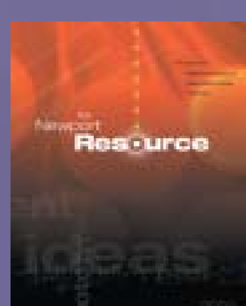
Power Meters and Detectors



Home Page

Selection Guide

Newport offers a complete line of optical meters and detectors, enabling low and high-power, as well as energy measurements. Four family types of photodetectors can be used with our optical meters: Low-Power Semiconductor Photodiodes, High-Power Thermopile Detectors, Pyroelectric Energy Detectors and Integrating Spheres. This detector line is quite flexible and can be used to measure power and energy with both free-space and fiber optic inputs.

The following tables, in combination with the Detector Performance Charts on the following page, should help identify the optical meter/detector combination appropriate for your particular optical measurement needs. It is always a good idea to select a detector that suits your needs before selecting an optical meter.

Power Measurements

Mode	Repetition Rate	Power Level	Power Meter	Detector Family	FO Adaptor	Page
CW		1pW–2W[2]	840-C, 1825-C, 1830-C, 1835-C, 2832-C, 2835-C, 4832-C	818 Series	FC, ST,SC, & Bare Fiber	128
		100pW–0.2W		818-IS-1	FC, ST,SC, & Bare Fiber	134
		15pW–20W+[4]		819 Series	FC, ST, SMA	136
		1mW–300W	1825-C, 1835-C, 2835-C	818T Series	None	140
Pulsed	>10 Hz	1mW–300W (<0.6 J/cm^2)	1825-C, 1835-C, 2835-C	818T Series	None	140
	>100 Hz[1]	1pW–2W[2] (<1 µJ/cm^2)	840-C, 1825-C, 1830-C, 1835-C, 2832-C, 2835-C, 4832-C	818 Series	FC, ST,SC, & Bare Fiber	128
		100pW–0.2W (>1 µJ)		818-IS-1	FC, ST,SC, & Bare Fiber	134
		15pW–20W+[4]		819 Series	FC, ST, SMA	136
Peak-to-Peak	<200 kHz[1]	1pW–2W[2]	840-C, 1825-C, 1835-C, 2835-C	818 Series	FC, ST,SC, & Bare Fiber	128
		100pW–0.2W		818-IS-1	FC, ST,SC, & Bare Fiber	134
		15pW–20W+[4]		819 Series	FC, ST, SMA	136

Energy Measurements

Mode	Repetition Rate	Power Level	Power Meter	Detector Family	FO Adaptor	Page
Energy per Pulse	80–4000 Hz[1]	>35 nJ	1825-C, 1835-C, 2835-C	818J Series	None	143
	>10 Hz	<0.6 J/cm^2(>1mW avg.)	1825-C, 1835-C, 2835-C	818T Series[3]	None	140
	>100 Hz[1]	<1 µJ/cm^2 (1pW–2W[2])	840-C, 1825-C, 1830-C, 1835-C, 2832-C, 2835-C, 4832-C	818 Series[3]	FC, ST, SC, & Bare Fiber	128
		>1 µJ (100pW–0.2W)		818-IS-1[3]	FC, ST, SC, & Bare Fiber	134
		15pW–20W+[4]		819 Series[3]	FC, ST, SMA	136
Integrated (power x time)	>10 Hz	<0.6 J/cm^2(>1mW avg.)	1825-C, 1835-C, 2835-C	818T Series	None	140
	>100 Hz[1]	1pW–0.2W[2]		818 Series	FC, ST,SC, & Bare Fiber	128

1) Power meter dependent. Minimum 1% duty cycle is recommended.
2) Maximum peak power density for OD3 attenuator that comes with the 818 Series detectors is 2W/cm^2.
3) These detectors actually measure power, but the energy can be derived by the calculation, energy = power/(rep rate).
4) Upper power limit depends on several factors, e.g., sphere size, port aperture size, and wavelength.

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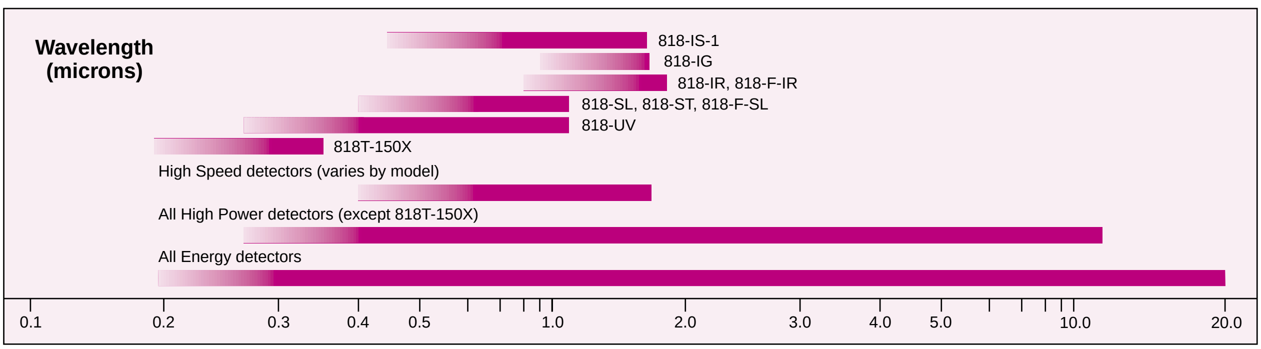
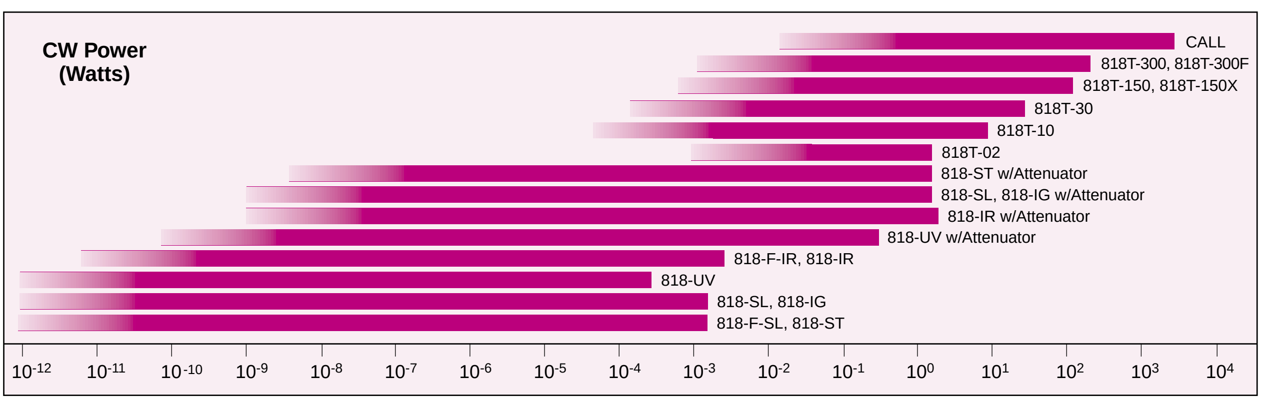
Optical Meter Features

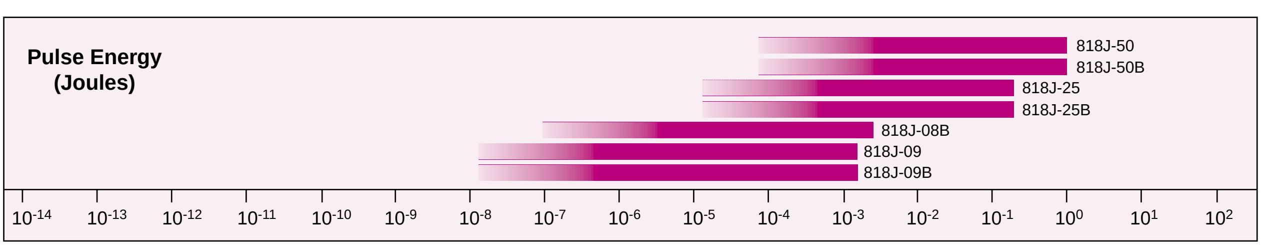
Optical Meter	Display Units W	dB	dBm	J	erg	V	A	REL	W/cm²	J/cm²	erg/cm²	IEEE-488 Interface	RS-232 Interface	Analog Output
4832-C[1]	•		•				•					PC ISA Bus	PC ISA Bus	•
2832-C	•	•	•				•	•	•			•	•	•
2835-C	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1835-C	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1830-C	•	•	•					•				•	•	•
1825-C	•			•										•
1815-C	•													•
840-C	•	•	•											•

1) The 4832-C has no front panel display. Available units are software driven.

Detector Performance Charts







Note: The gradient shaded regions of the detector power and energy operating ranges reflect the dependence of the measurement noise floor on the amplifying electronics used with the detector. Newport's optical meters are designed to minimize the noise floor.

LASER DIODE TESTING

FIBER OPTICS TEST INSTRUMENTATION

POWER METERS & DETECTORS

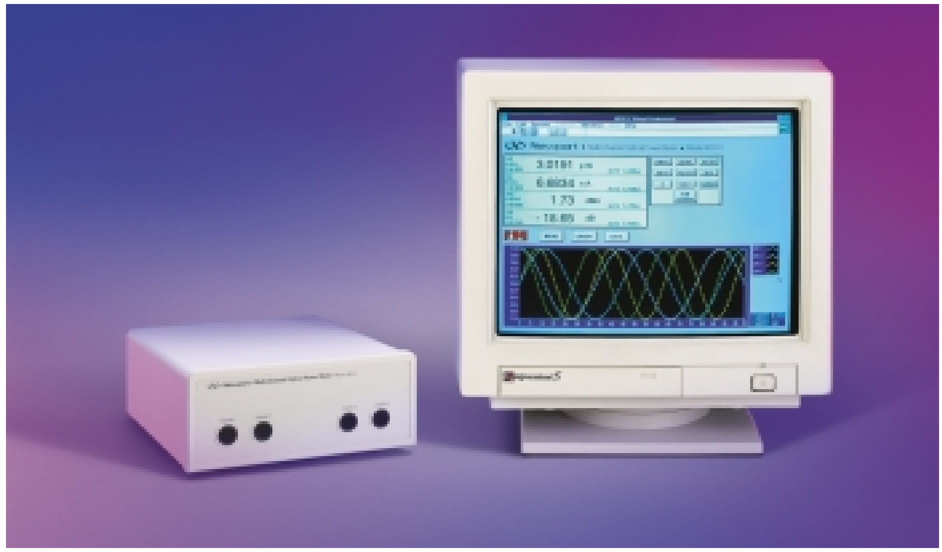
FIBER ALIGNMENT & ASSEMBLY

LASERS

FIBER OPTIC COMPONENTS

OPTICAL FIBERS & ACCESSORIES

Multi-Channel Optical Power Meter



Key Features

- *Four-channel, NIST traceable optical power measurements*
- *High-speed data acquisition up to 3500 Hz for single channel, with 12-bit resolution*
- *15-bit resolution at 15 Hz sampling rate*
- *Noise/bandwidth performance optimized for Newport's small and large area semiconductor detectors*

Applications

- *High-speed scanning*
- *High-speed optical component and fiber alignment*
- *Multi-channel optical power measurements during photonic component manufacturing and testing*

The 4832-C Multi-Channel Optical Power Meter features multi-channel, high-speed and high-precision, NIST calibrated optical power measurements. The system consists of a breakoutbox connected to a PC plug-in board. The breakout box can be located up to 30 feet away from the PC, allowing its easy integration in manufacturing and assembly environments.

3500 Hz, single-channel data acquisition rates are achieved through a PCISA bus plug-in board. The on-board processor controls both the auto-ranging and data acquisition overhead.

The exceptional combination of speed and accuracy is achieved by using a 12-bit, high-speed A/D for fast sampling and a 15-bit integrating A/D for the ultimate in precision DC measurements. The sensitive analog circuitry is kept in the breakout box, away from the noisy PC environment. All communications with the PC are performed via a high-speed serial bus.

Measurement units of Watts, Amps or direct A/D data can be selected. In alignment or scanning applications requiring high-speed measurements, the A/D data and range information can be transferred directly to the PC, where further computations or conversion to dB or other units can be performed very quickly. The system throughput is further optimized by using computers equipped with 486 or Pentium® CPUs.

System flexibility allows the meter to be configured with one to a maximum of four channels, specified at the time of purchase. Future channel expansions can be performed by Newport. The **4832-C** is compatible with all of Newport's Low-Power, **818 Series detectors**. Each channel is optimized to a specific detector, in order to maximize bandwidth and minimize noise.

LabVIEW, DOS C, and Windows® DLL software drivers are provided with the 4832-C.

