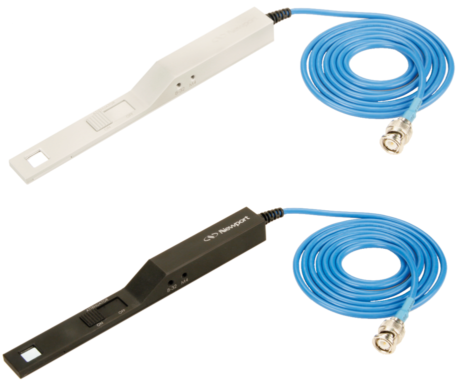
Model 818-ST2 & 918D-ST Series

Slim Profile Wand Detectors



User's Manual

Experience | Solutions

Model 818-ST2 & 918D-ST Series
Slim Profile Wand Detectors

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 2012

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Newport Corporation
1791 Deere Avenue
Irvine, CA, 92606, USA
Part No. 90051561, Rev. A

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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.

Technical Support Contacts

North America
Newport Corporation Service Dept.
1791 Deere Ave. Irvine, CA 92606
Telephone: (949) 253-1694
Telephone: (800) 222-6440 x31694

Europe
Newport/MICRO-CONTROLE S.A.
Zone Industrielle
45340 Beaune la Rolande, FRANCE
Telephone: (33) 02 38 40 51 56

Asia
Newport Opto-Electronics Technologies (Wuxi) Co., Ltd
理波光电科技（无锡）有限公司
江苏省无锡市新区出口加工区
J3-8厂房 204028
Lot J3-8, Wuxi Export Processing Zone,
New District, Jiangsu China 204028
Telephone: +86-510-8113 2999
Fax: +86-510-8526 9050

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 representativewith 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?

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General Information

This guide contains information necessary for using model 818-ST2 and 918D-ST series slim-profile wand photodetectors. Please read through the guide before attempting to make optical power measurements or energy measurements.

1.1 Unpacking and Inspection

The 818-ST2 and 918D-ST Series photodetectors are shipped in a foam padded cardboard box, along with this user's manual and the calibration report. The calibration report is unique to each detector and should be archived for future reference. The calibration interval recommended for these detectors is 12 months. Please make sure that these items are received in good condition.

NOTE
Fragile parts are contained. Use caution when handling.

The only user serviceable part of this detector is the cleaning of the attenuator filter. See Section 1.5 for a description on how to clean this part.

1.2 Product Models

Model	Detector Type	Connector Type
818-ST2	Silicon	BNC
818-ST2/DB	Silicon	15-pin D-Sub
818-ST2/CM	Silicon	8-pin Din
818-ST2-UV	UV Enhanced Silicon	BNC
818-ST2-UV/DB	UV Enhanced Silicon	15-pin D-Sub
818-ST2-UV/CM	UV Enhanced Silicon	8-pin Din
818-ST2-IR	Germanium	BNC
818-ST2-IR/DB	Germanium	15-pin D-Sub
818-ST2-IR/CM	Germanium	8-pin Din
918D-ST-SL	Silicon	15-pin D-Sub
918D-ST-UV	UV Enhanced Silicon	15-pin D-Sub
918D-ST-IR	Germanium	15-pin D-Sub

Table 1 – Available 818-ST2 and 918D-ST Series Models

1.3 818-ST2 and 918D-ST Series Features

818-ST2 and 918D-ST Series detectors utilize Silicon, UV enhanced Silicon, and Germanium photodiodes covering a broad wavelength range from 200 to 1800 nm. These highly sensitive, low-noise photodiodes enable measurements from sub-pW to 3 mW optical power. The built-in attenuator extends the dynamic range into the watt range.

818-ST2 Series detectors are terminated with a BNC connector. A 15-pin D-Sub type connector, containing the calibration data, is use to plug in to Newport's optical power meters. 918D-ST Series detectors are directly terminated with a 15-pin D-Sub type connector. Please check www.newport.com for the latest product offering.

