displaying the detector's noise component, the individual stored readings may be retrieved via the USB interface. Summing these readings will yield the pulse energy.

NOTE

This method works best if the integrated result of the pulse signal is much larger than the integral of the detector's noise component. If the integrated result of the pulse is not much larger, then error in the measurement will arise due to the uncertainty generated by integration of the noise component terms.

NOTE

The time constant of a thermopile detector determines the amount of time that one should expect to wait when making an integrated energy measurement of an optical pulse. Typically, an accurate value will be at 5 time constant after the arrival.

5.9 RMS Measurements

This section describes the procedure for making a basic signal RMS (Root Mean Square) measurement while properly removing the influence of ambient light and other drift effects. The 1928-C begins and ends the signal RMS every second.

- With a 918D or 818P Detector connected to the meter, turn the meter on. Set the Mode to RMS. Set the Range to Auto and press the Lambda (λ) key to set the measurement wavelength to the desired value.
- Cover or otherwise block the light source being measured, turn Zero on. Immediately upon entering the RMS mode, the meter will begin to acquire and calculate RMS value of the data. The display value may reflect the RMS of noise due to ambient temperature fluctuations (when using the 818P detectors) or light fluctuations (when using the 918D detectors).
- Uncover or trigger the source. The displayed value should now reflect the detector signal RMS value.
- The RMS value is calculated based on data acquired over a one second time period. The formula used to calculate the RMS value is given below:

$$y = \sqrt{\frac{\sum_{i=0}^{n} x_i^2}{n}}$$

Where x_i is the signal measured, n is the number of samples acquired over a one second period, and y is the RMS value.

NOTE

This process assumes that ambient signals are not changing between the moments when the user zeros the display and when the measurement is made.

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6 Software Application

6.1 Overview

The 1928-C has a USB connector on the rear panel of the unit that is used to connect to a computer for use with this application.

Provided on the CD that comes with the unit is an installation for this software application. The installation installs the USB drivers that are required to use USB communication.

The software is designed to allow the user to remotely control basic functions of the instrument.

6.2 Connection

Start the application, which will detect and connect the attached optical power meter. The 1928-C Optical Power Meter has just one channel, so channel B is grayed out.

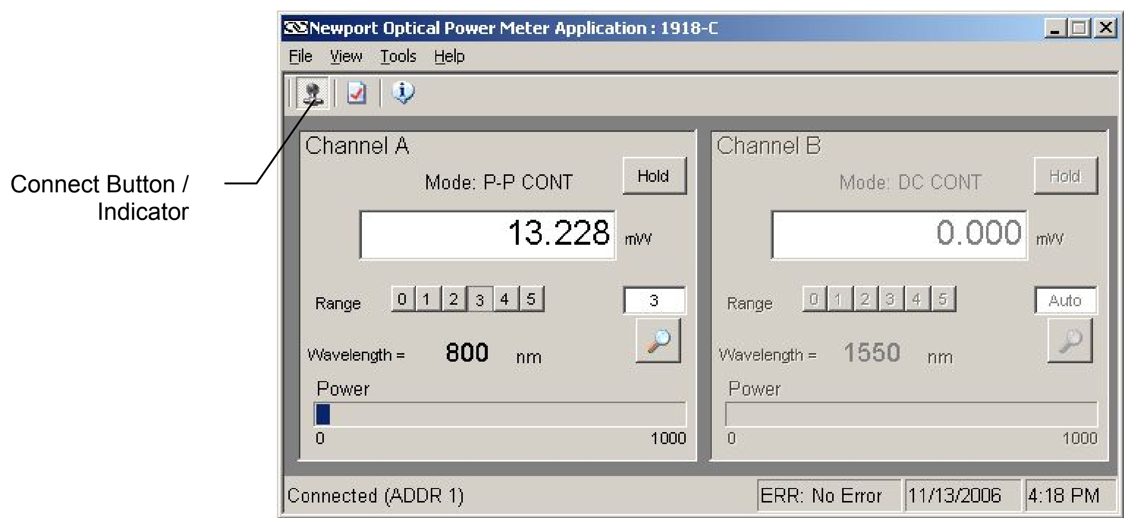

Figure 55 Application front panel

6.3 General Usage

This software application allows the user to setup and monitor the instrument remotely.

The controls on the instrument are available in the software in a very easy to read and change format.

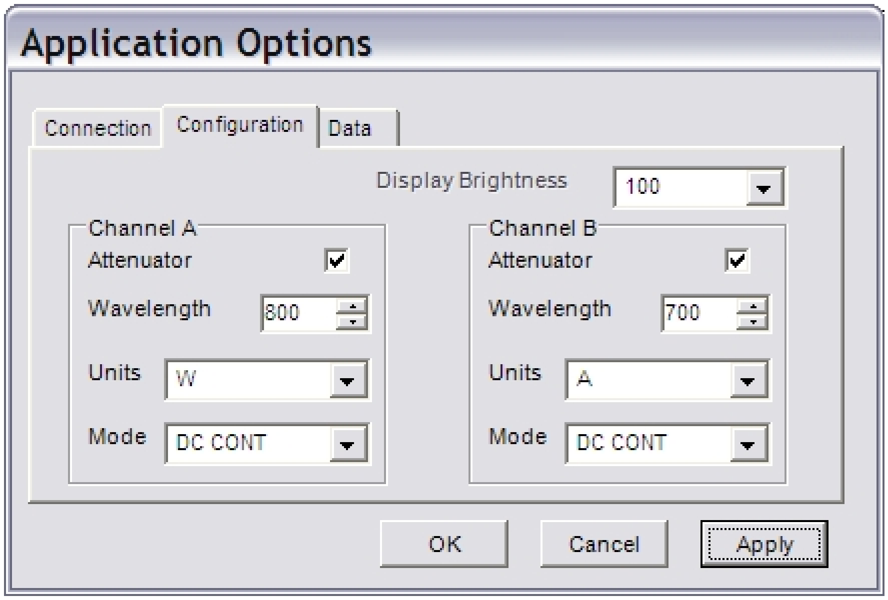

Figure 56 Application Advanced Options (Configuration Tab)

The application is designed to have menus similar to standard Windows applications like MS Word, to ease usability.

6.4 Menu Structure

To Exit the application go to the File menu and select Exit.

The Edit/Advanced Options menu has additional property settings, including channel settings and data logging options.

The Help/About will show information about the application, including firmware version when an instrument is connected and communicating.

7 Computer Interfacing

7.1 General Guidelines

The 1928-C Optical Power Meter has a USB computer interface port used to send commands to the instrument from a host PC. The connection to a computer is done via a USB cable Type "A" Male Connector to Type "Mini-B" Male Connector.

The commands supported by the Optical Power Meter can be divided into the following two categories: commands that cause the instrument to take a desired action, and commands (queries) that return a stored value or state of the Optical Power Meter.

Query commands are always terminated by a question mark (?). It is recommended that when a query command is sent, the response to that command from the Optical Power Meter be read before issuing any other command.

Set commands, on the other hand, are used to configure/setup the Optical Power Meter for a desired mode of operation. These commands take at least one parameter. The subsequent sections in this chapter detail the USB communication protocols supported by the Optical Power Meter.

7.2 Computer Interface Terminology

Listed below are the key abbreviations and concepts used in the command reference section (Section 8) of this manual.

7.2.1 <…> Delimiting Punctuation

For the purposes of this manual, any string enclosed by <…> is considered to be a command, a string or numerical argument. The punctuation <…> is used to symbolize the typographic limits of the command, string or argument in question.

7.2.2 <CR> Carriage Return

The ASCII encoded byte 13 in decimal. (0D hex)

7.2.3 <LF> Line Feed

The ASCII encoded byte 10 in decimal. (0A hex)

7.2.4 (;) Semicolons

Semicolons are used to separate commands within a single transmission (concatenation).

7.2.5 <number> Numerical Types

Numerical parameters are passed and returned as the actual ASCII characters in the string representation of the number. See section 12.2 for more detailed information.

7.2.6 <string> String Types

See the section 12.1 for a detailed description of <string>.

7.3 USB Communication

The instrument is designed to communicate with standard USB interfaces. Before connecting the instrument to the USB interface the user should install the application included in the software CD that accompanies the Optical Power Meter. The application automatically installs the right USB drivers. Communication can be done through this interface by using the application or by developing software in the user's preferred programming language. The software CD contains drivers and example programs in the following programming languages: LabVIEW, Visual Basic, and Visual C++.

8 Communication Command Reference

8.1 1928-C Optical Power Meter Remote Interface Commands

A complete listing of the commands supported by the 1928-C Optical Power Meter is provided below.

8.2 Command Overview

There are two types of commands: commands that cause the Optical Power Meter to take a desired action, and queries that return a stored value or state of the instrument. Queries must end with a question mark (?), while commands may require parameter(s) to follow:

PM:Lambda 810

For example, the value “810” in the command **PM:Lambda 810** sets the wavelength to 810nm. The table below summarizes all the commands and queries supported by the 1928-C Optical Power Meter. The command/query MUST contain all of the letters, which are shown in upper case in this table. The lower case letters shown with the commands are optional, and may be used for clarity. If any of the optional letters are used, then all of the optional letters are required for the command.

The commands may be sent to the instrument in either upper or lower case or in any combination. For example, the following commands are equal:

PM:Lambda 810

PM:L 810

pm:L 810

Pm:L 810

COMMAND EXECUTION:

The controller interprets the commands in the order they are received and execute them sequentially. If a set of commands have to be executed closer to each other, these commands can be sent to the controller simultaneously by creating a command string with semicolon (;) used as a command separator. The command string length should not exceed 50 characters. In the example shown below, a command string was created with semicolon separating 5 queries. The controller responds to this command string with a response that has 5 values using a comma (,) as a separator.

COMMAND STRING:

PM:P?;PM:ATT?;PM:L?;ERR?

INSTRUMENT RESPONSE:

1.2450,1,810,0

8.3 Optical Power Meter Command Description

8.3.1 Command Glossary

Root level Commands/Queries Summary

Name	Number of Parameters	Function	Page No.
*IDN?	NONE	Identification query	69
*RCL	1	Recall configuration settings	69
*SAV	1	Save configuration settings	69
ADDRess	1	Sets the instrument's USB address	70
ADDRess?	NONE	Returns the instrument's USB address	70
ERRors?	NONE	Returns errors generated since the last query.	70
ERRSTR?	NONE	Returns errors and their corresponding error text generated since the last query.	71

Table 2 Root level Commands/Queries Summary

Tree level Commands/Queries Summary

Name	Number of Parameters	Function	Page No.
DISP:BRIGHT	1	Sets the backlight level of the display and the keypad	68
DISP:BRIGHT?	NONE	Returns the backlight level of the display and the keypad	68
PM:ANALOGFILTER	1	Sets the analog filter to desired value	71
PM: ANALOGFILTER?	NONE	Returns the analog filter setting	71
PM:ANALOG:IMP	1	Sets the analog input impedance to desired value	72
PM:ANALOG:IMP?	NONE	Returns the analog input impedance value	72
PM:ANALOG:OUT	1	Sets the analog output range to desired level	72
PM:ANALOG:OUT?	NONE	Returns the analog output range	73
PM:ATT	1	Selects if the attenuator's calibration data is included for power calculation.	73
PM:ATT?	NONE	Returns setting if attenuator data should or should not be used when calibrating the Optical Power Meter.	73
PM:ATTSN?	NONE	Gets the attenuator serial number.	74
PM:AUTO	1	Sets the Optical Power Meter ranging to manual or automatic.	74
PM:AUTO?	NONE	Returns 1 if automatic Optical Power Meter ranging is selected.	74
PM:CALDATE?	NONE	Returns the calibration date of the detector.	74
PM:CALTEMP?	NONE	Returns the temperature at which the calibration was performed.	75
PM:CORR	3	Sets the power measurement correction settings.	75
PM:CORR?	NONE	Power measurement correction settings query	75
PM:DETMODEL?	NONE	Returns the model number of the detector.	76
PM:DETSIZE?	NONE	Returns the detector surface area	76
PM:DETSN?	NONE	Returns the serial number of the detector.	76
PM:DIGITALFILTER	1	Sets the digital filter to desired value	77