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Instrument Specifications

Sampling Resolution/Rate	15-bit at 15 Hz; 12-bit at 3500 Hz (single channel)
Skew between channels	250 µs
Gain Ranges	Up to 7 decades
Current Sensitivity (full-scale)	2.5 nA–2.5 mA
Resolution	80 fA at 15-bit
Bandwidth (-3 dB)	DC to 300 kHz (gain and detector dependent)
Analog Output	0–2.5 V into 1 MΩ
DC Accuracy	<±0.1% typical
Weight	2.5 lb (1.1 kg)
Dimensions (W x H x D)	8.5 x 3.5 x 8.75 in. (216 x 89 x 222 mm)
Operating Temperature	10°C to 40°C, <80% RH
Storage Temperature	-25°C to 60°C, <90% RH

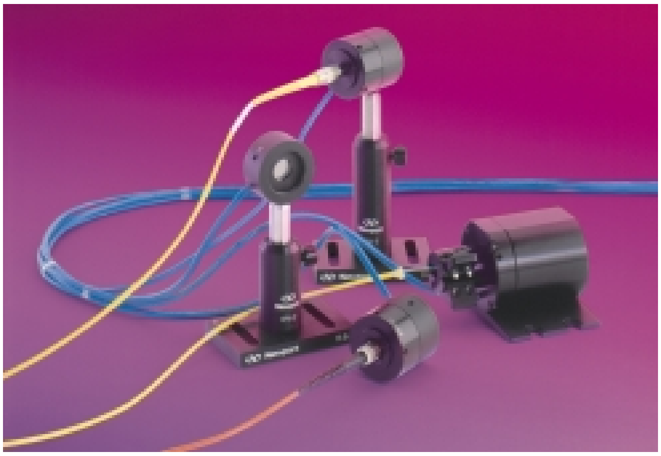
For more details on Newport's low-power detectors and fiber optic attachments compatible with the 4832-C, please see page 128 thru 139 in this catalog.

System Specifications

The 4832-C is compatible with Newport's Ge, Si and InGaAs detectors, allowing both free-space and fiber pigtailed measurements in the 190–1800 nm range. When using one of these detectors with the 4832-C, a calibration module needs to be attached to the detector, assuring the correct reading at any pre-selected wavelength.

Model	818-UV/CM	818-SL/CM	818-F-SL	818-ST/CM	818-IR/CM 818-F-IR	818-IG/CM	818-IS-1
Material	Silicon	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide	InGaAs/Si
Diameter	1.13 cm	1.13 cm	0.3 cm	1 x 1 cm	0.3 cm	0.3 cm	
Wavelength	190–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1800 nm	800–1650 nm	400–1650 nm
Power Range	-83 to +23 dBm	-90 to +33 dBm	-90 to +3 dBm	-70 to +33 dBm	-70 to +21.5 dBm[2]	-90 to +21.5 dBm	-70 to +23 dBm
Display Resolution				0.01 dB or dBm			
Display Resolution	0.1 pW	0.1 pW	0.1 pW	0.1 pW	10 pW	0.1 pW	0.1 pW
Accuracy[1]	±2%	±2%	±2%	±2%	±3%	±2%	±2.5%
Applicable wavelength range	200–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1700 nm	800–1650 nm	400–1650 nm
Linearity				±0.5%			
NEP @ 5 Hz and 1 A/W	50 fW/√Hz	50 fW/√Hz	50 fW/√Hz	3 pW/√Hz	4 pW/√Hz	30 fW/√Hz	3 pW/√Hz[3]

1) At calibration temperature maintained to ± 0.2°C, -20 dBm level having 99% encircled energy on detector with no optical attenuator
2) -70 to +3 dBm for 818-F-IR
3) 0.01 A/W for the 818-IS-1



The 4832-C is compatible with Newport's complete line of fiber-coupled and free-space low-power, 818 Series detectors—for measurements up to 2W—and with our new 818-IS-1 integrating sphere detector.

Call Newport's Application Sales Engineers to help you select the best product configuration for your application.

Ordering Information

Each 4832-C includes a break-out box, a PC plug-in board and the interconnecting cable assembly. Up to four pre-amplifier boards can be inserted in the break-out box, depending on the number of channels required. Two kinds of pre-amplifier boards are available, depending on the type of detectors used. The compatible 818 Series low-power detectors and the rack mount kit are sold separately.

Model	Description	Option Code
4832-C	Multi-Channel Optical Power Meter, Single-Channel	01
	Multi-Channel Optical Power Meter, Dual-Channel	02
	Multi-Channel Optical Power Meter, Three-Channel	03
	Multi-Channel Optical Power Meter, Four-Channel	04
4832-SL	Pre-Amplifier Board for 818-UV, 818-SL, 818-F-SL, 818-ST, 818-IG and 818-IS-1 Detectors	11
4832-IR	Pre-Amplifier Board for 818-IR and 818-F-IR Detectors	12
4832-15	15 ft. Cable Assembly	1
4832-30	30 ft. Cable Assembly	2
4832-RACK	Rack Mount Kit(1)	

1) The 19 in., single-height 4832-C Rack Mount Kit can hold up to two 4832-C break-out boxes

Ordering Instructions

When ordering your customized system configuration, specify the following Model number:

4832-C-OPT-□□-□□-□□-□□-□□-□ (Ch.1, Ch.2, Ch.3, Ch.4)

Number of Channels	Pre-Amplifier Boards		Cable Length	
01	NN	None2	1	15 ft.
02	11	4832-SL	2	30 ft.
03	12	4832-IR		
04				

2) The NN code cannot be entered in the Ch. 1 option field, since the 4832-C is sold with at least one pre-amplifier channel in the break-out box.

Indicate the Option Code Number for the specific pre-amplifier boards you would like us to install in the required channels, and the Option Code Number for the desired cable length. Please indicate NN in the unused break-out box channels.

Example: 4832 - C - OPT 03 11 11 12 NN 1

Three-channel 4832-C Multi-Channel Optical Power Meter with the first two channels configured for 818-IG detectors and the third channel configured for an 818-IR detector. The unit will be supplied with a 15 ft cable.

In future instrument upgrades, an existing break-out box can be retrofitted by Newport to increase the number of pre-amplifier boards. Please call Newport's Application Engineers for ordering instructions when upgrading a previously acquired 4832-C.

Model 2832-C

Dual-Channel Optical Power Meter

For optical measurements that require two channels, high-precision, and fast data acquisition, the **2832-C** is the ideal choice. This is ideal for production testing of fiber optic components.

Single- and dual-channel operations are supported, with channels displayed individually or simultaneously in dual-channel operation.

The power sensitivity ranges from 100 fW–2W over a wavelength range of 0.19–1.8 µm. The unit is compatible with Newport's **818 Series** silicon, germanium, and indium gallium arsenide detectors, and a wide variety of accessories for measuring bare or connectorized fiber or free space light sources.

Measurements can be made in W, A, dBm, dB or relative units. These may be displayed directly or as relative ratio measurements from present or stored values.

Moving statistical measurements permit you to compute moving statistics for 1 to 100 measurements with Min, Max, Max-Min, Mean, and Standard Deviation. You may also select from many programming features such as sampling frequency and precision,digital and analog filtering, and data storage of up to 1000 readings per channel.

Additional Benefits

- Includes both RS-232C and IEEE-488 interfaces
- Six-digit vacuum fluorescent display is legible from any angle and in any light condition
- Stores and recalls up to 10 operating configurations for setup convenience
- System calibration is user-adjustable, with wavelength settings in 1 nm increments
- Provides trigger in/out control with alarm levels and adjustable trigger polarity

Key Features

- *Fast IEEE-488 (GPIB) end-to-end data transfer rate, 50–100 Hz, depending on software interface*
- *Data acquisition rate of 1000/500 samples per second, in single/dual channel operation*
- *Advanced features include 1000 point data storage, statistical measurements, and triggers with reconfigurable alarms*
- *Instrument can be integrated in the most sophisticated automated systems in production and laboratory applications*

For more details on Newport's low-power detectors and fiber optic attachments compatible with the 2832-C, please see page 128 thru 139.

Instrument Specifications

Display	6-digit vacuum fluorescent
Sampling Resolution	20,000 count ≤25 Hz, 4096 count ≤1 kHz
Gain Ranges	Up to 7 decades
Current Sensitivity (full-scale)	2.5 nA–2.5 mA
Resolution	100 fA
Sampling Rate	Up to 1 kHz single-channel, Up to 500 Hz dual-channel
Bandwidth (-3 dB)	DC to 47 kHz(1)
Analog Output	0–2.5 V into 50Ω
DC Accuracy	<±0.1% typical
Power Requirements	90 to 240 VAC lb (1.1kg)
Weight	2.5 lb (1.1kg)
Dimensions (W x H x D)	8.5 x 4 x 14 in. (216 x 102 x 356 mm)
Operating Environment	10°C to 40°C, <80% RH
Storage Environment	-25°C to 60°C, <90% RH

1) Gain and detector dependent

System Specifications

The 2832-C is compatible with Newport's Ge, Si and InGaAs detectors, allowing both free-space and fiber pigtailed measurements in the 190–1800 nm range. When using one of these detectors with the 2832-C a calibration module needs to be attached to the detector, assuring the correct reading at any pre-selected wavelength.

Model	818-UV/CM	818-SL/CM	818-F-SL	818-ST/CM	818-IR/CM 818-F-IR	818-IG/CM	818-IS-1
Material	Silicon	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide	InGaAs/Si
Diameter	1.13 cm	1.13 cm	0.3 cm	1 x 1 cm	0.3 cm	0.3 cm	
Wavelength	190–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1800 nm	800–1650 nm	400–1650 nm
Power Range	-83 to +23 dBm	-90 to +33 dBm	-90 to +3 dBm	-70 to +33 dBm	-70 to +21.5 dBm(2)	-90 to +21.5 dBm	-70 to +23 dBm
Accuracy(1)	±2%	±2%	±2%	±2%	±3%	±2%	±2.5%
Applicable wavelength range	200–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1700 nm	800–1650 nm	400–1650 nm
Linearity				±0.5%			
NEP @ 5 Hz and 1 A/W	50 fW/√Hz	50 fW/√Hz	50 fW/√Hz	3 pW/√Hz	4 pW/√Hz	30 fW/√Hz	3 pW/√Hz(3)

1) At calibration temperature maintained to ± 0.2°C, -20 dBm level having 99% encircled energy on detector with no optical attenuator
2) -70 to +3 dBm for 818-F-IR
3) 0.01 A/W for the 818-IS-1

Ordering Information

Model	Description
2832-C	Dual-Channel Optical Power Meter
2832-C-CAL	2832-C with test data and certificate

Call Newport's Application Sales Engineers to help you select the optical detector that best meets your application requirements.

Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Model 1835-C
Model 2835-C

High-Performance Optical Meters

1835-C *Single-Channel*

2835-C *Dual-Channel*

Whether your application requires measurement of low-power, high-power or energy of continuous or pulsed light sources, Newport's **Models 1835-C and 2835-C** will do the job!

DC, peak-to-peak and pulse measurements can be displayed in units of W, dBm, dB, J, Ergs, A, and V. Simultaneous measurements of a variety of light sources operating at different power levels and wavelengths can be performed with our dual-channel **2835-C** optical meter.

Low-power measurements, in the 100 fW–2 W range, can be accomplished with any one of Newport's **818 Series** silicon, germanium or indium gallium arsenide semiconductor detectors, covering 190–1800 nm wavelengths.

High-power measurements, in the 10 mW–300 W range, can be performed with Newport's **818T Series** air-cooled thermopile detectors, enabling measurements in the 0.19–11 µm wavelength range.

Energy measurements of pulsed laser sources, from 35 nJ–1 J, can be taken with Newport's **818J Series** family of pyroelectric detectors, operating in the 0.19–20 µm wavelength range. Pulse repetition rates from single shot to 2 kHz can be accommodated.

Advanced features include a 2500 data point storage buffer; analog and digital filtering; programmable sample rates; moving statistics; and up to 10 recallable configurations.

Additional Benefits

- Includes both RS-232C and IEEE-488 interfaces
- Vacuum fluorescent display provides excellent legibility from any angle, in any light condition
- Analog bar graph with 10X zoom
- Audible beep on pulse arrival
- Wavelength calibration in 1 nm steps
- Trigger in/out control with alarm levels

Key Features

- *Greatest possible versatility in a single optical meter*
- *DC optical power measurements in the 100 fW–300 W range*
- *Pulsed and integrated energy measurements*
- *Fast IEEE-488 data throughput, 50–100 Hz, depending on software interface*
- *Large variety of programmable input and output controlling triggers*
- *Sophisticated automation capabilities in testing and laboratory applications*

Specifications

Display Type	6-digit vacuum fluorescent
Sampling Resolution	20,000 count ≤25 Hz, 4096 count ≤1 kHz
Gain Ranges	7 decades
Current Sensitivity (full-scale)	2.5 nA–2.5 mA
Voltage Sensitivity (full-scale)	790 µV–25 V
Resolution	100 fA, 125 nV
Sampling Rate	Up to 1 kHz single-channel, Up to 500 Hz dual-channel
Bandwidth (-3 dB)	DC to 1 MHz[1]
Analog Output	0–2.5 V into 50Ω
DC Accuracy	<±0.1% typical
Peak-to-Peak Accuracy	±1% typical
Pulse-to-Pulse Accuracy	±1% typical
Integration Accuracy	±1% typical
Power Requirements	90–240 VAC
Weight	2.5 lb (1.1 kg)
Dimensions (W x H x D)	8.5 x 4 x 14 in. (216 x 102 x 356 mm)
Operating Temperature	10°C to 40°C, <80% RH
Storage Temperature	-25°C to 60°C, <90% RH

1) Gain and detector dependent

Please see page 128 thru 145 for a detailed description of Newport's semiconductor, thermopile and pyroelectric detectors, compatible with the 2835-C and 1835-C.