Figure 1 918D-ST Series detector has an integrated 15-pin D-Sub calibration module.

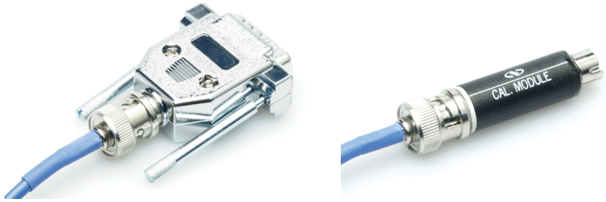

Figure 2 Calibration modules (On the left, /DB, and on the right, /CM style) for 818-ST2 Series detectors.

Key Features

- The detectors are in a sturdy, economically designed aluminum housing.
- 818-ST2 Series, 818-ST2-IR Series, 918D-ST-SL, and 918D-ST-IR detectors are in a black anodized housing, while 818-ST2-UV and 918D-ST-UV Series UV detectors are in a clear anodized housing to avoid photo contamination.
- The detectors are available with a built-in OD3 optical attenuator, which is mounted on a thumb slide. The actual attenuation of the filter varies depending on the wavelength and the batch-to-batch coating variations. The On/Off position of the attenuator is automatically detected by the optical meter Models 1918-R, 1936-R/2936-R, and 1830-R.

Figure 3 – Attenuator 'ON/OFF' Switch

- The detectors can be used hand-held or mounted on a post and a post holder. Unlike the legacy 818-ST Series detectors, the 818-ST2 and 918D-ST Series have the mounting holes on both the sides, not at the back, of the housing, as shown in Figure 4.

Figure 4 – Location of the mounting holes, available on both the sides

- The detectors have a built-in EEPROM which stores the responsivity data, measured for every 10 nm step within the specified spectral range, for the detector. The responsivity data is stored for both with and without the attenuator filter in the beam path. The detectors are "hot-pluggable", enabling this data to be uploaded onto the power meter when the detector is first connected to the instrument, allowing for corrections of the responsivity as a function of the wavelength selected by the user.

- 918D-ST Series detectors include a thermistor which measures the temperature of the detector and allows the optical meter to make numerical corrections of the responsivity as a function of temperature.

1.4 Specifications

Model (w/ DB15 Connector)	**918D-ST-UV 818-ST2-UV(/DB)**	**918D-ST-SL 818-ST2(/DB)**	**918D-ST-IR 818-ST2-IR(/DB)**
Spectral Range (nm)	200 to 1100	400 to 1100	780 to 1800
Power Density, Average Max w/ Attenuator (W/cm^2)	0.20	2.00	2.00
Power Density, Average Maximum w/o Attenuator (mW/cm^2)	0.50	5.00	3.00
Pulse Energy, Maximum - w/ Attenuator ($\mu J/cm^2$)	0.10	1.00	0.35
Pulse Energy, Maximum - w/o Attenuator (nJ/cm^2)	0.10	1.00	0.35
Uniformity (%)[1]	±2	±2	±3
Linearity (%)	±0.5		
Calibration Uncertainty w/o Attenuator	4% @ 200-219 nm 2% @ 220-349 nm 1% @ 350-949 nm 4% @ 950-1100 nm	1% @ 400-940 nm 4% @ 941-1100 nm	2% @ 780-910 nm 2% @ 911-1700 nm 4%@1701-1800 nm
Calibration Uncertainty, w/ Attenuator	8% @ 200-219 nm 2% @ 220-349 nm 1% @ 350-949 nm 4% @ 950-1100 nm	1% @ 400-940 nm 4% @ 941-1100 nm	5% @ 780-910 nm 2% @ 911-1700 nm 4%@1701-1800 nm
Rise Time (μs)	≤3		≤3.5
Shunt Resistance (MΩ) (typ)	≥200		≥0.005
Reverse Bias, Max. (V)	5.00		2.00
NEP (pW/√Hz)	0.02	0.02	4.00
Material	UV Enhanced Silicon	Silicon	Germanium
Shape	Wand		
Attenuator, OD3	Built-In		

[1] *When measured with beam centered and filling 80 % of active area.*

Table 2 – Specifications Table

Making Measurements

Attach the 15-pin D-Sub connector of an 818-ST2 or a 918D-ST Series detector to Newport's optical power meters (Refer to the power meter user manual for details on how to operate the meter). In order to assure good electrical connectivity, it is recommended that the thumbscrews located on both sides of the connector be hand-tightened.