Name	Number of Parameters	Function	Page No.
PM: DIGITALFILTER?	NONE	Returns the digital filter setting	77
PM:DPower?	NONE	Detector Power query	77
PM:DS:BUFfer	1	Set data store behavior select.	77
PM:DS:BUFfer?	NONE	Returns data store behavior select.	78
PM:DS:Clear	NONE	Clear data store.	78
PM:DS:Count?	NONE	Returns data store count of items stored.	78
PM:DS:Enable	1	Set data store enable.	79
PM:DS:Enable?	NONE	Returns data store enable.	79
PM:DS:GET?	1	Returns data store data. {1,1-10,-5,+5} – value, range, oldest 5, newest 5	79
PM:DS:INTerval	1	Set data store interval.	80
PM:DS:INTerval?	NONE	Returns data store interval.	80
PM:DS:SAVEBUFER	1	Saves the data store buffer to a WinCE compatible USB flash disk	80
PM:DS:SIZE	1	Sets the size of the Data Store buffer	81
PM:DS:SIZE?	NONE	Returns the sizes of the Data Store buffer	81
PM:DS:UNITs?	NONE	Returns data store units.	81
PM:FILTer	1	Selects the filtering operation: no filtering, analog filter, digital filter, or analog and digital.	82
PM:FILTer?	NONE	Returns the filtering operation: no filtering, analog filter, digital filter, or analog and digital.	82
PM:Lambda	1	Sets the wavelength for use when calculating power.	82
PM:Lambda?	NONE	Gets the selected wavelength in nanometers.	83
PM:MAX:Lambda?	NONE	Returns the longest calibrated wavelength in nanometers.	83
PM:MAX:Power?	NONE	Returns the maximum readable power in present range	83
PM:MIN:Lambda?	NONE	Returns the shortest calibrated wavelength in nanometers.	83
PM:MIN:Power?	NONE	Returns the minimum readable power in present range	84
PM:MEAS:TIMEOUT	1	Sets the measurement timeout period	84
PM:MEAS:TIMEOUT?	NONE	Returns the measurement timeout period	84
PM:MODE	1	Acquisition mode select	85
PM:MODE?	NONE	Returns the currently selected acquisition mode.	85
PM:Power?	NONE	Returns the power in the selected units.	86
PM:PWS?	NONE	Returns the power with status.	86
PM:RANge	1	Selects the gain stage when making readings with the detector head within a range from 0 to 6 (with zero being the highest).	87
PM:RANge?	NONE	Returns an integer indicating the current range.	87
PM:REF:VALue	1	Sets the user reference value for use in relative or dB readings.	87
PM:REF:VALue?	NONE	Returns the user reference value.	88
PM:REF:STOre	NONE	Sets the user reference value for use in relative or dB readings as the present reading.	88
PM:RESPonsivity?	NONE	Gets the responsivity currently used for making power calculations.	87
PM:RUN	1	Disables or enables the acquisition of data.	89
PM:RUN?	NONE	Returns the present acquisition mode.	89
PM:SPOTSIZE	1	Sets the detector spot size	89
PM:SPOTSIZE?	NONE	Returns the detector spot size	89
PM:STAT:MAX?	NONE	Returns statistics buffer maximum value.	89
PM:STAT:MEAN?	NONE	Returns statistics buffer mean value.	90
PM:STAT:MIN?	NONE	Returns statistics buffer minimum value.	90
PM:STAT:MAXMIN?	NONE	Returns statistics buffer maximum-minimum value.	90
PM:STAT:SDEViation?	NONE	Returns statistics buffer standard deviation value.	91
PM:Temp?	NONE	Returns the 918 detector's temperature in degrees Celsius.	91
PM:TRIG:START	1	Set the optional start event	91
PM:TRIG:START?	NONE	Returns optional start event	92
PM:TRIG:STOP	1	Set the optional stop event	92
PM:TRIG:STOP?	NONE	Returns optional start event	92
PM:TRIG:STATE	1	Set the trigger state	92
PM:TRIG:STATE?	NONE	Returns the trigger state	93

Name	Number of Parameters	Function	Page No.
PM:UNITs	1	Selects the units for readings.	93
PM:UNITs?	NONE	Returns an integer indicating the selected units.	94
PM:ZEROSTOre	NONE	Sets the zeroing value with the present reading.	94
PM:ZEROVALue	1	Sets the zeroing value.	94
PM:ZEROVALue?	NONE	Gets the zeroing value.	95

Table 3 Tree Level Commands/Queries Summary

8.3.2 Display Commands

8.3.2.1 DISP:BRIGHT

Description Display brightness command

Syntax **BRIGHT** *brightness*

Remarks The **BRIGHT** command controls the brightness of the instrument display.

Argument	**Type**	**Description**
Brightness	int	Brightness, in levels from 0 to 7

Related Commands: DISP:BRIGHT?

8.3.2.2 DISP:BRIGHT?

Description Display brightness query

Syntax **DISP:BRIGHT?**

Remarks The **BRIGHT?** query returns the display brightness setting.

Response	**Type**	**Description**
Brightness	int	Display brightness, in levels from 0 to 7

Related Commands: DISP:BRIGHT

8.3.3 Optical Power Meter Commands

8.3.3.1 *IDN?

Description Identification Query

Syntax ***IDN?**

Parameters None

Function

Remarks This query will cause the Optical Power Meter to return an identification string.

Model name | Firmware version # | Firmware date | Controller Serial #

NEWPORT XXXX vYYY mm/dd/yy SNZZZZ

Examples:
NEWPORT 1928-C v2.0.0 11/07/06 SN0001

8.3.3.2 *RCL

Description Recall Configuration Settings

Syntax ***RCL** *bin*

Remarks The ***RCL** command restores the power meter to the setup state saved in its non-volatile flash memory.

Argument	Value	Description
bin	*0*	*Reserved*
	1 to 5	*Valid configuration settings*

Related Commands: ***SAV**

8.3.3.3 *SAV

Description Save Configuration Settings

Syntax ***SAV** *bin*

Remarks The ***SAV** command saves the present state of the power meter in its non-volatile flash memory. A particular state is then recalled using the ***RCL** command. If any one of these parameters are changed, the present state of the power meter will automatically be saved in configuration setting #1. When the power meter is reset, the state of the meter defaults to configuration setting #1. The setup parameters saved include:

Display brightness level

USB address

Color scheme

Measurement display mode

Custom wavelengths

Argument	Value	Description
bin	*0*	*Reserved*
	1 to 5	*Valid configuration settings*

Related Commands: ***RCL**

8.3.3.4 ADDRess

Description USB address command.

Syntax **ADDRess** value

Remarks **The ADDRess** command sets the Optical Power Meter USB address. After changing USB address, the communication with the Optical Power Meter has to be re-initialized.

Argument	Value	Description
Value	*0*	*Reserved*
	1 to 31	*Valid USB address range*

Related Commands: **ADDRess?**

8.3.3.5 ADDRess?

Description USB address query.

Syntax **ADDRess?**

Remarks **The ADDRess** query returns the Optical Power Meter's USB address.

Response	Value	Description
address	*0*	*Reserved*
	1 to 31	*Valid USB address range*

Related Commands: **ADDRess**

8.3.3.6 ERRors?

Description Error query

Syntax **ERRors?**

Remarks	The ERRors? query returns a single error number that has occurred since the last query. This error is indicated by a number that corresponds to the type of error that occurred. This command also clears the read error from the Error buffer.	
Response	**Type**	**Description**
Error code	int	Error code number per Appendix B, 0 if no errors

Related Commands: ERRSTR?

8.3.3.7 ERRSTR?

Description Error string query

Syntax **ERRSTR?**

Remarks The **ERRSTR?** query returns a single error number along with the corresponding error text string that have occurred since the last error query.

Response	**Type**	**Description**
Error code,	string	Error code number and text for error code as*"text"*per Appendix B, 0 if no errors

Related Commands: ERRors?

8.3.3.8 PM:ANALOGFILTER

Description Analog filter select command

Syntax **PM:ANALOGFILTER** *value*

Remarks The **PM:ANALOGFILTER** command selects the analog filter setting.

Argument	**Value**	**Analog Filter**
Value	0	None
	1	250 kHz
	2	12.5 kHz
	3	1 kHz
	4	5 Hz

Related Commands: PM:ANALOGFILTER?

8.3.3.9 PM: ANALOGFILTER?

Description Analog filter query

Syntax **PM:ANALOGFILTER?**

Remarks The **PM:ANALOGFILTER?** query returns an integer indicating the present analog filter setting.

Argument	Value	Analog Filter
Value	0	None
	1	250 kHz
	2	12.5 kHz
	3	1 kHz
	4	5 Hz

Related Commands: PM:ANALOGFILTER

8.3.3.10 PM:ANALOG:IMP

Description Analog input impedance select command

Syntax **PM:ANALOG:IMP** *value*

Remarks The **PM:ANALOG:IMP** command selects the analog input impedance.

Argument	Value	Input Impedance
Value	0	50 Ω
	1	100 kΩ
	2	1 MΩ

Related Commands: PM:ANALOG:IMP?

8.3.3.11 PM:ANALOG:IMP?

Description Analog input impedance query

Syntax **PM:ANALOG:IMP?**

Remarks The **PM:ANALOG:IMP?** query returns an integer indicating the present analog input impedance.

Argument	Value	Input Impedance
Value	0	50 Ω
	1	100 kΩ
	2	1 MΩ

Related Commands: PM:ANALOG:IMP

8.3.3.12 PM:ANALOG:OUT

Description Analog output range select command

Syntax **PM:ANALOG:OUT** *range*

Remarks The **PM:ANALOG:OUT** command selects the analog output range.

Argument	Value	Max. Output
Range	0	1 V
	1	2 V
	2	5 V
	3	Reserved

Related Commands: PM:ANALOG:OUT?

8.3.3.13 PM:ANALOG:OUT?

Description Analog output range query

Syntax **PM:ANALOG:OUT?**

Remarks The **PM:ANALOG:OUT?** query returns an integer indicating the present analog output range.

Response	Value	Max. Output
Range	0	1 V
	1	2 V
	2	5 V
	3	Reserved

Related Commands: PM:ANALOG:OUT

8.3.3.14 PM:ATT

Description Attenuator enable command

Syntax **PM:ATT** *enable*

Remarks Indicates whether or not the attenuator for the 818 Series power detector is on the detector.

Argument	Type	Description
Enable	int	Enable use of detector responsivity with attenuator available in the calibration module for 818 detectors.

Related Commands: PM:ATT?

8.3.3.15 PM:ATT?

Description Attenuator enable query

Syntax **PM:ATT?**

Remarks The **PM:ATT?** query returns 1 when using attenuator calibration, 0 when calculating power without attenuator data.

Response	Value	Description
attenuator	0	Calibrating power without attenuator
	1	Calibrating power using attenuator

Related Commands: PM:ATT

8.3.3.16 PM:ATTSN?

Description Attenuator serial number query

Syntax **PM:ATTSN?**

Remarks The **PM:ATTSN?** query returns the serial number of the attenuator. When no detector is found the Optical Power Meter responds with "no detector".

Response	Type	Description
serial number	string	Serial number of the attenuator

Related Commands: PM:DETMODEL?, PM:DETSN?