Detector Compatibility and Performance

When used with various Newport detector types, the measurement modes shown below can be accessed:

Detector Family	DC Average Power	Integrated Energy	Peak-to-Peak Power	Pulse-to-Pulse Energy
Low-Power (818 Series)	Yes	Yes	Yes	No
High-Power (818T Series)	Yes	Yes	No	No
Energy (818J Series)	No	No	No	Yes

When used with our low-power semiconductor detectors, the system specifications for the Model 1835-C and 2835-C optical meters are the same as for our Model 2832-C, shown on page 118.

Ordering Information

Model	Description
1835-C	High-Performance Optical Meter
1835-C-CAL	1835-C with test data and certificate
2835-C	High-Performance Optical Meter
2835-C-CAL	2835-C with test data and certificate

Picowatt Digital Optical Power Meter

Key Features

- *Compact, full featured, benchtop instrument*
- *Standard configuration includes both RS-232C and IEEE-488 interfaces*
- *DC power measurements in the 100 fW–2 W range*
- *Additional features include large, backlit LCD display, autoranging and an audible tone for alignment optimization*

The **Model 1830-C** Power Meter is a high-resolution autoranging picoammeter compatible with all of Newport's **818 Series** low-power silicon, germanium and indium gallium arsenide detectors. It is the most popular Newport model used in production testing of fiber optic components.

DC power measurements can be displayed in units of W and dBm on the instrument's 4 1/2 digit annunciated, backlit, wide-angle view LCD, providing wide dynamic range with power sensitivities down to 100 fW and full scale readings up to 2 W, with the OD-3 calibrated optical attenuator. Various detector accessories allow for free-space, as well as for fiber coupled power measurements.

Relative power measurements, in reference to a previously stored value, can also be performed with the result displayed either as a ratio or in dB.

A built-in beeper, which changes its frequency as a function of incident optical power, can be utilized to optimize optical beam alignment.

RS-232C and IEEE-488 (GPIB) interfaces are both provided as standard features, allowing the remote control of the instrument with a personal computer. Sample LabVIEW drivers are provided upon request.

Additional features include wavelength adjustment in 1 nm steps from the front panel, and an analog output that provides a voltage proportional to the detector current, to be used for recorder or control loop applications.

For more details on Newport's low-power detectors and fiber optic attachments compatible with the 1830-C, please see page 128 thru 139.

Call Newport's Application Sales Engineers to help you select the optical detector that best meets your application requirements.

Instrument Specifications

Signal Ranges	Up to 8 decades (dependent on detector type)
Display Type	4.5 digit, annunciated, backlit, wide-angle view LCD
Display Update Rate	75 ms
Auto-Ranging Time	200 ms (typical)
GPIB Bus Transfer Time	10 ms (typical)
Analog Output	0–2V into 1 MΩ
DC Accuracy	<±0.2% (typical)
Connectors	
Calibration Module	8 pin Sub-mini DIN
Analog Output	0–2V into 1 MΩ
RS-232C	9 pin D-Sub
GPIB	24 Conductor D
Power Requirements	100–120/220–240 VAC, 50/60 Hz
Absolute Maximum Line Current Rating (W x H x D)	200 mA
Dimensions (W x H x D)	3.7 x 7.5 x 9.0 in. (94 x 191 x 229 mm)
Weight	5 lb (2.3 kg)
Enclosure (W x H x D)	Metal case, painted 7.5 x 9.0 in. (94 x 191 x 229 mm)
Operating Temperature	0°C to +40°C; <70% RH noncondensing
Storage Temperature	-20°C to +60°C; <90% RH noncondensing

System Specifications

The 1830-C is compatible with Newport's Ge, Si and InGaAs detectors, allowing both free-space and fiber pigtailed measurements in the 190–1800 nm range. When using one of these detectors with the 1830-C a calibration module needs to be attached to the detector, assuring the correct reading at any pre-selected wavelength.

Model	818-UV/CM	818-SL/CM	818-F-SL	818-ST/CM	818-IR/CM 818-F-IR	818-IG/CM	818-IS-1
Material	Silicon	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide	InGaAs/Si
Diameter	1.13 cm	1.13 cm	0.3 cm	1 x 1 cm	0.3 cm	0.3 cm	
Wavelength	190–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1800 nm	800–1650 nm	400–1650 nm
Power Range	-83 to +23 dBm	-90 to +33 dBm	-90 to +3 dBm	-70 to +33 dBm	-70 to +21.5 dBm(2)	-90 to +21.5 dBm	-70 to +23 dBm
Display Resolution				0.01 dB or dBm			
Display Resolution	0.1 pW	0.1 pW	0.1 pW	0.1 pW	10 pW	0.1 pW	0.1 pW
Accuracy(1)	±2%	±2%	±2%	±2%	±3%	±2%	±2.5%
Applicable wavelength range	200–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1700 nm	800–1650 nm	400–1650 nm
Linearity				±0.5%			
NEP @ 5 Hz and 1 A/W	50 fW/√Hz	50 fW/√Hz	50 fW/√Hz	3 pW/√Hz	4 pW/√Hz	30 fW/√Hz	3 pW/√Hz(3)

1) At calibration temperature maintained to ± 0.2°C, -20 dBm level having 99% encircled energy on detector with no optical attenuator
2) -70 to +3 dBm for 818-F-IR
3) 0.01 A/W for the 818-IS-1

Ordering Information

Model	Description
1830-C	Picowatt Digital Optical Power Meter
1830-C-CAL	1830-C with test data and certificate

Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Multi-Fuction Optical Meter

The **Model 1825-C Multi-Function Optical Meter** is easy to use, yet provides the capabilities to handle nearly any optical measurement task. No other meter matches the **Model 1825-C's** price/performance ratio.

Low-power, CW measurements, in the 10 pW–2 W range can be performed with Newport's semiconductor, **818 Series** Si, Ge and InGaAs detectors. Peak-to-peak low-power measurements can be performed on square waves with repetition rates of up to 8 kHz.

High-power measurements, in the 10 mW–300 W range can be performed with Newport's thermopile, **818T Series** detectors.

Pulsed-energy measurements, in the 35 nJ–1 J range can be performed with Newport's pyroelectric, **818J Series** detectors, with pulse repetition rates of up to 8 kHz. Integrated energy measurements can be accommodated with self-triggering on 1% of the full scale level.

Analog needle and digital LED displays provide end-users the comfort of optimizing their laser setup with a glance at the needle on the instrument front panel, while taking accurate measurements with the 3 1/2 digit LED display.

Additional features include: Wavelength Compensation, Zero, Average, Range and Mode Functions, and an audible beep with pulse frequency function.

Key Features

- *Low-cost, versatile optical meter*
- *Compatible with Newport's Low-Power, High-Power, and Energy detectors*
- *Measures average power, peak-to-peak power, integrated energy and pulse-to-pulse energy*

Instrument Specifications

For more details on Newport detectors compatible with the 1825-C, see page 128 thru 145, or call our Application Sales Engineers.

Display Type	3.5-digit LED, 3.5 in. analog needle, backlit
Sampling Rate	12 Hz maximum
Gain Ranges	12 ranges, 2 per decade
Full Scale Readings:(1)	
Low-Power Detector	20 nW–2 W
High-Power Detector	20 mW–300 W
Energy Detector	20 nJ–1 J
DC Accuracy	0.5%, 0.25% Typ.
Analog Output	0–2 V into 1 MΩ
Input Connector	BNC
Battery Life	20 hrs
Battery	Sealed lead-acid (rechargeable)
Wall Power	AC adaptor/charger 12 V/250 mA
Weight	4.0 lb (1.8 kg)
Dimensions (W x H x D)	3.7 x 7.5 x 9.0 in. (95 x 191 x 229 mm)
Operating Temperature	0°C to 50°C, <80% RH
Storage Temperature	-25°C to 60°C, <90% RH

1) When used with Newport's various detector families. The full dynamic range of the display is: 2.0 nW–20 kW or 2.0 nJ–200 kJ.

Four measurement modes provide the following capabilities when used with various Newport detector types:

Detector Family	DC Average Power	Integrated Energy	Peak-to-Peak Power	Pulse-to-Pulse Energy
Low-Power (818 Series)	Yes	Yes	Yes	No
High-Power (818T Series)	Yes	Yes	No	No
Energy (818J Series)	No	No	No	Yes

System Specifications

When used with Newport's low-power semiconductor detectors, the following system specifications are attained:

Model	818-UV	818-SL	818-ST	818-IR	818-IG
Material	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide
Diameter	1.13 cm	1.13 cm	1x1 cm	0.3 cm	0.3 cm
Wavelength	190–1100 nm	400–1100 nm	400–1100 nm	780–1800 nm	800–1650 nm
Power Range	-83 to +23 dBm	-90 to +33 dBm	-70 to +33 dBm	-70 to +21.5 dBm	-90 to +21.5 dBm
Display Resolution	0.1 pW	0.1 pW	0.1 pW	10 pW	0.1 pW
Accuracy(1)	±2%	±2%	±2%	±3%	±2%
Applicable wavelength range	200–1100 nm	400–1100 nm	400–1100 nm	780–1700 nm	800–1650 nm
Linearity			±0.5%		
NEP @ 5 Hz and 1 A/W	50 fW/√Hz	50 fW/√Hz	3 pW/√Hz	4 pW/√Hz	30 fW/√Hz

1) At calibration temperature maintained to ± 0.2°C, -20 dBm level having 99% encircled energy on detector with no optical attenuator, Calibration Factor = 5
2) Append /220 for 220V version

Ordering Information

Model	Description
1825-C(2)	Multi-function Optical Meter
1825-C-CAL(2)	1825-C with test data and certificate

Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Hand-Held Optical Power Meter

(*Detector not included*)

The Model 840-C hand-held optical power meter is fully compatible with all of Newport's **818 Series** low-power silicon, germanium and indium gallium arsenide detectors. Detectors connect to the power meter through an in-line calibration module that is dedicated to each detector. These detachable modules provide the Model **840-C** with calibration and operating information specific to the assigned detector. Various detector accessories allow for free-space, as well as for fiber coupled power measurements.

DC and AC peak-to-peak power measurements can be displayed in units of W and dBm on the instrument's 4 digit, backlit LCD. The meter's power sensitivity ranges from 2 mW down to 100 pW (-70 to +3 dBm). When using Newport's detectors with an OD-3 calibrated optical attenuator, the upper measurement limit can be extended to 2 W (+33 dBm).

Excellent signal-to-noise performance and reliable day-to-day operation of the instrument even in harsh measurement environments are assured by the instrument's thermally stable electronic design and full EMI/RFI shielding.

Additional Benefits

- Wavelength correction in 1 nm steps
- Audible tone for no-look tuning
- Rechargeable batteries for full portability
- Travel case included with power meter
- Most recent operating parameters are saved when unit is turned off

Key Features

- *Power and precision typical of a benchtop meter*
- *Includes both DC and AC peak-to-peak measurement modes*
- *Power sensitivity from 100 pW to 2 W (-70 to +33 dBm)*
- *Wavelength and range settings*
- *Linear, dB, dBm and linear ratio readouts*
- *Background subtraction and digital averaging*

For more details on Newport's low-power detectors and fiber optic accessories compatible with the 840-C, please see page 128 thru page 135.

Call Newport's Application Sales Engineers to help you select the Optical Detector that best meets your application requirements.

Instrument Specifications

Display Type	4-digit LCD w/ backlight
Sampling Rate	2.5 Hz
Gain Ranges	6 decades, DC; 4 decades, AC Pk-Pk
Full Scale Readings, Low-Power Detector	100 nA–5 mA
DC Accuracy, 100 nA range, full scale	±(0.5% + 50 pA)
DC Accuracy, 1 µA to 5 mA range, full scale	±(0.25% + offset) See Manual
Peak-to-Peak Accuracy, 50 Hz to 1 kHz	Squarewave ±5%, Sinewave ±1%
Peak-to-Peak Accuracy, 1 kHz to 2 kHz	Squarewave ±1%, Sinewave ±2%
Peak-to-Peak Accuracy, 2 kHz to 5 kHz	Squarewave ±2%, Sinewave ±5%
Analog Output Accuracy, 100 nA range	±(2.5% + 15 mV)
Analog Output Accuracy, 1 µA to 5 mA range	±(2% + 10 mV)
Analog Output	BNC, 0–1 V into 1 MΩ
Temperature Coefficient	0.1 x Accuracy/°C
Battery Life	18 hours (backlight on)
Battery	Ni-Cd rechargeable
Wall Power	AC adaptor/Charger
Dimensions (W x H x D)	7.2 x 3.0 x 1.5 in. (183 x 76 x 38 mm)
Weight	1.1 lb (500 kg)
Operating Temperature	0°C to 50°C, <80% RH
Storage Temperature	-25°C to 60°C, <90% RH

System Specifications

The 840-C is compatible with Newport's Ge, Si and InGaAs detectors, allowing both free-space and fiber pig-tailed measurements in the 190–1800 nm range. When using one of these detectors with the 840-C, a calibration module needs to be attached to the detector, assuring the correct reading at any pre-selected wavelength.