Each detector comes with its unique calibrated responsivity data encoded in an EEPROM built into the connector. When the detector is connected to a power meter for the first time, manually set up the wavelength from the power meter. Calibration data is provided for the detector with and without the optical attenuator. Newport's 1830-R, 1918-R, 1928-C, and 1936/2936-R optical meters read the EEPROM data, not only during initial power-up, but any time a detector is connected, and subsequently sensed by the optical meter. To ensure an accurate measurement, it is recommended that the detector be mounted securely on an optical table. Keep in mind that slight movement of the detector can easily misalign an optical beam from the detector active area.

Any optical surface will change its reflectivity depending on the beam incident angle. All Newport optical detectors are calibrated with the detector housing surface normal to the incident beam, with the reflectivity from the detector-air interface and from the attenuator already taken into account during calibration.

818-ST2 and 918D-ST Series detectors have a built-in optical attenuator, which can be manually switched into or out of the optical path using a slider. Attenuator 'ON' and 'OFF' markings indicate the attenuator position (see Figure 5). A built-in sensor automatically detects the attenuator position, signaling the power meter to use the appropriate responsivity for the detector/attenuator combination.

Figure 5 – Attenuator in the ON Position

1.5 Cleaning

The detector must not be disassembled for cleaning purposes. The attenuator filter can be cleaned by sliding the filter to the ‘ON’ position. Use the proper optics grade lint-free cotton swabs and organic solvent, such as optical-grade isopropyl alcohol, reagent-grade acetone, or lens cleaning solution.

NOTE
Kleenex and Kim wipes contain wood and fiber glass respectively and will scratch optical surfaces.

Care must be taken not to touch the photodiode window or attenuator with bare fingers. Contaminants may cause inaccurate measurements, particularly at ultraviolet wavelengths where absorption is common.

Potentially large measurement errors can be induced by scratches, digs and damage to the optical surfaces of the attenuator or detector. For dust removal, use pressurized gas (filtered dry nitrogen) and lint-free cotton swabs dabbed in an organic solvent.

1.6 Temperature and Humidity

The temperature range of +5 to +50°C should not be exceeded and the detector should not be exposed to humidity levels greater than 70%. The photodiode sensitivity increases with temperature, mainly for wavelengths longer than the peak response wavelength. The temperature of the 918D-ST series detectors is monitored with a thermistor and the responsivity is numerically compensated to keep the calibration accurate within specification throughout the operating temperature for a given wavelength.

2 Calibration Uncertainties and Limitations

2.1 Spectral Response

The response of the detector depends on the wavelength of the incident light. The photodiode is transparent for photon energies less than the band gap, which determines the long wavelength infrared sensitivity limit. The short wavelength limit is determined by the photodiode manufacturing process and possibly, in the case of silicon photodiodes, by strong window absorption. The photodiode response is commonly measured in amps of photocurrent per watt of incident optical power. The response curves for the photodetector are shown on the calibration report, shipped with each detector.

2.2 Calibration Uncertainties and Service

STATEMENT OF CALIBRATION:
The uncertainty and calibration of this photodetectors are traceable to National Institute of Standards and Technology (NIST) or an equivalent body, through equipment which is calibrated at planned intervals, and by comparison to certified standards maintained at Newport Corporation.

Newport Corporation calibrates its detectors using secondary standards directly traceable to NIST and/or NRC. The absolute uncertainty of the photodetector calibration is indicated on the calibration report. Detector response can change with time at different wavelengths, especially in the ultraviolet, and should be returned for recalibration at 12 month intervals to ensure confidence in the accuracy of the measurement.