8.3.3.17 PM:AUTO

Description Auto range enable command

Syntax **PM:AUTO** *mode*

Remarks The **PM:AUTO** command sets the power ranging to either manual or automatic.

Argument	Value	Description
mode	0	Manual Optical Power Meter ranging
	1	Automatic Optical Power Meter ranging

Related Commands: PM:AUTO?, PM:RANge

8.3.3.18 PM:AUTO?

Description Auto range mode query

Syntax **PM:AUTO?**

Remarks The **PM:AUTO?** query returns a value to indicate if auto ranging is enabled or not.

Response	Value	Description
mode	0	Manual Optical Power Meter ranging
	1	Automatic Optical Power Meter ranging

Related Commands: PM:AUTO, PM:RANG

8.3.3.19 PM:CALDATE?

Description Detector calibration date query

Syntax **PM:CALDATE?**

Remarks The **PM:CALDATE?** query returns the calibration date of the detector.

For example: 21JUN1999.

Response	Type	Description
Date	string	DDMMMYYYYY

8.3.3.20 PM:CALTEMP?

Description Temperature at which detector was calibrated query

Syntax **PM:CALTEMP?**

Remarks The **PM:CALTEMP?** query returns the temperature (degrees Celsius) at which the detector was calibrated. When no detector is present, "no detector" is returned.

Response	Type	Description
temperature	float	Returns the temperature at which the detector was calibrated.

8.3.3.21 PM:CORR

Description Power measurement correction settings

Syntax **PM:CORR** *value1, value2, value3*

Remarks The **PM:CORR** command sets the power measurement correction settings. These settings are used by the power meter to correct the actual power measurement. The corrected power is calculated using the formula provided below:

Corrected Measurement =

*((Actual Measurement * value1) + value2) * value3*

Argument	Type	Description
value1	float	Multiplier 1 (default = 1.000)
value2	float	Offset (default = 0.000)
value3	float	Multiplier 2 (default = 1.000)

Related Commands: PM:CORR?, PM:Power?, PM:DPower?

8.3.3.22 PM:CORR?

Description Power measurement correction settings query

Syntax **PM:CORR?**

Remarks The **PM:CORR?** command returns the power measurement correction settings. These settings are used by the power meter to correct the actual power measurement. The corrected power is calculated using the formula provided below:

Corrected Measurement =

*((Actual Measurement * value1) + value2) * value3*

Response	**Type**	**Description**
value1	float	Multiplier 1 (default = 1.000)
value2	float	Offset (default = 0.000)
value3	float	Multiplier 2 (default = 1.000)

Related Commands: PM:CORR, PM:Power?, PM:DPower?

8.3.3.23 PM:DETMODEL?

Description Detector model query

Syntax **PM:DETMODEL?**

Remarks The **PM:DETMODEL?** query returns the model number of the detector.

For example: 818-SL.

Response	**Type**	**Description**
model	string	Detector model number

8.3.3.24 PM:DETSIZE?

Description Detector surface area

Syntax **PM:DETSIZE?**

Remarks The **PM:DETSIZE?** query returns the surface area of the detector in cm^2.

Response	**Type**	**Description**
Area	float	Detector surface area

8.3.3.25 PM:DETSN?

Description Detector serial number query

Syntax **PM:DETSN?**

Remarks The **PM:DETSN?** query returns the serial number of the detector.

For example: 0001

Response	**Type**	**Description**
serial number	string	Detector serial number

8.3.3.26 PM:DIGITALFILTER

Description Digital filter select command

Syntax **PM:DIGITALFILTER** *value*

Remarks The **PM:DIGITALFILTER** command specifies the digital filter setting.

Argument	Type	Description
Value	int	digital filter size between 0 and 10000

Related Commands: PM:DIGITALFILTER?

8.3.3.27 PM:DIGITALFILTER?

Description Digital filter query

Syntax **PM:DIGITALFILTER?**

Remarks The **PM:DIGITALFILTER?** query returns the present digital filter setting.

Argument	Type	Description
Value	int	digital filter size between 0 and 10000

Related Commands: PM:DIGITALFILTER

8.3.3.28 PM:DPower?

Description Detector power query

Syntax **PM:DPower?**

Remarks The **PM:DPower?** returns the actual power measurement. This measurement does not include any correction settings specified using “PM:CORR” command. When the correction settings are set to default values, the power measurement returned by this command is same as the measurement returned by “PM:P?” command.

Response	Type	Description
Power	float	Power in Watts

Related Commands: PM:Power?

8.3.3.29 PM:DS:BUFfer

Description Data Store buffer behavior selection

Syntax **PM:DS:BUFfer** *behavior*

Remarks The **PM:DS:BUFfer** command selects the behavior mode for control of the Data Store buffer.

Argument	**Value**	**Description**
Mode	0	Fixed Size
	1	Ring Buffer

The behavior of the ring buffer is to allow continual data collection after the buffer is full where the oldest values will be overwritten when new measurements are taken.

Related Commands: PM:DS:BUFfer?

8.3.3.30 PM:DS:BUFfer?

Description Data Store buffer behavior selection query

Syntax **PM:DS:BUFfer?**

Remarks The **PM:**DS:BUFfer**?** query returns the value of the Data Store buffer behavior.

Argument	**Type**	**Description**
Behavior	int	See **PM:**DS:BUFfer for a definition of the behavior status.

8.3.3.31 PM:DS:CLear

Description Clear the Data Store of all data

Syntax **PM:DS:CLear**

Remarks The PM:DS:CLear command resets the data store to be empty with no values.

Argument	**Type**	**Description**
none	-	

8.3.3.32 PM:DS:Count?

Description Data Store data item count query

Syntax **PM:DS:Count?**

Remarks The **PM:DS:Count?** query returns the number of measurements that have been collected in the Data Store.

Argument	**Type**	**Description**
count	int	The number of measurements that have been collected.

8.3.3.33 PM:DS:ENable

Description Enable Data Store Collection

Syntax **PM:DS:ENable** *enable*

Remarks The **PM:DS:ENable** enables or disables the collection of measurements in the Data Store.

Argument	Value	Description
enable	0	Disabled
	1	Enabled

Data will be collected after the PM:DS:ENable command has been called with a parameter of 1. Data collection will stop when the PM:DS:ENable command has been called with a parameter of 0 or when a fixed size data buffer is full.

Related Commands: PM:DS:ENable?

8.3.3.34 PM:DS:ENable?

Description Enable Data Store Collection query

Syntax **PM:DS:ENable?**

Remarks The **PM:DS:ENable?** query returns the enabled status of the Data Store.

Argument	Type	Description
enable	int	See PM:DS:Enable for a description of the enable argument

8.3.3.35 PM:DS:GET?

Description Retrieve Data Store data query

Syntax **PM:DS:GET? *num***

Remarks The **PM:DS:GET?** command returns a number of measurements that have been collected in the Data Store.

Argument	Type	Description
selection	string	"1" – returns the single value specified "1-10" – returns values in the range from 1-10 "-5" – returns the oldest 5 values (same as 1-5) "+5" – returns the newest 5 values

Note: depending on the number of data points requested, there may be several read operations required on the USB interface.

8.3.3.36 PM:DS:INTerval

Description Data Store Interval Select

Syntax **PM:DS:INTerval <interval>**

Parameters

The parameter <interval>is of type <number>that is an integer. The parameter represents the interval in milliseconds for storing one measurement in the data buffer.

Function

This command sets the interval in milliseconds to be used for data storing. For example if DSINT = 100 and DSSIZE = 100 it will take 100 x 100ms to fill the buffer.

Related Commands: PM:DS:SIZE,PM:DS:SIZE?,PM:DS:INTerval?

8.3.3.37 PM:DS:INTerval?

Description Data Store Interval Query

Syntax **PM:DS:INTerval?**

Parameters None

Function

This query returns the interval in milliseconds currently used for data storing.

Related Commands: PM:DS:SIZE,PM:DS:SIZE?,PM:DS:INTerval

8.3.3.38 PM:DS:SAVEBUFFER

Description Save the current Data Store data to a file

Syntax **PM:DS:SAVEBUFFER** *filename*

Remarks The **PM:DS:SAVEBUFFER** command saves the current user Data Store to a file on the WinCE compatible USB Flash Disk plugged into the USB Host port on the front of the Optical Power Meter.

Argument	Type	Description
Filename	*string*	The filename that will be created or overwritten on the USB Flash Disk containing the measurments stored in the Data Store.

8.3.3.39 PM:DS:SIZE

Description Size of the Data Store query

Syntax **PM:DS:SIZE <size>**

Parameters

The parameter <size>is of type <integer> in the range 1 to 250000.The parameter represents the size of the data buffer to be used for data storing.

Function

This command sets the size of the buffer used for data storing.

NOTE

The data buffer is cleared automatically when this command is used and all previously stored data will be gone.

Related Commands: PM:DS:SIZE?,PM:DS:INTerval,PM:DS:INTerval?

8.3.3.40 PM:DS:SIZE?

Description Data Store Buffer Size Query

Syntax **PM:DS:SIZE?**

Parameters None

Function This query returns the data store buffer size.

Returns <size> is of type <number>and represents an integer of the range 1 to 250000.

Related Commands: **PM:DS:SIZE,PM:DS:INTerval,PM:DS:INTerval?**

8.3.3.41 PM:DS:UNITs?

Description Data store units query

Syntax **PM:DS**:**UNITS?**

Remarks The **PM:**DS:**UNITS?** query returns an integer indicating the units selected.

Response	**Value**	**Description**
units	0	Amps
	1	Volts
	2	Watts
	3	Watts/cm^2
	4	Joules
	5	Joules/cm^2
	6	dBm
	7-10	Reserved
	11	Sun

Related Commands: PM:UNITS,PM:UNITS?

Note: The UNITs selection depends on the detector used. Refer to Table 1 for the relationship between the detector type and units.

8.3.3.42 PM:FILTer

Description Filter select command

Syntax **PM:FILT** *filter type*

Remarks The **PM:FILT** command select the filtering operation to be performed on power readings.

Argument	Value	Description
Filter type	0	No filtering
	1	Analog filter
	2	Digital filter
	3	Analog and Digital filter

Related Commands: PM:FILT?

8.3.3.43 PM:FILTer?

Description Filter type query

Syntax **PM:FILT?**

Remarks The **PM:FILT?** query returns an integer indicating the present filter mode.

Response	Value	Description
Filter type	0	No filtering
	1	Analog filter
	2	Digital filter
	3	Analog and Digital filter

Related Commands: PM:FILT

8.3.3.44 PM:Lambda

Description Wavelength set command

Syntax **PM:Lambda** *value*

Remarks The **PM:Lambda** command selects the wavelength to use when calculating power. The value must fall within the calibrated wavelength of the detector.

Argument	Type	Description
Value	int	Wavelength in nanometers (nm)

Related Commands: PM:Lambda?, PM:MAX:Lambda?, PM:MIN:Lambda?

8.3.3.45 PM:Lambda?

Description Wavelength query

Syntax **PM:Lambda?**

Remarks The **PM:Lambda?** query returns the selected wavelength in nanometers. This is the wavelength used to look up the responsivity from the calibration data.

Response	**Type**	**Description**
Wavelength	int	Wavelength in nanometers (nm)

Related Commands: PM:Lambda, PM:MAX:Lambda?, PM:MIN:Lambda?

8.3.3.46 PM:MAX:Lambda?

Description Maximum wavelength query

Syntax **PM:MAX:Lambda?**

Remarks The **PM:MAX:Lambda?** query returns the longest calibrated wavelength in nanometers. If no detector is preset, the max lambda for the last read detector is returned.

Response	**Type**	**Description**
Wavelength	int	Wavelength in nanometers (nm)

Related Commands: PM:MIN:Lambda?