Model	818-UV/CM	818-SL/CM	818-F-SL	818-ST/CM	818-IR/CM 818-F-IR	818-IG/CM	818-IS-1
Material	Silicon	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide	InGaAs/Si
Diameter	1.13 cm	1.13 cm	0.3 cm	1 x 1 cm	0.3 cm	0.3 cm	
Wavelength	190–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1800 nm	800–1650 nm	400–1650 nm
Power Range	-83 to +23 dBm	-90 to +33 dBm	-90 to +3 dBm	-70 to +33 dBm	-70 to +21.5 dBm(2)	-90 to +21.5 dBm	-70 to +23 dBm
Display Resolution				0.01 dB or dBm			
Display Resolution	0.1 pW	0.1 pW	0.1 pW	0.1 pW	10 pW	0.1 pW	0.1 pW
Accuracy(1)	±2%	±2%	±2%	±2%	±3%	±2%	±2.5%
Applicable wavelength range	200–1100 nm	400–1100 nm	400–1100 nm	400–1100 nm	780–1700 nm	800–1650 nm	400–1650 nm
Linearity				±0.5%			
NEP @ 5 Hz and 1 A/W	50 fW/√Hz	50 fW/√Hz	50 fW/√Hz	3 pW/√Hz	4 pW/√Hz	30 fW/√Hz	3 pW/√Hz(3)

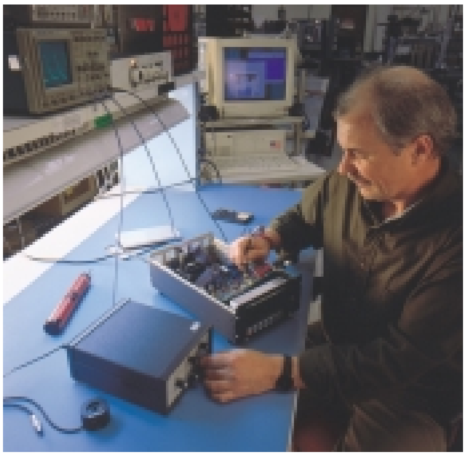
1) At calibration temperature maintained to ± 0.2°C, -20 dBm level having 99% encircled energy on detector with no optical attenuator
2) -70 to +3 dBm for 818-F-IR
3) 0.01 A/W for the 818-IS-1
4) Append /220 for 220V version

Ordering Information

Model	Description
840-C(4)	Hand-held Power Meter
840-C-CAL(4)	840-C with test data and certificate

Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Optical Meter Calibration Services



All meters come with either a Certificate of Conformance or a Certificate of Calibration.

All Newport optical meters are calibrated in compliance with ANSI/NCSL Z540-1-1994 using NIST traceable measurement equipment, and comply with the specifications published in this catalog. When ordering our optical meters with the –CAL option, they include a **Certificate of Calibration** and a calibration sticker, identifying the next date of calibration.

Newport optical meters may also be sent in periodically for re-calibration using the calibration model numbers listed below. This calibration is performed independent of the detector calibration service (see page 159). Newport recommends a recalibration every 12 months.

Ordering Information

If you already own a Newport optical meter and would like to have it recalibrated, please contact Newport's Customer Service Department to receive a return authorization number for your meter prior to ordering a meter calibration.

Please specify the calibration Model number for your particular optical meter, as shown in the table below.

Optical Meter Model	Model
Model 815*	PMRCAL-01
Model 820*	PMRCAL-02
Model 835*	PMRCAL-03
Model 840-C	PMRCAL-04
Model 1815-C	PMRCAL-05
Model 1825-C	PMRCAL-06
Model 1830-C	PMRCAL-07
Model 1835-C	PMRCAL-08
Model 2835-C	PMRCAL-09
Model 2832-C	PMRCAL-10
Model 4832-C	PMRCAL-11

* Older model, not currently sold.

Low-Power Detectors

Key Features

- *Power levels from pW to 2W*
- *Wavelengths from 190–1800 nm*
- *Proprietary detector optics*
- *Patented, matched OD3 attenuator*
- NIST/NPL-*traceable calibration included*
- EMI/RFI *shielded*
- *Free-space and fiber optic versions available*

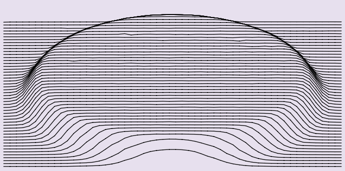


Figure 1—Newport detector response uniformity with coherent light.

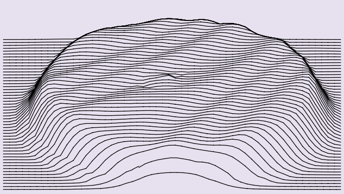


Figure 2—Typical detector response uniformity with coherent light.

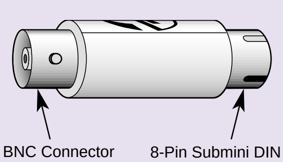


Figure 3—"/CM" Calibration Module, Patent Pending

Newport uses the highest quality semiconductor detector materials available in our **818 Series Low-Power Detectors.** In addition, each detector arrives with a complete full-spectrum calibration report detailing detector responsivity in 10 nm increments.

Proprietary detector optics are designed to address the problems associated with measuring coherent light (see Fig. 1 and 2). In ordinary detectors, coherent light causes reading errors across the detector surface and measurements are more sensitive to thermal drift. This results in an additional, unreported 5% to 8% calibration uncertainty when making laser power measurements. Newport's detector design eliminates these problems for stable, uniform detector response.

Newport's advanced in-house calibration facility performs the tightest calibrations in the business, further improving the absolute accuracy of our detectors. For more information, refer to Detector Calibration Services (see page 159).

Exclusive OD3 attenuator technology extends the calibrated optical dynamic range of our Cylindrical and Hand-Held Wand Detectors by three decades, as shown in Fig. 4. Our patented attenuator design provides low reflection, high damage threshold and spectral flatness, without the damage susceptibility problems of thin-film attenuators or the spectral variance of simple volume-absorbing attenuators.

Calibration modules are required when using Cylindrical and Hand-Held Wand Detectors with Newport's **Model 840-C, 1830-C, 1835-C, 2832-C, 2835-C or 4832-C optical meters**. The module, shown in Figure 3, is matched to an individual detector and provides the meter with detector calibration and operating information. The calibration module option is indicated by the /CM suffix in the detector Model number.

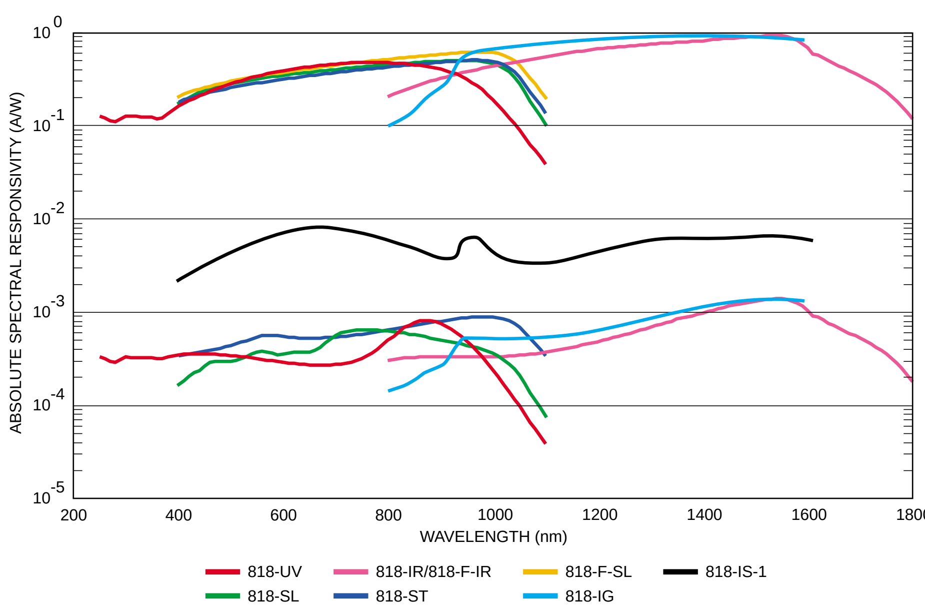
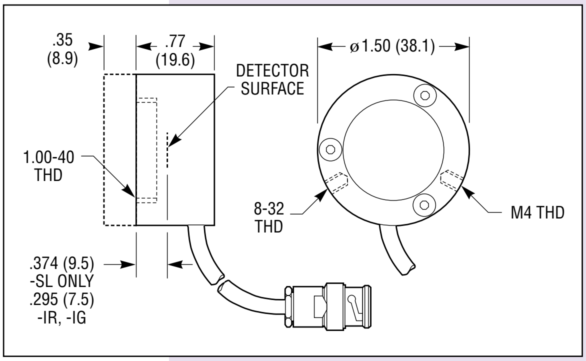


Figure 4—Low-power detector responsivity curves.

818 Series Cylindrical Detectors



The 818 Series Cylindrical Detectors (818-UV, 818-SL, 818-IR, 818-IG) are offered for broad wavelength ranges covering UV, visible, near-IR, and IR regions. They use the finest large-area planar-diffused PIN silicon, indium gallium arsenide, germanium PIN or inverted-channel silicon detectors. Each is optimized for zero-bias operation to provide the low noise, high stability and uniformity demanded by critical radiometric measurements. Compact packaging, international mounting holes and BNC-terminated cabling make incorporation into experimental, production and field applications straightforward. Please see page 133 for Specifications and Ordering Information.

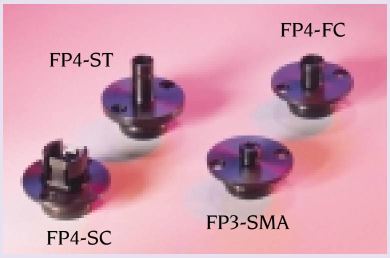
818-SL and 818-IG detectors can be mounted to our 819 Series Integrating Spheres and calibrated as a system. Please see page 139 for more information.

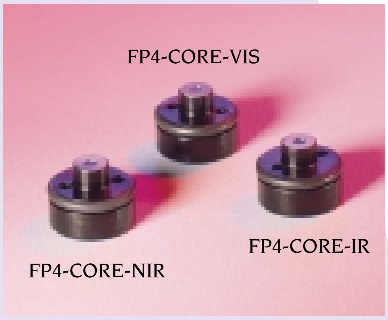
Cylindrical Detector Accessories

Fiber optic adaptors for the **818 Series Cylindrical Detectors** allow the user to perform optical power measurements when working with bare and connector terminated optical fibers.

The FP3-FH1 Bare Fiber Holder is a cleverly designed clamp that is used to hold 250 µm bare fibers without damaging the fiber. It in turn plugs into the **818-FA2 Bare Fiber Holder Mount**, which allows one to attach the assembly to the front end of Newport's Cylindrical Detector housing.

FP3/FP4 Series Connector Adaptors accommodate optical fibers terminated in the most popular fiber optic connector styles: SMA, ST, FC and SC. The redesigned adaptors have more space around the threaded input and can be attached to the **818-FA Fiber Adaptor Mount** with two screws, allowing for easier insertion and unplugging of fiber optic connectors. When working with our small area detectors (**818-IR/818-IG**), we recommend using an **FP4-CORE-IR**, described next. **FP4-CORE-VIS/NIR Adaptor Cores** do not contain collimating optics, and are suitable only for use with our large area detectors.

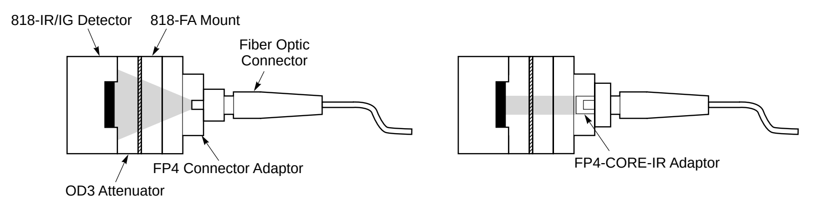




FP4-CORE-IR Series Adaptor Cores allow you to make accurate measurements from connectorized fibers regardless of input conditions by preventing detector overfill effects. The **FP4-CORE-IR** collimates the light emerging from the fiber tip to prevent detector overfill when using small area detectors (**818-IR, 818-IG**), even when the attenuator is used. Insertion loss and backreflection from the fiber tip may be reduced by applying a small amount of index matching gel to the air gap between the fiber tip and the fused silica input surface. The coating is optimized for 900–1600 nm.

Models **FP4-CORE-NIR** and **FP4-CORE-VIS** do not have the collimating optics, and are intended only for use with our large area detectors (**818-UV, 818-SL**). They do have the fused silica window, and can be used with index matching gel to obtain low backreflection and low insertion loss connections. The modularity of the **FP4 Series** allows quick interchangeability of the cores into the various **FP4 Series** connector adaptors. The FP4 cores cannot be used with the **FP3-SMA** connector adaptor.