For recalibration services, contact Newport Corporation at 800-222-6440.

2.3 Uniformity

Fabrication processes may cause the response of the detector to vary slightly over the detector surface. Calibration involves illumination of approximately 70% of the detector's central active diameter. Optical signals being measured should illuminate approximately this same area. Care should be taken not to overfill the detector if accuracy is to be maintained.

2.4 Detector Saturation

For low optical power, the photocurrent is linearly proportional to the optical signal incident on the photodiode. For high optical powers, saturation of the detector begins to occur and the response signal is no longer linearly proportional to the incident power. Optical power measurements must be made in the linear region to be valid. Newport's optical meters measure the current coming from the detector and will let you know before the detector is near its saturation point. However, even with low total power, it is possible to locally saturate the detector by subjecting it to high power densities (power per unit area), i.e., a very small beam size. This is why it is important to fill the central portion of the detector's active area as much as possible.

NOTE

The saturation is "soft", i.e. the detector output does not suddenly stop increasing, but the rate of increase slows. For Gaussian and other signals with spatially varying intensities, local saturation may occur. The onset of saturation is not always obvious and is a common source of inaccurate measurements.

To determine if the detector is saturating, follow the steps below:

1. Measure the photodetector current (or power), and record this value (A).
2. Place a filter or attenuator of known transmission (T) in the beam path. Record the current again (B). A filter transmission of 0.001 is a convenient choice.
3. The power with the filter in place should be the product of the power measured without the filter and the transmission of the filter, i.e. B = A x T.

If the transmission (T) of the filter is not known, it can be determined by following the steps below:

1. Reduce the optical power to a level low enough to avoid saturation, but high enough that, when it is reduced by the filter it can still be accurately measured.
2. Follow steps 1 and 2 in the procedure above.
3. Calculate the ratio T = B/A to determine the transmission of the filter at the wavelength of light used for the measurement.

   The calibrated filter (or attenuator) can be used with the detector to measure the power of higher power beams.

2.5 Saturation with Pulsed Power Measurements

Saturation effects, when using pulsed lasers, are a complex phenomenon and depend upon the wavelength, peak power, pulse shape, average power, repetition rate, and on the type of detection circuit. However, the test for saturation described immediately above should be used whenever pulsed power measurements are being made.

2.6 Reflections

The photodetector surface, window material and the attenuator all reflect light. The amount of reflected light depends upon the angle of incidence and the polarization of the beam. Reflected light does not get absorbed by the detector, and therefore is not included in the detector signal. The Newport detector and attenuator calibration include the loss due to reflection for incoherent light incident normal to the detector. For accurate power measurements the detector should therefore be used at near normal incidence.

2.7 Photodiode Operation

When a photon is absorbed in the photodiode, an electron-hole pair is formed within the device and a voltage is developed across the diode junction. If the photodiode terminals are connected a photocurrent proportional to the light intensity will be generated. Measuring this photocurrent provides a measurement of the optical power incident upon the detector. Newport's power meters utilize an Op Amp to enable unbiased photocurrent measurement. Operation with zero bias is called the Photovoltaic Mode.

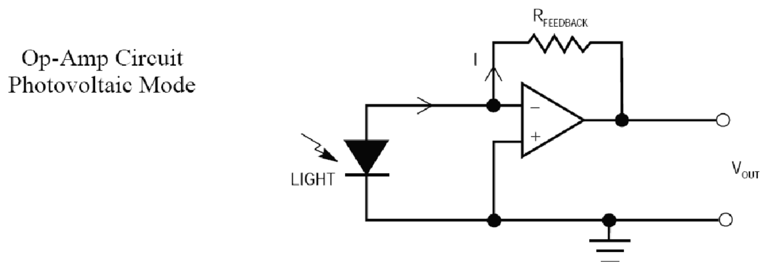

Figure 6 – Newport 818-ST2 and 918D-ST Series detectors in photovoltaic mode

2.8 Low Power Measurement Considerations

Measurements of very low power optical sources are possible with the 818-ST2 and 918D-ST series photodetectors. Proper detector usage and achievement of accurate results requires the understanding of a number of effects that limit the device performance which are discussed below.