8.3.3.47 PM:MAX:Power?

Description Maximum power query

Syntax **PM:MAX:Power?**

Remarks The **PM:MAX: Power?** returns current range’s maximum readable power.

Response	**Type**	**Description**
Power	float	Power in Watts

8.3.3.48 PM:MIN:Lambda?

Description Minimum wavelength query

Syntax **PM:MIN:Lambda?**

Remarks The **PM:MIN:Lambda?** query returns the shortest calibrated wavelength in nanometers. If no detector is preset,min lambda for the last read detector is returned.

Response	Type	Description
Wavelength	int	Wavelength in nanometers (nm)

Related Commands: PM:MAX:Lambda?

8.3.3.49 PM:MIN:Power?

Description Minimum power query

Syntax **PM:MIN:Power?**

Remarks The **PM:MIN: Power?** returns current range's minimum readable power.

Response	Type	Description
Power	float	Power in Watts

Related Commands: PM:MAX:Power?

8.3.3.50 PM:MEAS:TIMEOUT

Description Measurement timeout set command

Syntax **PM:MEAS:TIMEOUT** *value*

Remarks This command sets the measurement timeout period. This value is used for making the following measurements:

1. Peak-to-peak measurements: These measurements are updated once every timeout period when the power meter is in Peak-Peak Continuous mode.

2. Auto-ranging in Pulse Continuous mode: The power meter automatically shifts to a lower range once every timeout period when it determines that no pulse measurements could be taken in the existing range. Users must set this timeout value to 250ms or larger than their pulse repetition rate in order to be able to perform measurements accurately.

Argument	Type	Description
Value	int	Timeout value (milliseconds)

Related Commands: PM:MEAS:TIMEOUT?

8.3.3.51 PM:MEAS:TIMEOUT?

Description Measurement timeout query

Syntax **PM:MEAS:TIMEOUT?**

Remarks The **PM:MEAS:TIMEOUT?** query returns the selected measurement timeout value in milliseconds.

Response	Type	Description
Timeout	int	measurement timeout in milliseconds

Related Commands: PM:MEAS:TIMEOUT

8.3.3.52 PM:MODE

Description Acquisition mode select

Syntax **PM:MODE** *mode*

Remarks The **PM:MODE** command selects the acquisition mode for acquiring subsequent readings.

Argument	Value	Description
Mode	0	DC Continuous
	1	DC Single
	2	Integrate
	3	Peak-to-peak Continuous
	4	Peak-to-peak Single
	5	Pulse Continuous
	6	Pulse Single
	7	RMS

Related Commands: PM:MODE?

Note: The MODE selection depends on the detector used. Refer to Table 1 for the relationship between the detector type and MODE.

8.3.3.53 PM:MODE?

Description Acquisition mode query

Syntax **M:MODE?**

Remarks The **PM:MODE?** query returns an integer indicating the present acquisition mode.

Response	Value	Description
Mode	0	DC Continuous
	1	DC Single
	2	Integrate
	3	Peak-to-peak Continuous
	4	Peak-to-peak Single
	5	Pulse Continuous
	6	Pulse Single
	7	RMS

Related Commands: PM:MODE

Note: The UNITs selection depends on the detector used. Refer to Table 1 for the relationship between the detector type and units.

8.3.3.54 PM:Power?

Description Power query

Syntax **PM:P?**

Remarks The PM:P? query returns the power in the selected units.

Response Type Description *power* exp Exponential form (i.e. 9.4689E-04)

Related Commands: PM:UNITS?, PM:PWS?

8.3.3.55 PM:PWS?

Description Read with status query

Syntax **PM:PWS?**

Remarks The **PM:PWS?** query returns two values that are comma delimited: The first value is the power reading and the second value is the status. The status should be used to validate the reading. The reading is in units corresponding to the units field in the status word.

Response	Type	Description
Power reading	exp	Power in present units
Status	int	A bitfield in hexadecimal defining the current channel status

NOTE

The bitfield is defined as follows:

Bits 10-7	Channel Units. See PM:UNITS?
Bits 6-4	Channel Range, See PM:RANge?
Bit 3	Detector Present
Bit 2	Channel range change status. Indicates if a measurement has been taken while the unit is ranging
Bit 1	Detector Saturated (reserved, follows bit 0)
Bit 0	Channel overrange. Indicates that the current measurement is overrange for the current channel range

Related Commands: PM:MODE?

Example

If the query returns the following values

1.862153E-004, 118

then the Power reading is 1.862153E-004 and the Status is the hex value 118 or the binary value 00100011000b. Taking into consideration the bitfield definition, the status is decoded as follows:

Bits	Binary	Decimal	Function
10 - 7	0010	2	units = Watts
6 - 4	001	1	range # 1
3	1	1	detector present
2	0	0	instrument not ranging during measurement
1	-	-	reserved
0	0	0	measurement is not over-range

8.3.3.56 PM:RANge

Description Range select

Syntax **PM:RANge** *range*

Remarks The **PM:RANge** command selects the gain stage when making readings from the detector head. The range of this value depends on the detector being used.

Response	Type	Description
range	int	Values range from 0 to 5 for Thermopile and Energy detectors or 0 to 4 for Photodiodes (see Section 2.3.2).

Related Commands: PM:RANge?, PM:AUTO

8.3.3.57 PM:RANge?

Description Range query

Syntax **PM:RANge?**

Remarks The PM:RANge? query returns an integer that indicates the present range. The range of this value depends on the detector being used.

Response	Value	Description
range	0	Values range from 0 to 5 for Thermopile and Energy detectors or 0 to 4 for Photodiodes (see Section 2.3.2).

Related Commands: PM:RANge, PM:AUTO

8.3.3.58 PM:REF:VALue

Description Reference Value Define

Syntax **PM:REF:VALue <val>**

Parameters

The parameter <val>is of type <number>.

Function

This command provides a means of directly storing a reference value to be used in linear and logarithmic (dB) relative measurements. The units of this value are the current units being used by the instrument.

Related Commands: PM:REF:STOre,PM:REF:VALue?

8.3.3.59 PM:REF:VALue?

Description Reference Value Query

Syntax **PM:REF:VALue?**

Parameters None

Function

This query returns the user defined reference value. The units of this value are the current units being used by the instrument.

Returns <refval>

<refval> is of type <number>

Related Commands: PM:REF:STOre,PM:REF:VALue

8.3.3.60 PM:REF:STOre

Description Reference Value Store

Syntax **PM:REF:STOre**

Parameters None

Function

This command takes the latest reading and stores it as a reference reading to be used when making relative linear and dB measurements. The units of this value are the current units being used by the instrument.

Related Commands: **PM:REF:VALue,PM:REF:VALue?**

8.3.3.61 PM:RESPonsivity?

Description Responsivity query

Syntax **PM:RESP?**

Remarks The **PM:RESP?** query returns the responsivity currently used in making power calculations.

Response	Type	Description
Responsivity	float	Optical Power Meter responsivity

Related Commands: PM:UNITS?, PM:PWS?

8.3.3.62 PM:RUN

Description	Run command	
Syntax	**PM:RUN** *mode*	
Remarks	The **PM:RUN** command disables or enables the acquisition of data.	
Argument	**Value**	**Description**
Mode	0	Stop
	1	Run

Related Commands: PM:RUN?, PM:MODE?

8.3.3.63 PM:RUN?

Description	Run query	
Syntax	**PM:RUN?**	
Remarks	The **PM:RUN?** query returns an integer indicating the present run mode.	
Response	**Value**	**Description**
Mode	0	Stopped
	1	Running

Related Commands: PM:RUN, PM:MODE?

8.3.3.64 PM:SPOTSIZE

Description	Set detector spot size	
Syntax	**PM:SPOTSIZE** *value*	
Remarks	This command sets the detector spot size. By default, the spot size is same as a detector's surface area. This value is used to when measurement units are set to W/cm^2, J/cm^2 or Sun.	
Argument	**Type**	**Description**
Value	float	Spot size (cm^2)

Related Commands: PM:SPOTSIZE?, PM:DETSIZE?

8.3.3.65 PM:SPOTSIZE?

Description	Detector spot size query
Syntax	**PM:SPOTSIZE?**
Remarks	The **PM:SPOTSIZE?** query returns the detector spot size in cm^2.

Response	**Type**	**Description**
Spot size	float	detector spot size in cm^2

Related Commands: PM:SPOTSIZE, PM:DETSIZE?

8.3.3.66 PM:STAT:MAX?

Description Statistics Maximum Value Query

Syntax **PM:STAT:MAX?**

Parameters None

Function This query returns the maximum value in the statistics buffer.

Returns <max>

<max>is of type <number>in exponent notation.

8.3.3.67 PM:STAT:MEAN?

Description Statistics Mean Value Query

Syntax **PM:STAT:MEAN?**

Parameters None

Function This query returns the mean or average of all the values in the statistics buffer.

Returns <mean>

<mean>is of type <number>in exponent notation.

8.3.3.68 PM:STAT:MIN?

Description Statistics Minimum Value Query

Syntax **PM:STAT:MIN?**

Parameters None

Function This query returns the minimum value in the statistics buffer.

Returns <min>

<min>is of type <number>in exponent notation.

8.3.3.69 PM:STAT:MAXMIN?

Description Statistics Max-Min Query

Syntax **PM:STAT:MAXMIN?**

Parameters None

Function	This query returns the difference between the maximum and minimum readings in the statistics buffer.
Returns	<mxmn>
	<mxmn>is of type <number>in exponent notation.

8.3.3.70 PM:STAT:SDEViation?

Description	Statistics Standard Deviation Query
Syntax	**PM:STAT:SDEViation?**
Parameters	None
Function	This query returns the standard deviation of the readings in the statistics buffer.
Returns	<stddev>
	<stddev>is of type <number>in exponent notation.

8.3.3.71 PM:Temp?

Description	918 detectors temperature query
Syntax	**PM:Temp?**
Remarks	The **PM:Temp?** query returns the 918 detector's temperature as a float in degrees Celsius.

Response	**Type**	**Description**
temp	float	Detector temperature in degrees Celsius (°C)

Related Commands: PM:ATT?

8.3.3.72 PM:TRIG:START

Description	This command sets the optional start event.
Syntax	**PM:TRIG:START** *option*

Parameters

The parameter <option> is of type <number> and is an integer from 0 to 3.

Argument	**Value**	**Description**
option	0	Continuous measurement
	1	Reserved
	2	Measurement starts when a designated Soft key is pressed
	3	Measurement starts when PM:TRIG:STATE 1 command is issued.

Related Commands: PM:TRIG: START?

8.3.3.73 PM:TRIG:START?

Description Trigger START Query

Syntax **PM:TRIG:START?**

Parameters None

Function

This query returns the TRIGGER START condition.

Related Commands: PM:TRIG: START

8.3.3.74 PM:TRIG:STOP

Description This command sets the optional stop event.

Syntax **PM:TRIG:STOP** <option>

Parameters

The parameter <option> is of type <number> and is an integer from 0 to 6.

Argument	**Value**	**Description**
option	0	The measurement never stops
	1	Reserved
	2	Measurement stops when a designated Soft key is pressed
	3	Measurement stops when PM:TRIG:STATE 0 command is issued.

Related Commands: PM:TRIG: STOP?

8.3.3.75 PM:TRIG:STOP?

Description Trigger STOP Query

Syntax **PM:TRIG:STOP?**

Parameters None

Function

This query returns the TRIGGER STOP condition.

Related Commands: PM:TRIG: STOP

8.3.3.76 PM:TRIG:STATE

Description This command sets the trigger state

Syntax **PM:TRIG:STATE** <option>

Parameters

The parameter <option> is of type <number> and is an integer 0 or 1.