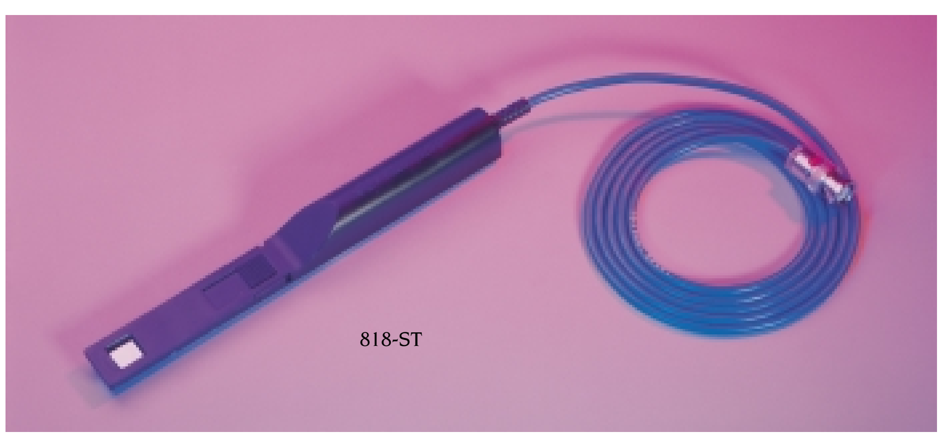
Please see page 133 for ordering information on Newport's cylindrical detector accessories.



Diverging beam overfills detector area

FP4-CORE-IR collimates beam onto small area detector, even with use of OD3 attenuator

818-ST Hand-Held Wand Detector



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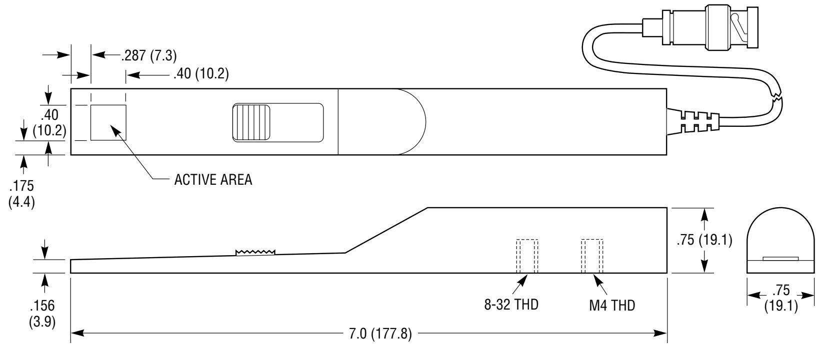
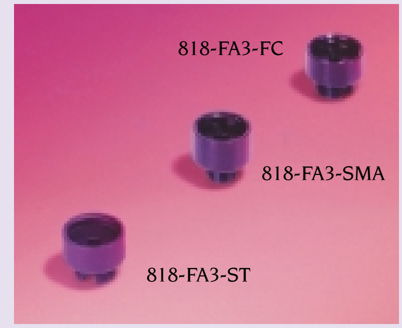




The **818-ST** Hand-Held Wand puts all the performance of the 818-SL detector into a narrow-profile, hand-held wand. It even provides a built-in OD3 attenuator at the flick of a button. BNC termination provides compatibility with Newport optical meters. The wand is compatible with both English and metric post mounts. Please see page 133 for specifications and ordering information.

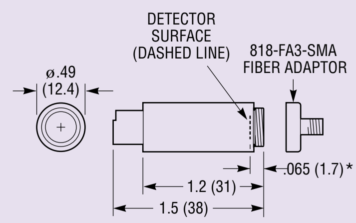
818-F Series Fiber Optic Detector Modules

818-F Series Fiber Optic Detector Modules are optimized for measurements on connectorized fiber optics. These compact detector modules allow the connection of an optical fiber directly to the meter, configuring it as a dedicated fiber optic power meter. These detector modules are only compatible with Newport meters that support the /CM detector option. They are not BNC-terminated.

Please see page 133 for specifications

Connector adaptors for the **818-F Series Fiber Optic Detector Modules** are available for five popular fiber optic connectors. An SMA adaptor comes with each fiber optic module.

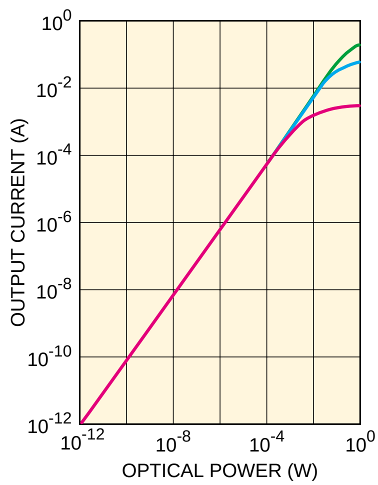
Dimensions



* This dimension is also the fiber tip-to-detector distance.

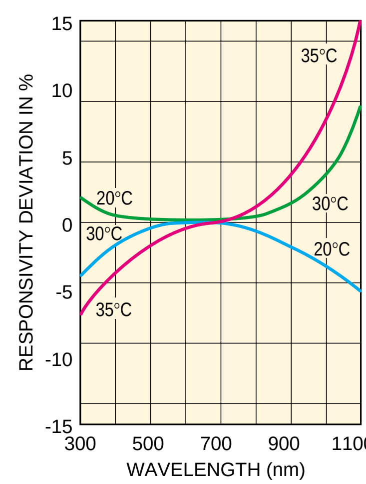
Ordering Information

Model	Description
818-F-SL	Detector Module 400–1100 nm
818-F-IR	Detector Module 780–1800 nm
818-FA3-SMA	SMA Adaptor
818-FA3-FC	FC Adaptor
818-FA3-ST	ST Adaptor

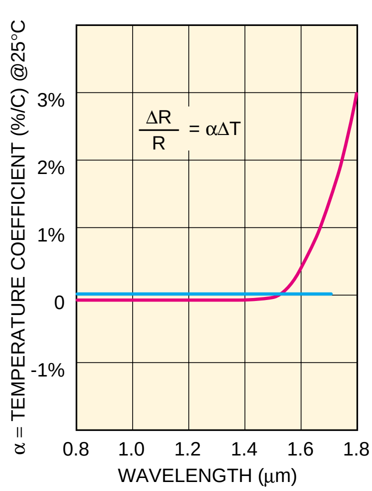


Linearity of photodiode response

818-UV
818-SL, 818-ST, 818-IS-1
818-IR, 818-IG

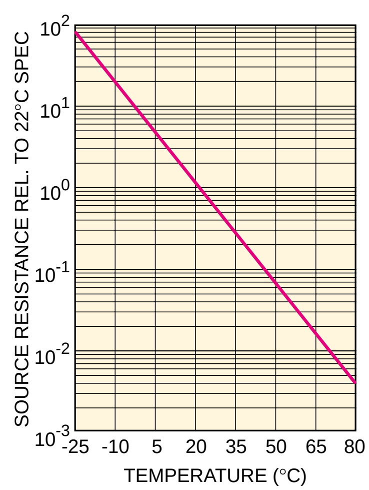


Temperature variation of response vs. wavelength for 818-UV, 818-SL, 818-ST



Temperature variation of response vs. wavelength

818-IG
818-IR



Relative shunt resistance vs. temperature

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818 Series Detector Specifications and Ordering Information

Model w/ Calib. Module	818-UV 818-UV/CM	818-SL 818-SL/CM	818-F-SL	818-ST 818-ST/CM	818-IR / 818-F-IR 818-IR/CM	818-IG 818-IG/CM
Spectral Range	0.19–1.1 µm	0.4–1.1 µm	0.4–1.1 µm	0.4–1.1 µm	0.78–1.8 µm	0.8–1.65 µm
Power, Average Max w/ Attenuator[1]	0.2 W/cm^2	2 W/cm^2		2 W/cm^2	2 W/cm^2	2 W/cm^2
Power, Average Maximum w/o Attenuator[1]	0.2 mW/cm^2	2 mW/cm^2	2 mW/cm^2	2 mW/cm^2	3 mW/cm^2	3 mW/cm^2
Pulse Energy, Maximum - w/ Attenuator[2]	0.10 µJ/cm^2	1 µJ/cm^2		0.03 µJ/cm^2	0.35 µJ/cm^2 Not Avail.[3]	0.35 µJ/cm^2
Pulse Energy, Maximum - w/o Attenuator[2]	0.1 nJ/cm^2	1 nJ/cm^2	0.03 nJ/cm^2	0.03 nJ/cm^2	0.35 nJ/cm^2	0.35 nJ/cm^2
Accuracy at constant temperature	±7% @ 0.19; ±2% @ 0.20-1.1	±2% @ 0.4-1.1	±2% @ 0.4 - 1.1	±2% @ 0.4-1.1	±3% @ 0.78-1.7; ±5% @ 1.71-1.8; ±7% w/ Attenuator[5]	±2% @ 0.8-1.65
Uniformity[4]	±2%	±2%	±2%	±2%	±2%	±2%
Linearity	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
Saturation Current	0.1 mA/cm^2	4.6 mA/cm^2	2 mA/cm^2	8 mA/cm^2	400 mA/cm^2	250 mA/cm^2
Responsivity	≥0.09 A/W 250–1000 nm	>0.1 A/W 400–1000 nm	>0.1 A/W 400–1000 nm	>0.1 A/W 400–1000 nm	≥0.2 A/W 850–1700 nm	≥0.1 A/W 800–1600 nm
Responsivity (Peak)	>0.4 A/W @ 850 ± 100 A/W	>0.5 A/W @ 920 A/W	>0.4 A/W @ 960 A/W	>0.5 A/W @ 960 A/W	>0.8 A/W @ 1550 A/W	>0.9 A/W @ 1550 A/W
Rise Time	≤2 µs	≤2 µs	≤1 µs	≤3 µs	≤2 µs	≤2 µs
Shunt Resistance	≥2 MΩ (typ)	≥2 MΩ (typ)	≥200 MΩ (typ)	≥50 MΩ (typ)	≥35 kΩ (typ)	≥20 MΩ (typ)
Die Capacitance	8,800 pF	12,000 pF	160 pF	1,100 pF	14 nF	1500 pF
Reverse Bias, Maximum	100 V	10 V	5 V	5 V	0.25 V	2 V
NEP	8.9 x 10^{-13} W/√Hz	5.5 x 10^{-13} W/√Hz	1.1 x 10^{-14} W/√Hz	1.5 x 10^{-14} W/√Hz	0.7 x 10^{-12} W/√Hz	3.0 x 10^{-14} W/√Hz
Material	Silicon	Silicon	Silicon	Silicon	Germanium	Indium Gallium Arsenide
Active Area	1 cm^2	1 cm^2	0.071 cm^2	1 cm^2	0.071 cm^2	0.071 cm^2
Active Diameter	1.13 cm	1.13 cm	0.3 cm	1x1 cm	0.3 cm	0.3 cm
Shape	Cylinder	Cylinder	Fiber Module	Wand	Cylinder[5] Fiber Module[3]	Cylinder
Attenuator, OD3	Detachable	Detachable		Built-In	Detachable[5] Not Avail.[3]	Detachable

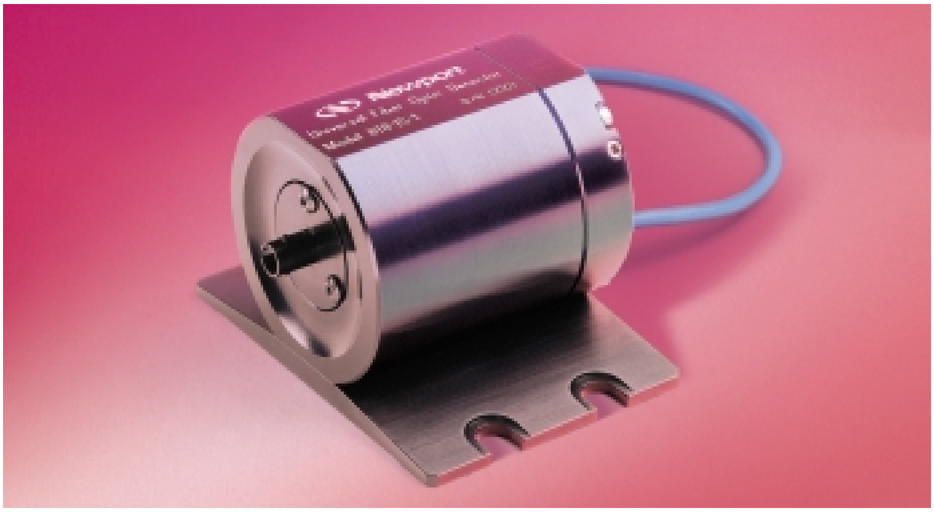
1) Applies to entire spectral response
2) 15 ns pulse width
3) Applies to 818-F-IR
4) When measured with 1.0 mm diameter beam centered within 80% of active area
5) Applies to 818-IR and 818-IR/CM

Cylindrical Detector Accessories Ordering Information

Model	Description
818-FA2	Bare Fiber Holder Mount
FP3-FH1	Bare Fiber Holder
818-FA	Fiber Adaptor Mount
FP3-SMA	Connector Adaptor
FP4-ST	ST Connector Adaptor
FP4-LC	LC Connector Adapter