2.8.1 Noise Characteristics

The lower limits of optical detection are determined by the noise characteristics of the detector and/or amplifier. Theory predicts that the photodiode noise is largely thermal (Johnson) noise associated with the effective resistance of the photodiode and shot noise from dark current. Additionally, there is Johnson noise contributed by the resistance of the amplifier's feedback resistor. The dark current at a 10mV bias voltage is measured and used to define the effective resistance of the photodiode, known as the shunt resistance:

$$R_{shunt} = V_{bias} / I_{dark} \text{ where } V_{bias} = 10\text{mV}$$

Ideally an input amplifier connected as in Figure 6 would have no offset voltage and there would be no dark current. In practice though, a small bias usually exists. For non-CW measurements the light detection limit is more generally expressed as the intensity of light required to produce a current equal to the noise current, i.e. a signal-to-noise level of 1. This is called the noise equivalent power (NEP) and is expressed as:

$$\text{NEP} = \text{Noise Current/Sensitivity} \qquad (W/\sqrt{Hz})$$

with sensitivity defined as the current generated by the photodiode for a given incident power, at a specific wavelength. NEP varies inversely with the spectral response of the photodiode and depends on the wavelength, λ, the noise frequency, f, and bandwidth, Δf.

Noise and dark current generally increase exponentially with detector temperature so it is best to keep the temperature close to 25°C.

2.8.2 Ambient Light and Electrical Offsets

Good measurement technique dictates that the effects of ambient light should be reduced as much as possible when using photodiodes. Although the photocurrent generated by ambient light can be easily zeroed out, the shot noise associated with the photocurrent will not be zeroed, nor will any changes in the ambient light levels, which might be caused by people moving around in the room. A small electronic offset will always be present with semiconductor detectors, caused by an interaction of the detector shunt resistance with voltage offsets in the amplifier circuitry. The offset can be removed by use of the optical meter's zero function. Please note, however, that the offset is a function of the temperature of both the photodiode and the amplifier inside the optical meter.

When measuring very low light levels, it is best to re-zero the meter whenever you think that the temperature of the detector or the optical meter may have changed. For instance, it is good practice to re-zero the meter after a warm-up period of about 30 minutes. Refer to your optical meter manual for details regarding the zeroing procedure.

2.9 Using the Detector for Non-CW Measurements

When the photodetector is used with a Newport optical meter, it is operated essentially without bias voltage, as depicted in Figure 6. The effective time constant of the detector/amplifier combination may be much slower than the characteristic time of the signal. Nonetheless, if the detector/amplifier combination does not become saturated, effective integration of the signal will occur, and accurate power measurements of very short pulses can be made. Additionally, if the repetition rate or duty cycle is sufficiently high, good average power measurements can be made. Usually it is helpful to turn on the analog filter (5Hz low-pass) to smooth the DC component so that the optical meter will make consistent measurements of the average power.

3 Factory Service

3.1 Introduction

This section contains information regarding obtaining factory service for the 818-ST2 and 918D-ST Series Wand Detectors. The user should not attempt any maintenance or service of this product. Contact Newport Corporation or your Newport representative for assistance. The detector calibration uncertainty is warranted for a period of 1 year with a normal use.

3.2 Obtaining Service

To obtain information concerning factory service, contact Newport Corporation or your Newport representative. Please have the following information available:

1. Product model number
2. Product serial number
3. Description of the problem.

If the instrument is to be returned to Newport Corporation, you will be given a Return Authorization 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.

3.3 Service Form

Newport Corporation
USA Office 800-222-6440
FAX: 949-253-1479

Name ____________________________ **Return Authorization #** ____________________
(Please obtain RA# prior to return of item)

Company ____

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):

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