Argument	Value	Description
option	0	Trigger is armed. The system waits for a trigger start event to occur in order to make a measurement.
	1	System is triggered and at least one measurement occurred.

Related Commands: PM:TRIG: STATE?

8.3.3.77 PM:TRIG:STATE?

Description Trigger STATE Query

Syntax **PM:TRIG:STATE?**

Parameters None

Function

This query returns the TRIGGER STATE condition.

Related Commands: PM:TRIG: STATE

8.3.3.78 PM:UNITs

Description Units select

Syntax **PM:UNITS** *units*

Remarks The **PM:UNITS** command selects the units for readings.

Argument	Value	Description
units	0	Amps
	1	Volts
	2	Watts
	3	Watts/cm^2
	4	Joules
	5	Joules/cm^2
	6	dBm
	7-10	Reserved
	11	Sun

Related Commands: PM:MODE?

Note: The UNITs selection depends on the detector used. Refer to Table 1 for the relationship between the detector type and units.

8.3.3.79 PM:UNITs?

Description Units query

Syntax **PM:UNITS?**

Remarks The **PM:UNITS?** query returns an integer indicating the units selected.

Response	**Value**	**Description**
units	0	Amps
	1	Volts
	2	Watts
	3	Watts/cm^2
	4	Joules
	5	Joules/cm^2
	6	dBm
	7-10	Reserved
	11	Sun

Related Commands: PM:UNITS

Note: The UNITs selection depends on the detector used. Refer to Table 1 for the relationship between the detector type and units.

8.3.3.80 PM:ZEROSTOre

Description Zero value set command

Syntax **PM:ZEROSTO**

Remarks The **PM:ZEROSTO** command sets the zeroing value with the present reading.

Argument	**Type**	**Description**
none	-	

Related Commands: PM:ZEROVAL?

8.3.3.81 PM:ZEROVALue

Description Zero value set command

Syntax **PM:ZEROVAL** *value*

Remarks The **PM:ZEROVAL** command sets the zeroing value. When enabled, zeroing subtracts the stored zero value from readings before making measurement calculations.

Argument	**Type**	**Description**
Value	float	Zeroing value

Related Commands: PM:ZEROSTO

8.3.3.82 PM:ZEROVALue?

Description Zero value query

Syntax **PM:ZEROVAL?**

Remarks The **PM:ZEROVAL?** query returns the zero value.

Response	**Type**	**Description**
value	float	Zero exponent

Related Commands: PM:ZEROVAL

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9 Principles of Operation

9.1 Introduction

The 1928-C Optical Power Meter electronics adapt to a number of signal measurement tasks: DC current or voltage, AC peak-to-peak current or pulse voltage, or integrated DC current or voltage signals. This versatility is required to handle the various signals that Newport's ***Low Power, High-Power, Energy*** and other detector families generate. These detector families are based on semiconductor, thermopile and pyroelectric. The detector data is introduced to the 1928-C by way of a calibration module specific to the detector in use. At power up (and RESET), the 1928-C downloads information about the detector from the calibration module or the detector internal memory. Based on the calibration module preprogrammed data, the meter learns the set of operating states available to the detector. The user then selects among the available operating states when using the meter. Front panel control and the operating states of the 1928-C Optical Power Meter are discussed in Section 3.

9.2 Analog Signal Flow

The detector signals can follow many different paths through the 1928-C input amplifier chain. A block diagram of analog signal flow is shown in Figure 57. The actual flow path depends upon the detector type and the mode of measurement.

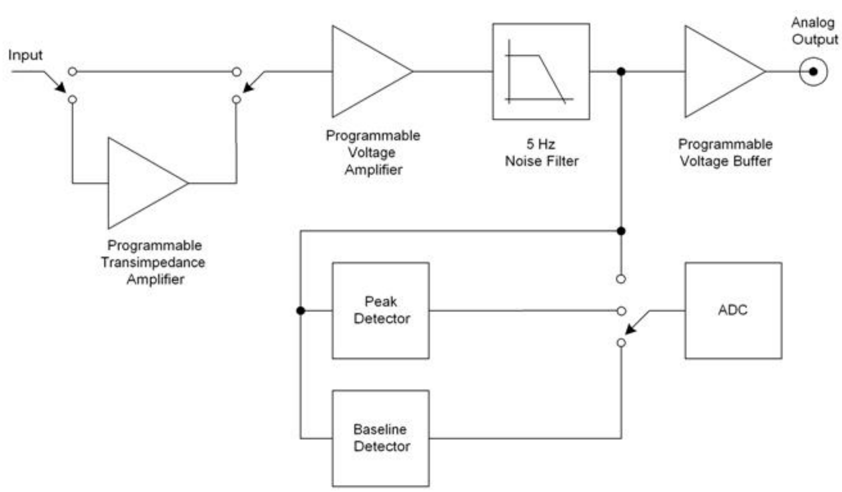

Figure 57 1928-C Optical Power Meter Analog Signal Flow Diagram

The analog signal flow path is primarily determined by the responsivity units of the detector. The numerator of these units indicates how the meter must be configured in order to obtain a calibrated optical measurement. Analog signal flow is independent of whether single or continuous measurements are made.

Responsivity units and signal flows for the various detector families are listed in Table 4.

Detector Family	Resp. Units	Mode	Amplifier Path	Peak-Baseline
Low-Power	A / W	DC	I	No
Low-Power	A / W	Peak-Peak	I	No
Low-Power	A / W	Integral	I	No
High-Power	V / W	DC	V	No
High-Power	V / W	Integral	V	No
Energy	V / J	Pulse	V	Yes

Table 4 Analog Signal Flow Paths.

9.3 Digitized Signal Flow

An analog-to-digital converter captures the input signal. The input signal has the units of current or voltage depending upon how the input amplifier chain was configured. Note: In this manual the digitized signal may be referred as *sampled signal* or *samples.*
This digitized signal moves through a number of process steps that may or may not alter the digitized value depending upon the operating state of the meter. Each of these possible-processing steps is discussed further.

Digital Filter

If the digital filter annunciator Dig or Digital is on, Section 4.2.5, the filter output is the average of the most recent 10, 100, 1000, 10000 samples. The number of samples is selectable by the user with the Filter menu. Also, the user can change the number of samples. When less than the selected number of samples has been acquired since the last reset of the digital filter, the output is the average of all the values received. The digital filter is reset when the 1928-C Optical Power Meter is turned on and whenever the UNITS or the range changes or when the MODE of operation changes.

NOTE

When using the digital filter in CW Single acquisition mode, each measurement is the average of the last 10, 100, 1000, 10000 acquisitions independent of how old any of the measurements are.

Gain

Gain processing accounts for the signal gain of the input amplifiers. The output is the product of the digitized value and the amplifier gain.

Zero Offset

Zero offset is active whenever the Offset annunciator is lit. The zero offset output is equal to the input value less the zero reference value.

Responsivity Map(s)

This process scales the input value in accordance with current calibration wavelength and the responsivity map downloaded from the detector calibration module. The output of this process, i.e. the measurement value, is the digitized input value divided by the responsivity associated with the current calibration wavelength or the user defined calibration value. Different responsivities are used depending upon if the attenuator is on as shown in the Setup Menu.

Units Correction

Unit's correction adjusts a measurement value to account for the display units selected. When the display units are equal to the detector signal units, i.e. equal to the numerator of the responsivity units, Table 1, the measurement value is not adjusted. Otherwise the digitized value is adjusted to account for detector responsivity and/or additional unit conversions such as W-to-W/cm^2.

NOTE

Per area unit conversions such as W-to-W/cm^2 divide the measurement value by the active area of the detector. This calculation assumes that the entire active area of the detector is uniformly illuminated. Per area measurements where the entire detector active area is not uniformly lit are not accurate. The user must insure that these conditions are met before utilizing per area units or make measurement corrections accordingly.

9.4 Typical Detector Signals

The flexibility of the 1928-C Optical Power Meter analog signal flow is required in order that it may properly measure the signals that various types of detectors make.

Basic optical power or energy measurements are related to a measured detector signal, *S*, in the following way:

$$P \text{ or } E = \frac{S}{R_\lambda}$$

Where: R_λ = Detector responsivity at λ
S = Detector signal

Semiconductor (918D/818 Series Low-Power) detectors provide a current signal. The 1928-C is capable of 10 pA resolution in order to provide the highest sensitivity performance with these detectors.

Thermopile (818P Series High-Power) detectors, provide a small voltage signal.
The 1928-C is capable of 76.3 nV resolution in order to reach the sensitivity limits of thermopile detectors.

Pyroelectric (818E Series Energy) detectors, deliver a peak voltage signal. The1928-C is capable of capturing 2 µsec rise time voltage spikes so that it may be operated with the fastest of these detectors.

9.5 Thermopile Detector Signals

Thermopile detectors respond with a voltage signal that slowly changes in incident optical power. The time constant of most thermopile detectors is on the order of 1 to 10 seconds.

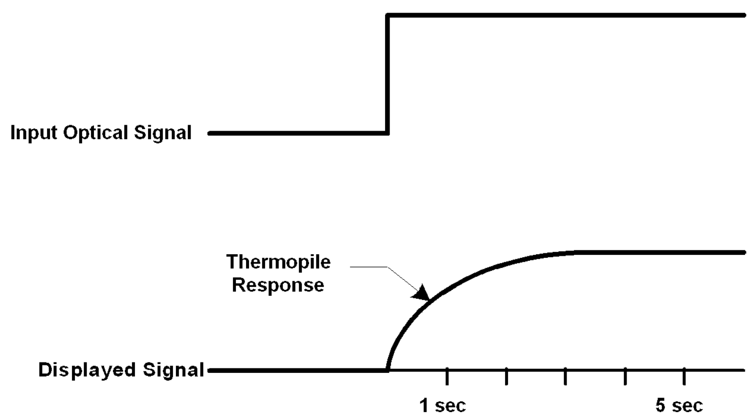

Figure 58 Thermopile Signals exhibit 1 to 10 second time constants.

9.6 Pulse Energy Detector Signals

A Newport Energy detector will respond to a single radiant energy pulse with a voltage pulse at its BNC output. This pulse exhibits a sharp voltage rise to a peak followed by slower voltage decay that “undershoots” zero volts before settling back to zero volts. When a detector is operated within its proper limits, the voltage difference from immediately before the sharp rise to the peak is linearly proportional to the radiant energy.

If a second pulse arrives before the “undershoot” rises back to zero volts, the voltage rise from this pulse will start from an initial negative value. At sufficient energy pulse repetition rates, a negative “baseline” voltage will develop from which the voltage rise must now be measured to achieve accurate energy readings. The 1928-C contains baseline capture circuitry that maintains its accuracy specifications over rep-rates ranging from single pulse to 10 kHz.

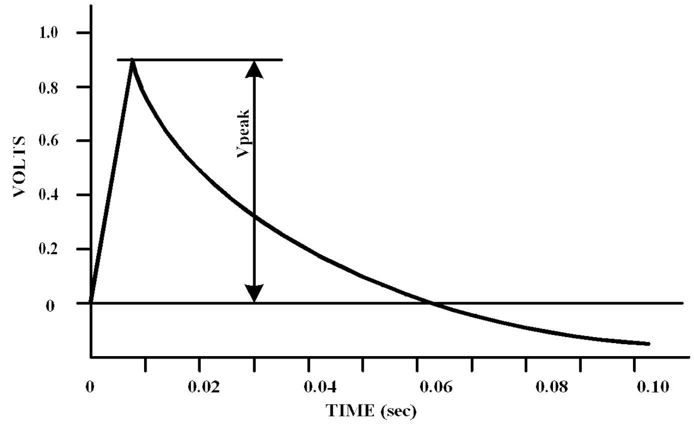

Figure 59 Typical Newport Energy Detector Signal Waveform
An energy detector signal sharply rises to a peak value and then decays going somewhat negative before finally returning to zero. The energy in the radiant pulse is proportional to the height of the peak measured from immediately before the sharp rise.