Model	Description
FP4-FC	FC Connector Adaptor
FP4-SC	SC Connector Adaptor
FP4-CORE-VIS	Adaptor Core (430-700 nm)
FP4-CORE-NIR	Adaptor Core (650-1000 nm)
FP4-CORE-IR	Lensed Adaptor Core (1000-1550 nm)

Universal Fiber Optic Detector



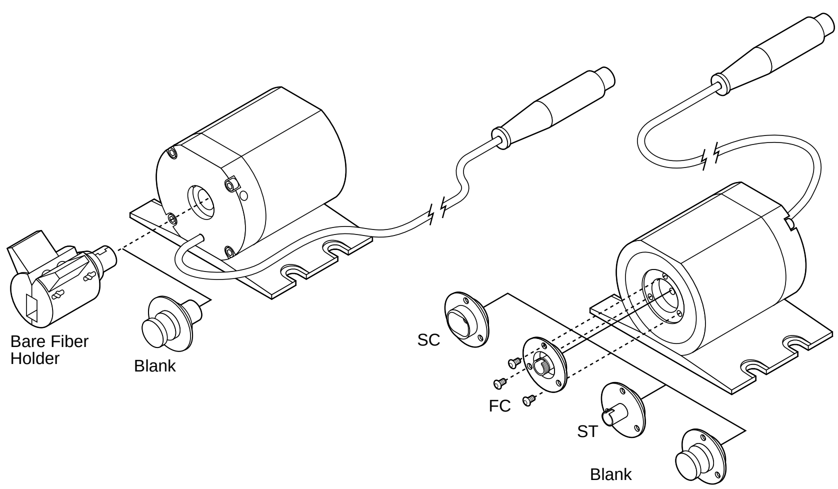
Key Features

- *Integrating sphere design enables accurate and polarization independent measurements from all fiber optic sources*
- *Continuous measurements over the entire 400–1650 nm wavelength range*
- *Optical power input up to 200 mW*
- *Accepts bare fiber and FC, ST, LC, and SC terminated fiber inputs*

The Model 818-IS-1 Universal Fiber Optic Detector uses a symmetrical integrating sphere design to ensure accurate calibration, regardless of the fiber type measured. The detector uses a novel dual detector design, with special optics that improve temperature sensitivity markedly from ordinary detectors. It can be used with Newport's power meters or with the **Model 8800/8200 OPM** power meter module.

Each detector is fully calibrated to NIST traceable standards over the wavelength range of 400–1650 nm. The calibration data is encoded in a calibration module integral to the electrical connector, which makes the 818-IS-1 compatible with all of Newport's power meters that use calibration modules.

Maximum versatility is provided by the detector's dual port design. A variety of adaptors for connector terminated fibers are provided, and plug into the detector's front port. The rear port is designed to measure light from straight and angle cleaved bare fibers, using Newport's **FP3-FH1** bare fiber holder. A complete kit of adaptors is included with each detector, together with a rugged carrying case.



Newport

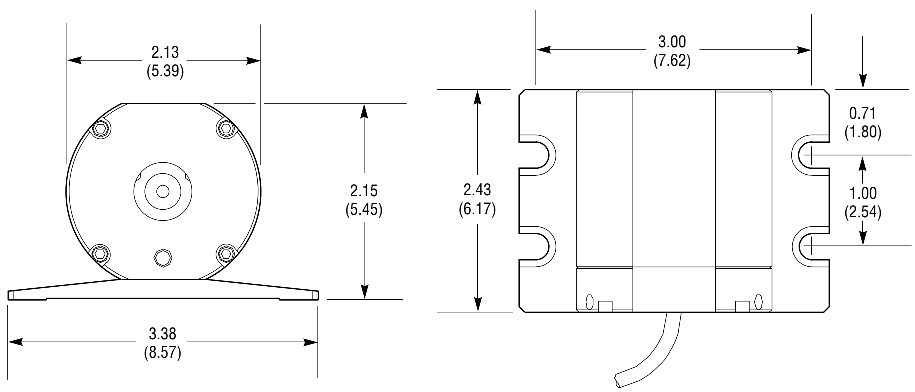
Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Specifications

Spectral Range	400–1650 µm
Saturation Power	>200 mW
Response Time, 1/e	>1 µJ (10–15 ns pulse)
Power, Average Max w/ Attenuator	0.25 W (Bare fiber), 1 W (Connectorized)(1)
Pulse Energy, Maximum - w/o Attenuator	100 µJ
Accuracy	± 2.5%
Responsivity	>0.0025 A/W (400–600 nm) >0.0075 A/W (610–1650 nm)
Rise Time	≤2 µs
Shunt Resistance	≥20 MΩ
Die Capacitance	800 pF max.
NEP @ 5 Hz and 1 A/W	3 pW/√Hz
Material	InGaAs/Si

1) Bare fiber specification is de-rated because bare fiber end is closer to sphere's first surface.

Dimensions



Ordering Information

Model	Description
818-IS-1	Universal Fiber Optic Detector

For calibrated integrated sphere based detectors for free-space light input, please see page 136.

818-IS-1 Accuracy

The specified accuracy of the 818-IS-1 equals two times the root-sum-of-square of NIST's combined standard uncertainty and Newport's calibration process standard deviation. This method results in a 95% confidence level for the accuracy specified. For more information on Newport's calibration process, see page 159.

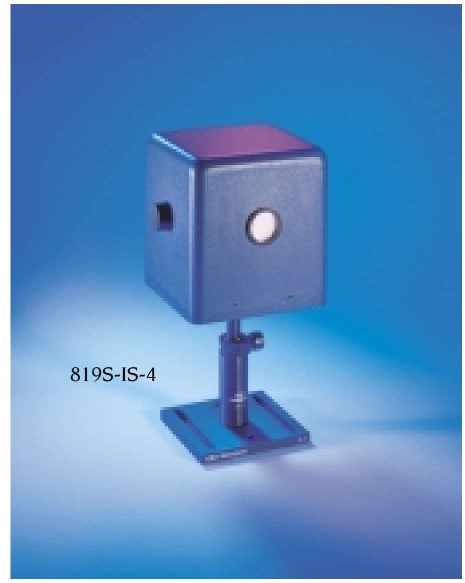
A bare fiber holder and various fiber optic connector adaptors are provided with the 818-IS-1 detector (LC adapter not shown).

Integrating Spheres

Key Features

- *Total collection of light and spatial integration. Useful for divergent and non-symmetrical beams*
- *Measurements insensitive to exact detector positioning*
- *Signal attenuation, advantageous in measurement of high-power beams*
- *High reflectance coating avoids direct damage from the first strike of the beam*
- *Thermally stable*
- *High* UV-VIS-NIR *reflectance*

For Applications and Tutorials for integrating spheres, see page 163.



819S *and* 819 *Integrating Spheres (stands sold separately)*

819S Integrating Spheres are useful for measurement of divergent light from laser diode sources. Their thin walls, only a few millimeters thick, make it possible to position the laser diode very close to the internal cavity of the sphere and thus collect 100 percent of the light emitted from the front facet of the device. A baffle, positioned between the input port and the detector port prevents the detector from directly viewing the emitting aperture of the laser or the direct area of illumination.

In an integrating sphere the detected flux is always a small fraction of the incident flux. This attenuation, caused by light reflecting many times before reaching the detector, makes the integrating sphere ideal for measurement of output light power of high-power lasers.

The 819S Integrating Sphere coating has an effective range from 300 nm to 2400 nm, with reflectivity of >97% at 600 nm. Each sphere is designed with four equally-spaced ports located on the equator of the sphere.

The unmatched environmental stability and high performance of Newport's **Model 819** Integrating Spheres are derived from their rugged monolithic thermoplastic material and are superior to coated integrating spheres. In addition, their high damage threshold surface can be cleaned with distilled water.

Hydrophobic, chemically inert and thermally stable to 350°C, Model 819 spheres can be used in demanding environments, including underwater, high or low temperature processes and high vacuum applications. At the same time, reflectance exceeding 95% from 250 to 2500 nm, 98% from 310 to 2100 nm, and 99% from 400 to 1500 nm make them ideal for even the most demanding measurements from the ultraviolet to the near infrared.

Specifications

Sphere Surface Reflectance (8° Hemispherical)

Wavelength (mm)	Reflectance (819S)	Reflectance (819)
250		0.958
300	0.963	0.980
400	0.976	0.991
500	0.979	0.990
600	0.977	0.990
700	0.973	0.991
800	0.968	0.990
900	0.967	0.992
1000	0.965	0.991
1100	0.959	0.989
1200	0.953	0.988
1300	0.948	0.987
1400	0.932	0.991
1500	0.917	0.991
1600	0.920	0.991
1700	0.922	0.988
1800	0.912	0.989
1900	0.910	0.981
2000	0.852	0.976
2100	0.858	0.953
2200	0.866	0.973
2300	0.837	0.972
2400	0.819	0.955
2500		0.950

Ordering Information

819S Integrating Spheres are available in 4 and 6 in. diameters and are fabricated from spun aluminum. 819S spheres include a baffle located between the input and detector port. The port frame at 90° position (relative to the input port) is 0.5 in. in diameter and is designed to accept a variety of detector assemblies and detector holders. Each sphere comes with a detector mask, port reducers and two port plugs.

819 Integrating Spheres are available in 2 and 4 in. inner diameters with a cube-shaped outer housing made of drawn aluminum. Each sphere comes with a detector mask, port reducers, and two port plugs. See Sphere Accessories on the next page for detector adapters, sample holders and additional sphere components.

The 2 and 4 in. diameter spheres come with a 8-32 tapped hole in the base for post mounting. The 6 in. spheres come with a 1/4-20 tapped hole.

Model	Description
819-IS-2	2 in. Integrating Sphere
819-IS-4	4 in. Integrating Sphere
819S-IS-4	4 in. Integrating Sphere
819S-IS-6	6 in. Integrating Sphere

Damage Threshold

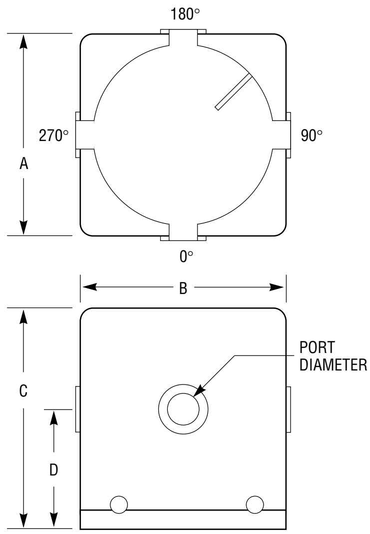
Damage to integrating spheres will typically occur on the first surface where the optical beam hits before it starts reflecting inside the sphere. A typical damage phenomenon is ellowing of the material which decreases the reflectivity, consequently compromising the calibration of the sphere.
If your source is divergent, use the diameter of the sphere as the distance the light must travel when calculating the area of the beam on the first surface. For Gaussian sources, multiply your calculated energy or power density by a factor of two to account for the higher densities in the center of the beam.

	Model 819S	Model 819
Damage Threshold	1.7 J/cm^2	8 J/cm^2

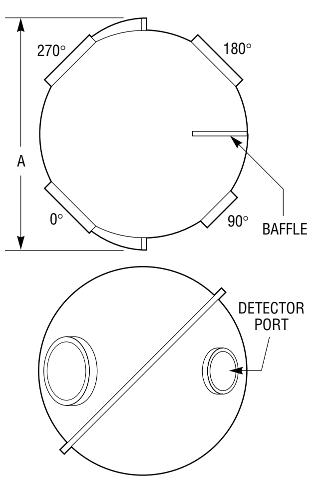
Call one of Newport's Application Sales Engineers to help you select the integrating sphere and accessories that best serve your measurement needs.

Dimensions

819



819S



	DIMENSION (IN.)			
MODEL	A	B	C	D
819-IS-2	3.00	3.00	3.38	1.88
819-IS-4	5.00	5.00	5.38	2.88
819S-IS-4	4.75			
819S-IS-6	7.25			

	PORT DIAMETERS		
MODEL	0.5 IN.	1.0 IN.	1.5 IN.
819-IS-2	4	0	0
819-IS-4	1	3	0
819S-IS-4	1	3	0
819S-IS-6	1	0	3

Integrating Sphere Optional Accessories

819-DA Detector Adaptors allow you to mount 818 Low-Power Cylindrical Detectors to a 1.0 in. (25.4 mm) port.

The 819-PC-0.5 and 819-PC-1.5 Port Converters convert 0.5 in. (12.7 mm) and 1.5 in. (38.1 mm) ports respectively into 1.0 in. (25.4 mm) ports to allow mounting of accessories.

819-PA Port Apertures reduce the clear aperture of a port. Port apertures do not alter port size or restrict the mounting of other accessories. Each set contains three different port apertures.

819-PP and 819S-PP Port Plugs seal off unused ports and are made of the same high reflectance material as the sphere.