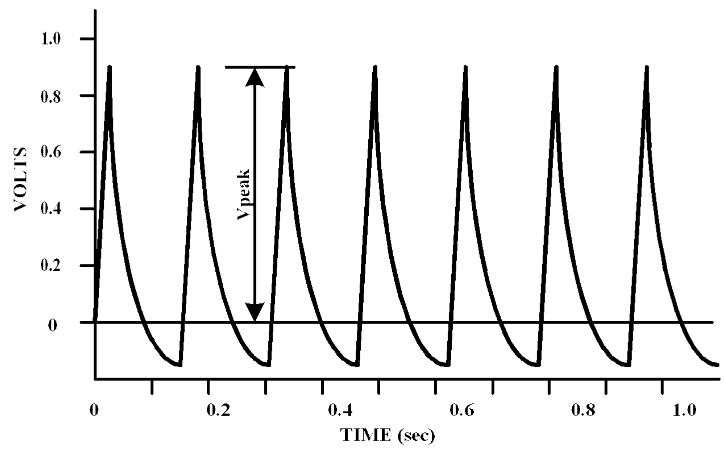

Figure 60 Negative Baseline Voltage.
Negative Baseline Voltage Due to a Pulse Train shown. If a laser pulse arrives before the previous Energy detector signal has fully decayed, the detector signal rises from the present decay point of the previous signal.

9.7 Peak-to-Peak (Photodiode) Detector Signals

The 1928-C enables one to make peak-to-peak measurements of time varying signals from semiconductor photodiode detectors. Since optical power is a zero bounded positive quantity, signals from a detector observing such modulated light will similarly be zero bounded positive signals.
To make a peak-to-peak measurement, the 1928-C must be able to capture both the maximum and minimum values of a detector signal. This is accomplished by sampling the signal.

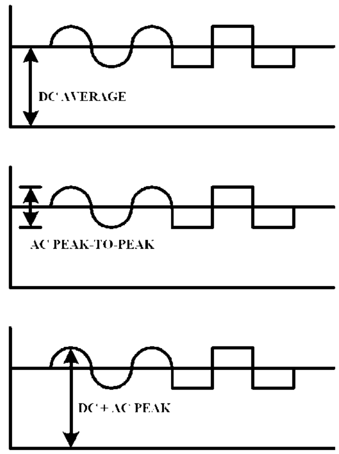

Figure 61 Time Varying Signal Measurements.
Many different measurements can be made on different portions of a time varying signal. The most common are: DC power, peak power, and peak-to-peak power.

9.8 Integration of Detector Signals

The 1928-C provides for making measurements that integrate incoming power detector signals to obtain energy via the CW Integrate mode. In CW Integrate mode, the display units indicate Joules since energy is the time integral of power:

$$E(\lambda) = \int_{t_0}^{t_1} P(\lambda)dt = \int_{t_0}^{t_1} \frac{S(t)}{R(\lambda)} dt$$

As the detector signal actually consists of a stream of digitized values, the integral becomes a numerical approximation using the trapezoid method. See Figure 62.

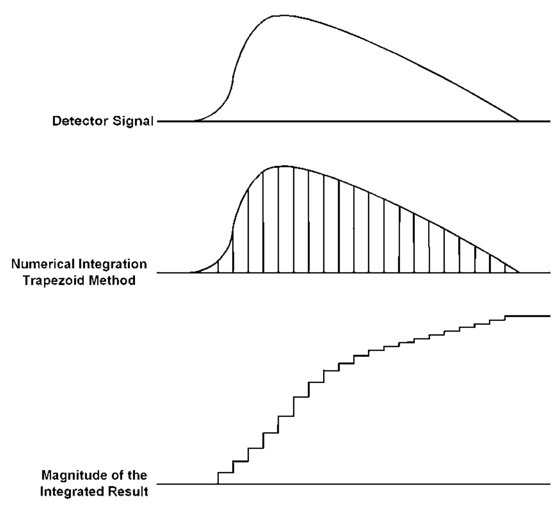

Figure 62 Integrated Energy Via a Trapezoid Approximation.
The INTG measurement mode performs a discrete integration at a 400 Hz sample rate.

Two common applications are natural extensions of the CW Integrate measurement mode:

3. Pulse laser energy measurement using a thermopile detector
4. Energy from exposure over a period of time (dosage)

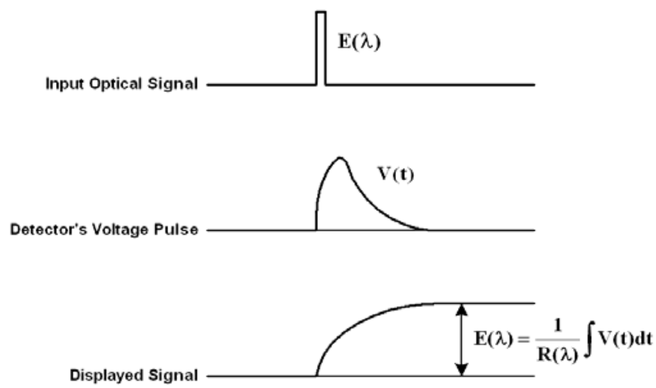

Figure 63 Measuring Laser Pulse Energy with a Thermopile.
Thermopiles are often used to measure pulsed laser energy by integrating the response of the detector to the pulse.

9.9 Analog Output

The 1928-C provides an analog output for signal monitoring. The analog output is the actual amplified detector signal and is uncorrected for the effects of the detector's responsivity, calibration, and ZERO. The analog output signal is a representation of what the meter "sees" at its input. However, the analog output signal may be filtered if the user selects the 5Hz filter (see paragraph 4.2.5). Also, the analog output signal is amplified and scaled to the selected analog output level (see Table 5).

The user can select the analog output level with a command, PM:.ANALOG:OUT (see Section 8.3). The analog output maximum level corresponds to the maximum full-scale input range the meter is set on. For example, if one selects the analog output level at 1 V, and the meter is set on 250 mW maximum full-scale input range, the analog output signal will have a transfer function of 250 mW/1 V. Therefore, if the analog output is connected to an oscilloscope or voltmeter and the user reads 0.125 V, the detector power is 125 mW.

The selectable analog output levels are given in Table 5.

Output Range	**0**	**1**	**2**
Full Scale Voltage (Load ≥ 1 MΩ)	1V	2V	5V

Table 5 Analog Output Range Table.

9.10 Measurement Considerations

This section describes detector characteristics, optical and electrical considerations, and environmental influences on optical measurements. In general, measurement accuracy is limited by the accuracy of the detector calibration.

Accurate measurements, however, are also dependent upon proper set-up, control of temperature and illumination conditions and understanding the factors that affect optical measurements.

9.10.1 Detector Calibration and Uncertainty

Newport Corporation calibrates its detectors using secondary standards directly traceable to the United States National Institute of Science and Technology (NIST), to Great Britain's National Physical Laboratory (NPL), or to National Research Council (NRC) of Canada.

The details and uncertainty of the calibration procedure vary with each detector model but a detailed description of the calibration results is supplied with each individually calibrated detector. In general, detector calibration uncertainty varies from 1% to 8% and varies with wavelength. Each detector will also have some variation in response over its surface. Therefore, for the most reproducible measurements, light should illuminate the detector as uniformly as possible over as large an area as practical.

	CAUTION
⚠	**Avoid focusing a light source onto the detector surface. Inaccurate readings and possible detector damage may result.** **Consult the detector manual for saturation or damage thresholds.**

NIST trace ability requires that detectors be recalibrated on one-year intervals. As individual detector responses change with time, especially in the ultraviolet, recalibration is necessary to assure confidence in the uncertainty of the measurement. For the most reproducible measurements, the same detector should always be used for measurements that are to be directly compared.

9.10.2 Quantum Detector Temperature Effects

Semiconductor (Newport Low-Power) detectors are affected by temperature. At long wavelengths, quantum detectors typically lose sensitivity with increasing temperature. Additionally, detector dark current increases exponentially with temperature. Observed dark current is often dominated by the interaction between the detector and a meter's amplifier and is typically larger than the theoretical dark current limit. Silicon detectors are inherently quieter than germanium detectors due to their higher internal resistance and lower capacitance. The noise or drift in the dark current sets a lower bound on the measurement resolution that can be achieved with any given detector. Cooling a detector significantly lowers its dark current and dark current noise.

The observed dark currents can also be zeroed at any moment via the ZERO function. Since dark currents drift with temperature, the ZERO should be adjusted just prior to taking any measurements. If the detector temperature is constant, sensitivity changes and dark current drifts are significantly reduced.

The 1928-C Optical Power Meter can measure the detector temperature and correct the power readings accordingly. The power correction happens automatically only for those detectors which are equipped with a thermistor (Newport offers detectors with thermistors for temperature compensation. See Newport web-site www.newport.com for more details.)

The thermistor signal is read via the detector DB-15 connector and the displayed power is adjusted continuously depending on the detector temperature. The analog output signal shows the detector signal and is not corrected for temperature.

9.10.3 Thermopile Detector Temperature Effects

Thermopile (Newport High-Power) detectors are significantly affected by temperature fluctuations arising from airflow disturbances. As the detector is a temperature-measuring device, airflow disturbances set a practical lower limit on the power that a detector can measure. In order to get the most out of any thermopile detector, be careful to shield the detector from airflow disturbances. Common sources of disturbance are: air conditioners and people walking past.

9.10.4 Energy Detector Temperature Effects

Pyroelectric (Newport Energy) detectors are AC coupled devices and thus are not susceptible to temperature induced DC signal offsets or noise floor changes.
One generally does not need to take much precaution with pyroelectric detectors except to make sure that their damage threshold is not exceeded.

9.10.5 Ambient and Stray Light

Ambient and stray light striking the detector should be considered when making a measurement. Ambient light can be distinguished from dark current (or the detector/meter noise floor) by either turning off or blocking the source and covering the detector face with opaque material such as a piece of black rubber.
Using the human hand to cover the detector is not advised because it emits a significant amount of infrared radiation and radiates a temperature significantly different from ambient. With the detector covered, a reading of the dark current may be made. Next, remove the material that is covering the detector and take another reading. The difference is the ambient light level.

NOTE

Changes in ambient light levels can occur from such factors as turning room lights on or off, or by moving people or equipment. Remember, if you can see your detector element, then your detector can see the light bouncing off you.
The effects of ambient light are greatly reduced when using a fiber-connectorized signal input to the detector. If free-space beam measurements are desired, using an attenuator will often improve the signal to ambient signal noise level.
Wavelength-specific filters, such as optical cutoff, band pass, or spike filters can be used if the signal wavelength spectrum permits. Other techniques to reduce stray light include using apertures, placing the detector in a box or other housing to shield the surface from light (or air currents) and turning off room and other polluting light sources.

9.10.6 Signal Filtering

The 1928-C Optical Power Meter offers the user the option to filter the detector signal. There are two programmable filters that can be used individually or together to condition the detector signal: the Analog Filter and the Digital Filter.

The Analog Filter is a hardware based, programmable low-pass filer. The user can select the following settings: 5Hz, 1kHz, 12.5kHz, and 250kHz. This flexibility is offered to the user to improve the measurement precision for different detectors.

It is well known that white noise has large spectrum. The noise level increases with bandwidth. The higher the noise, the higher the minimum signal that can be measured. The quality of the measurement can be linked to the signal-to-noise ratio (SNR): the higher the SNR, the better the measurement precision of very small signals. In order to increase the SNR the user may choose to cut the bandwidth of the power meter, depending on the detector signal.

For example, if the detector is modulated with a sine wave of 800Hz, the user may choose to set the Analog filter to 1kHz to increase the SNR and be able to measure very small signals. Also, cutting the bandwidth at 1kHz does not affect the measurement. However, if the modulation frequency is 800Hz, but the signal is a square, the user may opt to cut the bandwidth higher, at 12.5kHz, to let the signal harmonics be unfiltered and minimize the distortion. Of course, in this case, the noise in the system will increase with the square root of the bandwidth. The user needs to asses the tradeoffs in his measurement, taking advantage of the 1928-C high flexibility in setting the proper filters for the measurement.

Generally, the 5Hz filter is used for CW Cont. measurements. However, the 1928-C Optical Power Meter can measure the amplitude of AC signals down to 0.01Hz, so the 5Hz filter can be used for any modulating signal below 5Hz.

The Digital Filter is a moving average filter that can be set at 10, 100, 1000, or 10000 measurements. These values can be changed by the user. If the digital filter is set on 10, the average value is computed on 10 measurements, in a First In First Out (FIFO) fashion. The Digital Filter helps the SNR the same way as the Analog Filter does. With both filters on, low level, continuous signals can be measured with a high degree of accuracy.

The Analog Filter is always applied to the entire amplifier chain of the meter. Therefore, the user will see the detector signal filtered at the Analog Output BNC. The Digital Filter is a digital signal-processing filter and is only applied to the calculated measured values that are displayed on the meter screen. While the displayed values may have both filters applied (An+Dg) the Analog Output can only have the Analog Filter applied to the signal. Because of that, the user may see a difference in the way the signal is filtered between the displayed values and the Analog Output values.

9.11 Common Measurement Errors

The most common sources of optical measurement error are listed in Table 6 below. Other common errors are discussed in the preceding subsections of Measurement Considerations.

Type of Error	**What should be done?**
Radiometry	Check that all of the light is actually hitting the detector
Ambient light	Check that any ambient light was ZEROed before the measurement was made.
Wavelength calibration	Check that the calibration factor for the measurement wavelength is properly set.
Detector saturation or damage	Check that the optical power density remains below the detector’s saturation or damage

Table 6 Common Measurement Errors

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10 Troubleshooting

10.1 Power Supply Problems

	Problem	Solution
1	The unit does not turn on.	1. Verify that the power switch is in the ON position (See Section 1.1.6.). 2. Verify that the AC line cord is firmly connected to both the unit and the MAINS power outlet. 3. Verify that there is power to the MAINS power outlet.

10.2 Analog Output Problems

	Problem	Solution
1	There is no AC signal at the analog output	Check if the 5 Hz Analog Filter is on.

10.3 Questions and Answers

Q. I am trying to update the firmware but my USB flash drive is not working. I don't see any light on the memory stick.

A. The USB flash drive needs to be WinCE compatible. WinCE is the operating system of 1928C power meter.

Q. Is the detector hot swappable?

A. Yes, you can swap the detector without having to turn off the power meter.

Q. Is it possible to write the measurement data into Spreadsheet?

A. Yes, you can plug in a USB flash drive into the power meter and save the data from the Statistics screen.

Q. Is it possible to use a third party detector with the 1928-C Optical Power Meter?

A. It may be possible for some measurements by purchasing a special adaptor. Contact Newport Corporation for availability and details.

Q. I would like to change the configuration back to the factory default setting. How can I do that?

A. Turn off the Power Meter. Hold down both “ZERO and “HOLD” buttons and turn on the Power Meter. A message window appears. Choose YES or NO for reset by using the left-right arrow keys and press enter.

Q. The display shows some noise and fluctuation when I measure my CW light source. Any suggestions?

A. Turn on the analog/digital filter. Check whether the meter and detector calibration is up-to-date.

Q. Can I measure peak power or energy of a single pulse with a Newport low power detector (918D, etc.) and 1928-C?

A. No. There is no energy or peak power mode measurement with the 1928-C when using a low power detector.

11 Maintenance and Service

CAUTION

There are no user serviceable parts inside the 1928-C Optical Power Meter. Work performed by persons not authorized by Newport Corporation will void the warranty.

Calibration accuracy is warranted for a period of 1 year. After 1 year, the unit should be returned to Newport Corporation for recalibration and NIST traceability re-certification.

11.1 Enclosure Cleaning

WARNING

Before cleaning the enclosure of the 1928-C Optical Power Meter, the external power supply must be disconnected from the unit.

The enclosure should only be cleaned with isopropyl alcohol or a mild soapy water solution applied to a damp lint-free cloth.

11.2 Obtaining Service

The 1928-C Optical Power Meter contains no user serviceable parts. To obtain information regarding factory service, contact Newport Corporation or your Newport representative. Please have the following information available:

1. Instrument model number (on the rear panel).
2. Instrument serial number (on rear panel).
3. Description of the problem.

If the instrument is to be returned to Newport Corporation, you will be given a Return Number, which you should reference in your shipping documents. Please fill out a copy of the service form, located on the following page, and have the information ready when contacting Newport Corporation. Return the completed service form with the instrument.

11.3 Service Form

Newport Corporation
U.S.A. Office: 800-222-6440
FAX: 949/253-1479

Name ________________________________ **Return Authorization #**__________________
(Please obtain RA# prior to return of item)

Company ____
(Please obtain RA # prior to return of item)

Address _________________________________ ____________________Date _________________

Country _______________________ Phone Number ______________________________________

P.O. Number ___________________ FAX Number ____

Item(s) Being Returned:

Model # _______________________ Serial # __________________________

Description ____

Reason for return of goods (please list any specific problems):

____

____

____

____

____

12 Appendix A – Syntax and Definitions

12.1 Definition of <string>

For convenience, the 1928-C recognizes double quoted, single quoted, and unquoted strings with certain restrictions as detailed below. Any of these forms may be used where a <*string*> parameter is required.

1. <*string*>,using double quotes **"this is a string"**
2. <*string*>,using single quotes. **'this is a string'**
3. <*string*>,using no quotes. **thisisastring**

A description of each type of <*string* follows:

1. <*string*> defined using double quotes.

   A double quote indicates that a string follows, and the string is terminated by another double quote. A double quote may be embedded within the string by using two double quotes together:

   Example: "this string contains a ""double quote"

   All characters within the two outer double quotes are considered part of the string. It is an error if the string does not terminate with a double quote. The string cannot contain the <CR>(ASCII decimal 13), <LF>(ASCII decimal 10), or End or Identify characters.

2. <*string*> defined using single quotes.

   This form is similar to double quoted string. A single quote indicates that a string follows, and the string is terminated by another single quote. A single quote may be embedded within the string by using two single quotes together:

   Example: 'this string contains a''single quote'

   All characters within the two outer single quotes are considered part of the string. It is an error if the string does not terminate with a single quote. The string cannot contain the <CR>(ASCII decimal 13), <LF>(ASCII decimal 10), or End or Identify characters.

3. <*string*> defined using no quotes.

All strings using this format must start with an alphabetic character (A through Z, a through z). All other characters must be either alphabetic, digit (0 through 9)or the '_' character. Any other character will delimit the string.

Some examples are shown below:

Sent:	this is a string	
Interpreted:	this	(1st string)
	is	(2nd string)
	a	(3rd string)
	string	(4th string)

Sent:	this,isastring	
Interpreted:	this	(1st string)
	,	(separator character)
	isastring	(2nd string)

Sent:	w/cm	
Interpreted:	w	(1st string)
	ERROR	(unrecognized character)
	cm	(2nd string)

12.2 Definition of <number>

The 1928-C recognizes four types as <number> ,thus any format may be used.

1. <*number*> defined as floating point.
2. <*number*> defined as binary.
3. <*number*> defined as octal.
4. <*number*> defined as hexadecimal.

Where necessary, integers are converted to floating point numbers. In all cases, a number is terminated by any of the below characters:

<NL> <EOI> <SPACE>

Any non-valid characters detected in any number received are considered an error in format, and an error condition will be generated in the system.

A description of each type of <*number*> follows:

1. <number> defined as floating point.

Any of the following characters, as the first character of an ASCII sequence, indicates that a number is being defined:

+-.0 1 2 3 4 5 6 7 8 9

A floating point number is defined as follows:

1. Optional +-sign. This defines the sign of the number. If missing, positive is assumed.

2. Optional 0-9 digits. These digits define the integer portion of the mantissa.

3. Optional . decimal point. This defines the end of the integer portion of the mantissa, and indicates that the fractional portion of the mantissa follows.

4. Optional 0 -9 digits. These digits define the fractional portion of the mantissa.

5. Optional exponent indicator, an ASCII ‘E ’ or ‘e ’,followed by a ‘+’ or ‘-’ (optional), followed by decimal digits.

Examples:

The numbers below all represent the value “1.2 ”

1.2

1.2e0

+01.2E+00000

120E-2

.12e1

The numbers below all represent the value “-1.2 ”

-1.2

-1.2e+00

-0001.2e+0

-120e-2

.12E1

2. <number>defined as binary.

The 1928-C recognizes unsigned binary numbers in the range of 0 to 65535, decimal, or 0 to 1111111111111111 binary. Binary numbers are represented using only the digits 0 and 1.A binary number has the following format:

#B<*binary*>

Where

#B = mandatory binary number header

<*binary*> = binary digits (0’s or 1’s)

Example:

All numbers below represent the decimal value 129.

#B10000001

#b010000001

#b10000001

3. <*numbe*r> defined as octal.

The 1928-C recognizes unsigned octal numbers in the range 0 to 65535 decimal, or 0 to 177777 octal. Octal numbers are represented using digits from 0 to 7.An octal number has the following format:

#Q<octal>

Where

#Q =mandatory octal number header

<*octal*> =octal digits (0 to 7)

Example:

All numbers below represent the decimal value 129.

#Q201

#q0201

#q201

4. <number>defined as hexadecimal.

The 1928-C recognizes unsigned hexadecimal numbers in the range 0 to 65535 decimal, or 0 to FFFF hexadecimal. Hexadecimal numbers are represented using the digits 0 -9 and the characters A -F.A hexadecimal number has the following format:

#H<*hexadecima*l>

Where

#H =mandatory octal number header

<*hexadecimal*> =hexadecimal digits (0 -9 and A -F)

Example:

All numbers below represent the decimal value 127.

#H7f

#H007F

#h7f

13 Appendix B – Error Messages

13.1 Introduction

The communication errors can be retrieved with the following commands: *ERR? or ERRSTR?. The descriptions of the returned errors are detailed in the next sections.

13.2 Command Errors

Command Errors are associated with the conversion of the data received into the commands and their parameters (parsing). Incorrect syntax, incorrect parameters, and improper command format will generate these errors. Any command error will cause the Command Error bit (bit 5) in the Standard Event Status Byte to be set.

104, Numeric Type Not Defined

Generated during the parsing of a number and an undefined number type is encountered.

106, Digit Expected

Generated during the parsing of a number and the parser encounters a non-number when a number is expected.

107, Digit Not Expected

Generated during the parsing of a number and the parser encounters a number when a different character is expected.

115, Identifier Not Valid

Generated when a parameter is not valid or not properly formed.

116, Syntax Error

Occurs when an error in command structure or parameter type is detected. Some typical causes are:

- Using a number as a command mnemonic.
- Using the wrong parameter type.
- Using ASCII characters outside of a string constant that are not defined by the command language syntax.
- Missing or too many parameters.

The above list in not exhaustive but does give the basic idea of what to look for.

126, Too Many Or Few Arguments

Generated when command arguments are missing or too many.