819-SH Sample Holders are used for transmission and reflectance measurements and mount to 1.0 in. (25.4 mm) ports. The clear aperture of the 0° sample holder is 0.875 in. (22.2 mm) while the 8° sample holder has a clear diameter of 0.687 in. (17.4 mm). Each sample holder can be disassembled to facilitate the mounting of large samples.

819-LTP and 819-LTP-0.5 Light Traps mount on 1.0 in. (25.4 mm) and 0.5 in. (12.7 mm) ports respectively and deliver 99% absorptance from 250 to 2500 nm. The **819-LTSH** mounts on either 0° or 8° sample holders and delivers 98.5% absorptance from 250 to 2500 nm. The 819-LTSH is recommended when measuring the reflectance of translucent samples.

The 819-FH Filter Holder is designed to hold 2-inch-square optical filters up to 0.375 in. (9.5 mm) thick. You can use it with Newport's line of neutral-density filters and colored glass filters. The 819-FH mounts to 1.0 in. (25.4 mm) port frames.

Port Adaptors configured for SMA, ST *and* FC *terminated optical fiber are also available upon request. Call Newport's Application Sales Engineers for details.*

Optional Accessories Ordering Information

Model	Description	Compatible with 819 or 819S Sphere Model
819S-PP-1.0	Port Plug for 1.0 in. Port	819S
819S-PP-1.5	Port Plug for 1.5 in. Port	819S
819-PP-0.5	Port Plug for 0.5 in. Port	819
819-PP-1.0	Port Plug for 1.0 in. Port	819
819-PP-1.5	Port Plug for 1.5 in. Port	819
819-SH-0	0 deg. Sample Holder	819 and 819S
819-SH-8	8 deg. Sample Holder	819 and 819S
819-DA	Detector Adaptor	819 and 819S
819-PC-0.5	0.5 to 1.0 in. Port Converter	819 and 819S
819-PC-1.5	1.5 to 1.0 in. Port Converter	819 and 819S
819-LTP-0.5	Light Trap for 0.5 in. Port	819 and 819S
819-LTP	Light Trap for 1.0 in. Port	819 and 819S
819-LTSH	Light Trap for Sample	819 and 819S
819-FH	Filter Holder for 1.0 in. Port	819 and 819S
819-PA-0.5	0.5 in. Port Aperture Set	819 and 819S
819-PA-1.0	1.0 in. Port Aperture Set	819 and 819S
819-PA-1.5	1.5 in. Port Aperture Set	819 and 819S

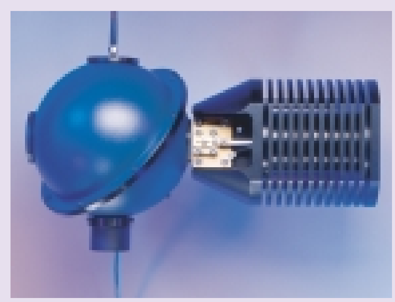
Integrating Sphere Optical Power Measurement Systems

Newport's Integrating Spheres and Low Power Detectors can be configured as a system to measure either diverging or collimated light inputs. The assembly could include either an 819 or 819S Integrating Sphere with one of the 818 Series low-power detectors, and is calibrated to NIST traceable standards containing the calibration data for the wavelength range of 400 nm to 1100 nm. To attach any of these detectors to an 819S or 819 Integrating Sphere, you need to use an 819-DA Detector Adaptor and an 819-PC-0.5 Port Converter (included with system).

This setup consisting of a combination of integrating sphere and calibrated detector is suitable for accurate, absolute value light power measurement of light sources with divergent beams. Such light sources include LEDs, laser diodes, and laser diode bars. In such applications, using the integrating sphere assembly ensures that your measurements are completely insensitive to errors caused by detector positioning or problems associated with overfilling, or saturation of the active area of the detector. This system can be used to perform optical power measurements of laser diodes operating under both CW and pulse modes. For details on how this can be accomplished please refer to the tutorial on pages see page 160 and Newport's Application Notes.

The integrating sphere shown in the photo is equipped with an optional fiber optic port (available on a semi-custom basis), enabling the simultaneous measurement of optical power and spectrum of lasers. For this purpose, the multi-mode optical fiber shown in the photo would be connected to an optical spectrum analyzer.

A 6 in. diameter 819S integrating sphere, equipped with an 818 Series detector and fiber optic connector port, shown with a Model 1835-C Optical Power Meter.



A 6 in. diameter 819S integrating sphere equipped with an 818-SL detector used for light power measurements of a CW high-power laser diode bar. The laser is mounted on Newport's 762 high-power laser diode mount.

Call Newport for price information.

Ordering Instructions

819-OPT-□□-□□-□□-□□

- 819-IS-2 02
- 819-IS-4 04

- UV 818-UV
- SL 818-SL
- IG 818-IG
- IR 818-IR

- NN BNC Connector
- CM Calibration Module

- DV Diverging Input
- CO Collimated Input

819S-OPT-□□-□□-□□-□□

- 819S-IS-4 04
- 819S-IS-6 06

- UV 818-UV
- SL 818-SL
- IG 818-IG*
- IR 818-IR*

- NN BNC Connector
- CM Calibration Module

- DV Diverging Input
- CO Collimated Input

* *Call for 6 in. availability.*

Example: 819S-OPT-04-IG-CM-DV

819S-IS-4 integrating sphere with 818-IG/CM detector, configured for diverging input beam.

Note: Optical power meter, stand and fiber optic port adaptor sold separately.

High-Power Detectors

Stands sold separately

Key Features

- *1 mW to 300 W air-cooled*
- *Fast response time*
- *Safe, low specular reflection front bezel*
- *Proprietary high-damage-threshold surface*
- *Flat spectral response from 0.19–11 µm*
- *NIST-traceable calibration included*
- *In-line calibration module option available*

Newport's 818T High-Power Detectors offer the highest quality in thermopile detectors. Utilizing an isothermal disk design, each 818T detector delivers accuracy, uniformity and rugged reliability for your CW or pulsed laser power measurements. All 818T detectors have a 1/4-20 tapped hole for post or plate mounting.

Typical applications include measurements of CW or pulsed Ion, Nd:YAG, Ti:Sapphire, CO_2, Holmium lasers, high-power laser diodes and Excimer measurements in the UV range (818T-150X).

The **818T-02 detector** features a compact, low-profile design allowing the measurement of maximum continuous power of up to 2 W in tight spaces. The detector's minimum detectable power of 1 mW makes it suitable for measuring laser diode outputs.

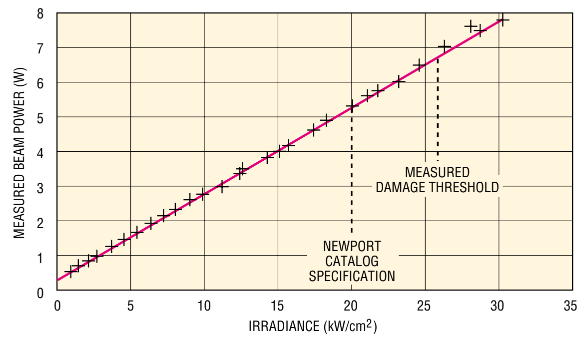
The 818T-300F fan-cooled detector bridges the gap between our air and water cooled high-power detectors. It can measure power levels of up to 300 W and requires no water cooling system. The low-noise, low-vibration fan inside the detector housing is powered via an AC/DC wall-plug adaptor, supplied with the detector.

The high-damage-threshold of the **818T Series High-Power Detectors** is 10 times more rugged than typical black thermopile probes. Exceeding the damage threshold only degrades detector performance without causing catastrophic failure.

All detectors feature a proprietary detector surface, providing a 10 kW/cm^2 CW and 0.3 J/cm^2 pulsed (0.5 J/cm^2 excimer) damage threshold. Additional details like a low specular reflectance front bezel (for protection from unwanted reflections), NIST-traceable calibration and competitive pricing establish maximum value for your dollar.

Calibrated measurements can be performed by ordering the /CM versions of these detectors for use with Newport's **1835-C and 2835-C Optical Meters**.

Calibration of optical detectors is required annually to assure NIST traceability. Newport's recalibration services are geared to provide fast turnaround to meet your tight schedule. Please refer to **Detector Calibration Services** for more details (see page 159).



Effective Beam Area: 2.69 x 10^{-4} cm^2; Effective Beam Diameter: 0.185 mm

Measurement accuracy and linearity remain well past the damage threshold.

Specifications

Model w/Calibration Module	818T-02 818T-02/CM	818T-10 818T-10/CM	818T-30 818T-30/CM	818T-150 818T-150/CM	818T-150X 818T-150X/CM	818T-300 818T-300/CM	818T-300F(5) 818T-300F/CM
Spectral Range	0.25 to 11 µm	0.25 to 11 µm	0.25 to 11 µm	0.25 to 11 µm	0.19 - 0.35 µm	0.25 to 11 µm	0.25 to 11 µm
Power, Maximum, Continuous	2 W	1 mW	30 W	150 W	150 W	300 W	300 W
Power, Maximum, Intermittent (1)	3 W/cm^2	20 W/cm^2	60 W/cm^2	300 W/cm^2	300 W/cm^2	450 W/cm^2	600 W/cm^2
Power Density, Maximum Average	26 kW/cm^2	26 kW/cm^2	26 kW/cm^2	26 kW/cm^2	26 kW/cm^2	26 kW/cm^2	20 kW/cm^2
Minimum Detectable Power	1 mW	1 mW	10 mW	10 mW	10 mW	100 mW	30 mW
Pulse Energy Density, Maximum (2)	0.6 J/cm^2	0.5 J/cm^2	0.5 J/cm^2	0.5 J/cm^2	0.5 J/cm^2	0.5 J/cm^2	0.6 J/cm^2
Response Time, 1/e	1 s	1 s	1 s	1 s	4 s	1 s	2 s
Linearity with Power	±1%	±1%	±1%	±1%	±1%	±2%	±2%
Power Measurement Accuracy (3) (% of reading)	±3 %	±3 %	±3 %	±3 %	±5 %	±5 %	±3 %
Uniformity over central 50%(4)	±2%	±2%	±2%	±2%	±2%	±2%	±2%
Uniformity of entire active area	±2%	±2%	±2%	±2%	±2%	±2%	±2%
Active Area	2.84 cm^2	2.84 cm^2	2.84 cm^2	2.84 cm^2	19.6 cm^2	2.84 cm^2	2.84 cm^2
Active Diameter	19 cm	19 cm	19 cm	19 cm	50 cm	19 cm	19 cm
Responsivity, approximate	1.0 mV/W	1.0 mV/W	0.4 mV/W	0.4 mV/W	0.4 mV/W	0.4 mV/W	0.4 mV/W
Shape	Rectangular	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Rectangular
Cooling	Air	Air	Air	Air	Air	Water	Air

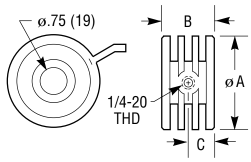
1) Intermittent power assumes low duty cycle use not to exceed 5 minutes
2) Pulse energy density determined using a 50 ns pulse
3) NIST-traceable calibration assumes 5 mm beam centered on thermal disc
4) Assumes a 5 mm diameter beam
5) Fan power: 12VDC/500 mA (wall-plug adaptor is provided)

Ordering Information

Model	with Calibration Module
818T-02	818T-02/CM
818T-10	818T-10/CM
818T-30	818T-30/CM
818T-150	818T-150/CM
818T-150X	818T-150X/CM
818T-300	818T-300/CM
818T-300F	818T-300F/CM

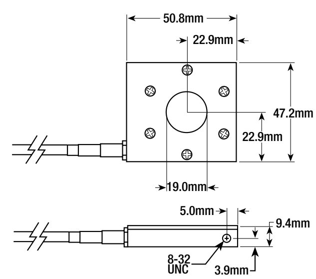
Dimensions

818T-10, 818T-30

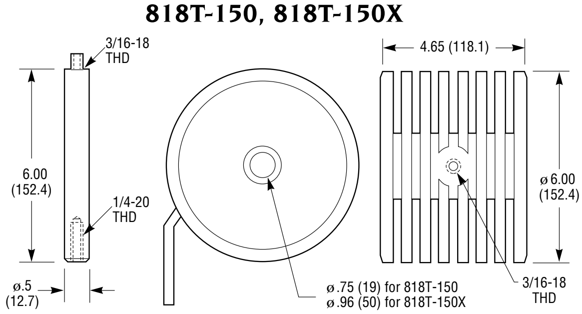


DIAMETER		DIMENSION	
MODEL	A	B	C
818T-10	2.480	1.420	.52
	(63.0)	(36.0)	(13.2)
818T-30	3.980	2.195	1.098
	(101.1)	(55.8)	(27.9)

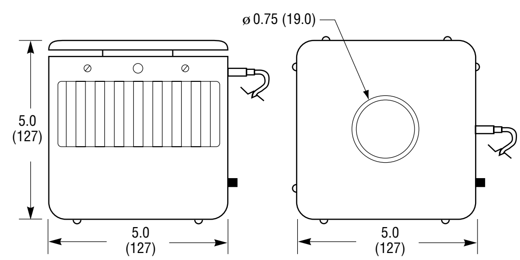
818T-02



818T-150, 818T-150X



818T-300F



Energy Detectors

Precise measurements of pulsed laser energy can be accomplished with Newport's **818J Series Energy Detectors**, which utilize crystalline pyroelectrics. Each detector includes NIST-traceable calibration and is packaged in an EMI-shielded cylindrical housing that mounts directly to our English posts.