13.3 Execution Errors

Execution Errors are associated with the interpretation of the converted commands and parameters received. Incorrect parameter values and numerical range errors are types of execution errors. Any execution error will cause the Execution Error bit (bit 4) in the Standard Event Status Byte to be set.

1, Out of memory

This error is caused by an internal program fault, and may be followed by an automatic instrument reset.

201, Value Out Of Range

This error will occur if a parameter is out of a valid range or not in the set of valid parameters for a given command.

214, Exceeds Maximum Length

Generated when the command exceeds the maximum command length. Try shortening the command string.

217, No saved information in recalled bin

Generated when the user attempts to recall a bin which has no previous stored data.

301, Query Error

The Query Error occurs when the instrument is in the midst of transmitting a message over a communication bus and the instrument exits remote mode.

303, Input Buffer Overflow

Error generated when the system parser runs out of space during reception of command. It may occur if commands are not terminated correctly. Input buffer is 1,024 characters long.

304, Output Buffer Overflow

Error generated when the system parser runs out of space for query results. It may occur if query results in too much data to be returned in a single response, or if multiple command queries are issued but not read. Output buffer is 4,096 characters long.

305, Parser Buffer Overflow

Error generated when the system parser runs out of space for commands. A command is received into the input buffer then transferred to the parser buffer. This error is generated if the command in the input buffer is too large to fit into the available space in the parser buffer. It is usually generated when commands are sent to the instrument faster than it can process. Parser buffer is 2,048 characters long.

13.4 Device Errors

Device Errors are associated with some system condition that affects the operation of the meter. Errors associated with data reading will set the appropriate bit but will not generate an error message to avoid jamming the error queue or the interface.

701, Detector Calibration Read or Write Failed.

An error was encountered during a read/write operation to the calibration EPROM in the detector. If problem persists, contact the factory.

703, Optical Power Meter set to defaults due to Firmware update

After upgrading the firmware, in some cases the changes are significant enough to require resetting the instrument to factory defaults.

704, User reference cannot be changed/stored while you are in units of Watts or dBm. Change to dB or Rel to set the user reference value.

User reference can only be stored in dB or Rel mode.

705, Illegal data store parameter change. Queue cleared.

An action that affects the data store caused the data store queue to be cleared.

706, Digital Filter Interval changed, must not be greater than Data Store interval.

The digital filter interval cannot be greater than the data store interval.

707, Digital Filter Disabled with External Trigger.

Digital filter must be disabled during external trigger mode.

708, There is no new data for a statistics update.

No new data has been stored in the data store since the last statistics update.

709, Statistics are not calculated while Data Store is running.

User attempted to compute statistics while data store was active. Turn off data store and compute.

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14 Appendix C - Legacy Commands Reference

Legacy Commands	New Commands	Number of Parameters	Function
ATTN_n	PM:ATT	1	Selects if the attenuator's calibration data is included for power calculation.
ATTN_n?	PM:ATT?	NONE	Returns setting if attenuator data should or should not be used when calibrating the Optical Power Meter.
ATTNSN_n?	PM:ATTSN?	NONE	Gets the attenuator serial number.
AUTO_n	PM:AUTO	1	Sets the Optical Power Meter ranging to manual or automatic.
AUTO_n?	PM:AUTO?	NONE	Returns 1 if automatic Optical Power Meter ranging is selected.
CALDATE_n?	PM:CALDATE?	NONE	Returns the calibration date of the detector.
CALTEMP_n?	PM:CALTEMP?	NONE	Returns the temperature at which the calibration was performed.
DETMODEL_n?	PM:DETMODEL?	NONE	Returns the model number of the detector.
DETSN_n?	PM:DETSN?	NONE	Returns the serial number of the detector.
DSBUF_n	PM:DS:BUFfer	1	Set data store behavior select.
DSBUF_n?	PM:DS:BUFfer?	NONE	Return data store behavior select.
DSCLR_n	PM:DS:CLear	NONE	Clear data store.
DSCNT_n?	PM:DS:Count?	NONE	Return data store count of items stored.
DSE_n	PM:DS:ENable	1	Set data store enable.
DSE_n?	PM:DS:ENable?	NONE	Return data store enable.
DS_n?	PM:DS:GET?	1	Return data store data. {1,1-10,-5,+5} – value, range, oldest 5, newest 5
SFREQ	PM:DS:INTerval	1	Set data store interval.
SFREQ?	PM:DS:INTerval?	NONE	Return data store interval.
DSSIZE_n	PM:DS:SIZE	1	Set data store max size.
DSSIZE_n?	PM:DS:SIZE?	NONE	Return data store max size.
DSUNITS_n?	PM:DS:UNITs?	NONE	Return data store units.
FILTER_n	PM:FILTer	1	Selects the filtering operation: no filtering, analog filter, digital filter, or analog and digital.
FILTER_n?	PM:FILTer?	NONE	Returns the filtering operation: no filtering, analog filter, digital filter, or analog and digital.
LAMBDA_n	PM:Lambda	1	Sets the wavelength for use when calculating power.
LAMBDA_n?	PM:Lambda?	NONE	Gets the selected wavelength in nanometers.
MODE_n	PM:MODE	1	
MODE_n?	PM:MODE?	NONE	Returns the currently selected acquisition mode.
R_n?	PM:Power?	NONE	Returns the power in the selected units.
RWS_n?	PM:PWS?	NONE	Returns the power with status.
RANGE_n	PM:RANge	1	Selects the gain stage when making readings with the detector head within a range from 0 to 5 (with zero being the highest).
RANGE_n?	PM:RANge?	NONE	Returns an integer indicating the current range.
RESP_n?	PM:RESPonsivity?	NONE	Gets the responsivity currently used for making power calculations.

Legacy Commands	New Commands	Number of Parameters	Function
RUN_n, STOP_n	PM:RUN	1	Disables or enables the acquisition of data.
RUN_n?, STOP_n	PM:RUN?	NONE	Returns the present acquisition mode.
STMAX_n?	PM:STAT:MAX?	NONE	Return statistics buffer maximum value.
STMEAN_n?	PM:STAT:MEAN?	NONE	Return statistics buffer mean value.
STMIN_n?	PM:STAT:MIN?	NONE	Return statistics buffer minimum value.
STMXMN_n?	PM:STAT:MAXMIN?	NONE	Return statistics buffer maximum-minimum value.
STSDEV_n?	PM:STAT:SDEViation?	NONE	Return statistics buffer standard deviation value.
UNITS_n	PM:UNITs	1	Selects the units for readings.
UNITS_n?	PM:UNITs?	NONE	Returns an integer indicating the selected units.
USRREF_n	PM:REF:VALue	1	Sets the user reference value for use in relative or dB readings.
USRREF_n?	PM:REF:VALue?	NONE	Returns the user reference value.
STOREF_n	PM:REF:STOre	NONE	Sets the user reference value for use in relative or dB readings as the present reading.
STOZERO_n	PM:ZEROSTOre	NONE	Sets the zeroing value with the present reading.
ZEROVAL_n	PM:ZEROVALue	1	Sets the zeroing value.
ZEROVAL_n?	PM:ZEROVALue?	NONE	Gets the zeroing value.

Table 7 Legacy Commands Reference

15 Appendix D – Sample Programs

15.1 Programming Samples

The CD will install some simple programming samples to get computer interfacing started. These are minimal samples and provided only for reference.

15.2 LabVIEW

LabVIEW programming samples separated in folders based on version of LabVIEW compiled with. SampleQuery.vi demonstrates the use of the drivers.

15.3 Microsoft® Visual Basic

A zip file in the application folder contains a simple Visual Basic project for communicating with the meter.

15.4 Microsoft Visual C++

A zip file in the application folder contains a simple Visual C++ project for communicating with the meter.

15.5 Microsoft .NET

A zip file in the application folder contains a simple .NET project for communicating with the meter.

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16 Appendix E – Disassembly Instructions

NOTE

These disassembly instructions are intended only for recycling at the end of the product lifetime.
For troubleshooting or servicing, users should contact the local Newport Corporation representative. There are no user serviceable parts inside the equipment.
Attempting to self-service the unit will void the warranty.

16.1 Disassembly instructions

Figure 64 shows an exploded version of the 1928-C.

For recycling purposes only, the disassembly steps are as follows:

1. Make sure the unit power cord is removed.
2. Remove any other cables: detectors, Analog Output monitor cables, USB, and ground cables.
3. Remove the bottom screws of the cover.
4. Remove the cover.
5. Remove all the screws on the rear panel.
6. Remove the rear panel.
7. Remove the screws and posts of each assembly and unplug each assembly from the enclosure.
8. Remove the front panel screws.
9. Remove Assembly 1 from the front panel.

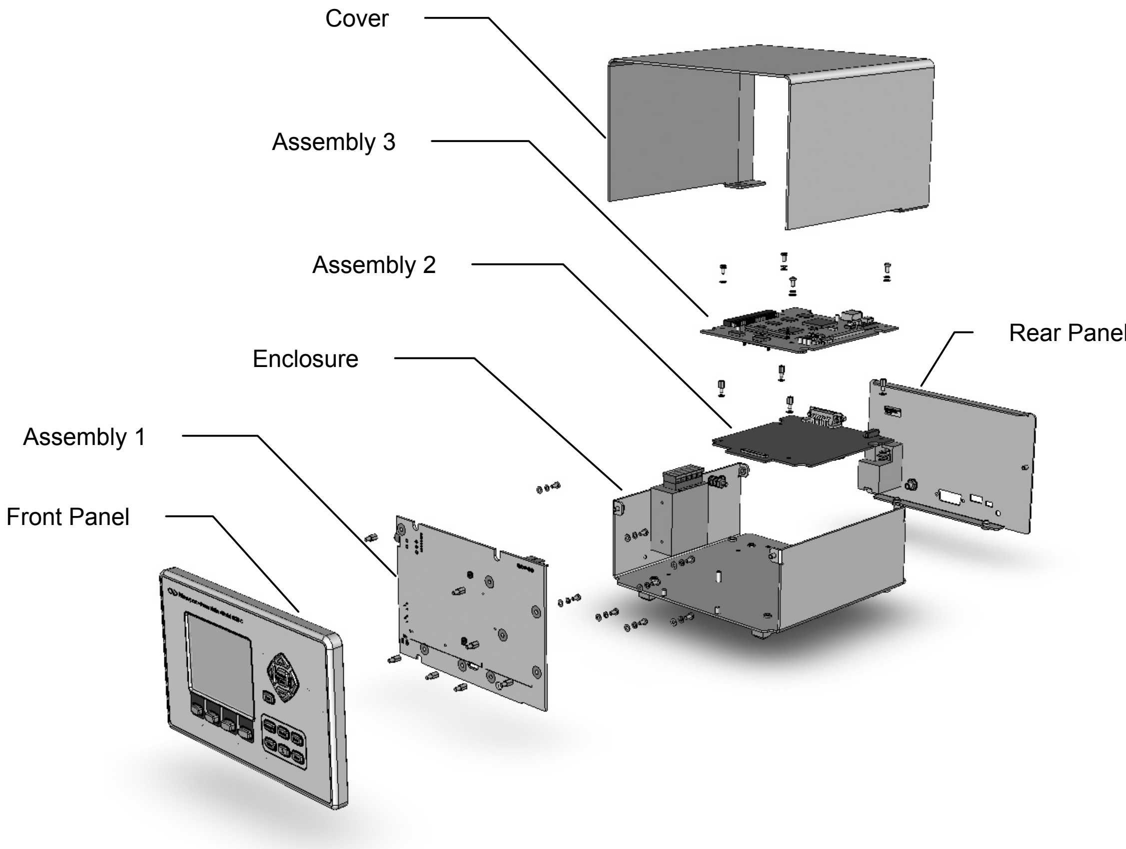

Figure 64 Disassembled 1928-C Optical Power Meter

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