Calibrated measurements can be performed by ordering the /CM versions of these detectors for use with Newport's **1835-C and 2835-C Optical Meters**.

The **818J-08B detector** features a compact, low-profile design, thus allowing energy measurements in very tight spaces. This detector can be used on its back or mounted on a post, for either vertical laser setups or horizontal laser beams.

A patented crystal material is utilized in Newport's large-area energy detectors, delivering higher repetition rates and better spatial uniformity than detectors built with conventional pyroelectric materials, while it is less sensitive to microphonic noise and temperature.

Large expanded beams can be accommodated with detector diameters of 25 and 50 mm. Black-organic coated **818J-25B and 818J-50B detectors** are suitable for most applications. This coating flattens spectral response from UV to deep IR and eliminates beam retro-reflection, while providing more damage resistant operation, but repetition rates are limited to 50 and 100 pps respectively. Uncoated **818J-25 and 818J-50 detectors** have a thin-film metal-oxide coating and are suitable for repetition rates up to 400 pps.

Superior low-noise performance can be accomplished with two battery-powered models using a pre-amplifier. Both models, the 818J-09 and 818J-09B (black-organic coated), are ideal with pulsed flashlamps, diode-pumped Nd:YAG lasers and tunable dye lasers. These 9 mm diameter pyroelectric detectors offer broad spectral response from 0.19 micron to 20 microns and repetition rates to 4,000 pps (200 pps for the 818J-09B). A three-position switch on the 818J-09 allows selection of integration time constant and voltage output for greater versatility.

Uncoated energy detectors can be damaged permanently if the damage threshold is exceeded. Energy detectors with a black-organic coating are more resistant to damage and may be re-coated if damage occurs. Repeated damage causes the black-organic coating to deteriorate gradually, although accuracy is not immediately affected. For best performance, detectors with black-organic coatings should be re-coated periodically.

Key Features

- *Measurement range in joules*
- *Broad* UV-VIS-IR *spectral response*
- *High repetition rates*
- *Low-profile detector enables measurements in tight spaces*
- NIST-*traceable calibration*

818J-08B
Stands sold separately

Specifications

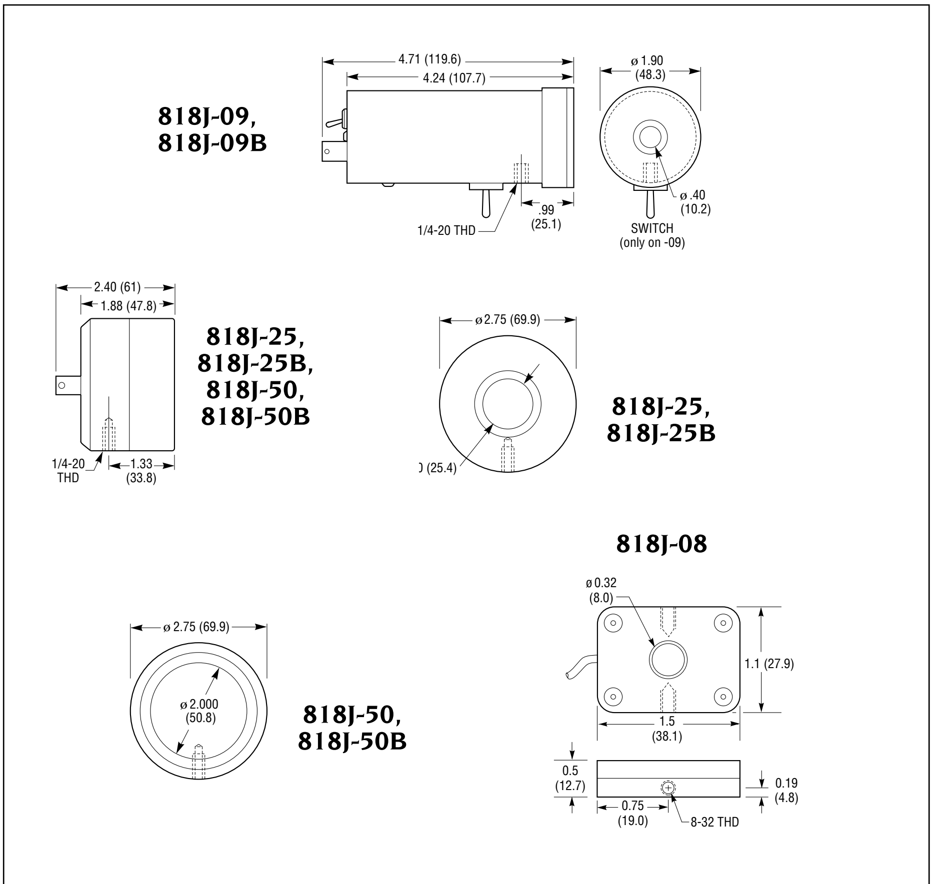
Model w/ Calibration Module	Time Constant[1]	818J-08B 818J-08B/CM	818J-09 818J-09/CM	818J-09B 818J-09B/CM	818J-25 818J-25/CM	818J-25B 818J-25B/CM	818J-50 818J-50/CM	818J-50B 818J-50B/CM
Spectral Range		0.19–20.0 µm	0.19–20.0 µm	0.19–20.0 µm	0.19–20.0 µm	0.19–20.0 µm	0.19–20.0 µm	0.19–20.0 µm
Maximum Energy[2]	S,I	25 mJ	2 mJ	2 mJ	253 mJ	253 mJ	1.01 J	1.01 J
	L		20 mJ					
Maximum Average Power		1 W	2 W	2 W	10 W	10 W	20 W	20 W
Accuracy		±5%	±7% <0.3 µm; ±5% 0.3< <4.5 µm; ±7% >4.5	±5%	±7%<0.3 µm; ±5%≥0.3	±5%	±5%	±5%
Responsivity	S,I	0.4 V/mJ	1 V/mJ	1.5 V/mJ	8 V/J	8 V/J	2 V/J	2 V/J
	L		0.01 V/mJ					
Pulse Damage Threshold[2]	S,I				50 mJ/cm²			
	L		50 mJ/cm²					
Maximum Pulse Repetition Rate	S	200 pps	4000 pps	200 pps	400 pps	100 pps	400 pps	100 pps
	I		400 pps					
	L		80 pps					
Maximum Pulse Width	S		5 µs					
	I	50 µs	50 µs	100 µs	45 µs	200 µs	45 µs	400 µs
	L		250 µs					
Noise Equivalent Energy	S		35 nJ					
	I	—[3]	35 nJ	35 nJ	—[3]	—[3]	—[3]	—[3]
	L		3500 nJ					
Linearity		0.2%	0.2%	0.2%	1%	1%	1%	1%
Rise Time		100 µs	300 ns	300 µs	300 ns	300 µs	300 ns	300 µs
Material		LiTa	LiTa	LiTa	LiTa	LiTa	LiTa	LiTa
Surface Coating		Black–Organic	Metal–Oxide	Black–Organic	Metal–Oxide	Black–Organic	Metal–Oxide	Black–Organic
Active Area		0.5 cm²	0.636 cm²	0.636 cm²	5.07 cm²	5.07 cm²	20.3 cm²	20.3 cm²
Active Diameter		8 cm	9 mm	9 mm	25.4 mm	25.4 mm	50.8 cm	50.8 cm

1) Integration Time Constant setting on 818J-09: Short, Intermediate, Long
2) 15 ns pulse width
3) Noise equivalent energy will depend on amplifying electronics connected to the detector

Ordering Information

Model	with Calibration Module
818J-08B	818J-08B/CM
818J-09	818J-09/CM
818J-09B	818J-09B/CM
818J-25	818J-25/CM
818J-25B	818J-25B/CM
818J-50	818J-50/CM
818J-50B	818J-50B/CM

Dimensions

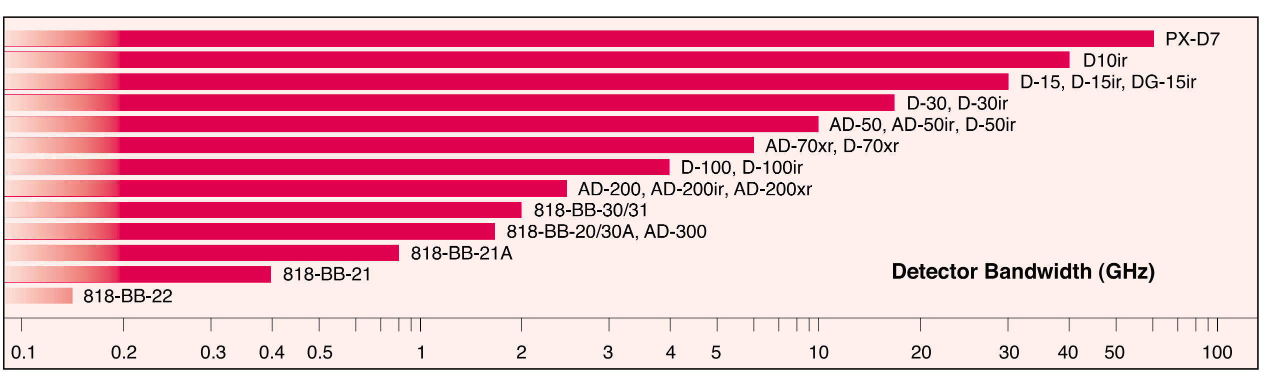


Selection Guide

For ease of selection, Newport's high-speed detectors are divided into two main categories: General Research and Communications. Within each major category are both unamplified and amplified models for high sensitivity applications. The following selection guide and performance chart provide a quick and easy way to locate the detector most suitable for your specific applications. Please review the appropriate catalog pages for more detail, or call Newport's Application Sales Engineers for further assistance.

General Research					Communications				
Model	Spectral Response (nm)	Impulse Response, Maximum (ps)	Voltage Bandwidth, -3 dB Typical[1] (GHz)	Conversion Gain, (into 50Ω) @ 1310 nm [2] (V/W)	Model	Spectral Response (nm)	Impulse Response, Maximum (ps)	Voltage Bandwidth, -3 dB Typical[1] (GHz)	Conversion Gain (into 50Ω)[2] (V/W)
Unamplified									
PX-D7	400–900	7	60	1.7					
					D-10ir	950–1650	10	40	15
D-15	400–1700	15	29	10	D-15ir[3]	950–1650	15	29	30
D-30	400–1700	30	15	10	DG-15ir[4]	950–1650		29	15
					D-30ir[3]	950–1650	30	15	40
					D-50ir[3]	950–1650	50	10	45
D-100	400–1700	100	4	10	DG-70xr[3]	700–1650	70	6	40
					D-100ir[3]	950–1650	100	4	45
818-BB-30/31	1.0–1.6 µm		2						
818-BB-20	0.3–1.1 µm		1.5						
818-BB-21	0.3–1.1 µm		0.4						
818-BB-22	0.2–1.1 µm		0.15						
Amplified									
AD-50	400–1700	50	10	100	AD-50ir	950–1650	50	10	425
					AD-70xr	700–1650	70	6	340
AD-200	400–1700	200	2.5	200	AD-200ir	950–1650	200	2.5	800
					AD-200xr	700–1650	200	2.5	700
AD-300	400–1700	300	1.5	200					
818-BB-30A	1.0–1.6 µm		1.5	400					
818-BB-21A	0.36–1.1 µm		0.8	500					

1) -3 dB voltage, optical
2) C.G. = Conversion Gain into 50 Ω @ 1310 nm
3) These models also available with optional 50 Ω termination
4) DG-15ir is a frequency-domain detector with 50 Ω termination



Detector Bandwidth (GHz)

High-Speed Detectors

Newport offers a complete line of high-speed detectors, useful in fiber optic telecommunications and in general research and development applications.

The detectors offered include the fastest detectors in their application category, such as the:

- **PX-D7:** fastest visible detector available—7 ps, 60 GHz
- **D-10ir:** fastest 1310/1550 nm detector available—10 ps, 40 GHz
- **AD-70xr:** fastest 780-1550 nm, 62.5 µm input, amplified detector available—70ps, 6 GHz

These high-speed detectors, designed and built for Newport exclusively by Picometrix®, Inc., find a wide variety of uses in the test and measurement of fast optical signals. From the **18 models available,** almost every customer's need can now be addressed.

Both amplified and unamplified models are available in compact, rugged, instrument-style cases. Each unit houses a sealed, fiber-coupled detector module together with internally regulated power, high gain current monitor, power indicating LEDs and a convenient, top-mounted power switch. Unamplified models offer internal battery power for the utmost ease of use, and all models come with the choice of either ST or FC fiber optic input connectors, to be specified at time of order.

These detectors are specifically designed to fulfill the variety of photonics testing and measurement applications including digital telecom and data communications, analog microwave communications, as well as general high-speed research from 300 ps temporal resolution (1.5 GHz) to 7 ps (60 GHz). General research detectors, for broad measurement interests are available, as well as a full range of products optimized for communications applications.

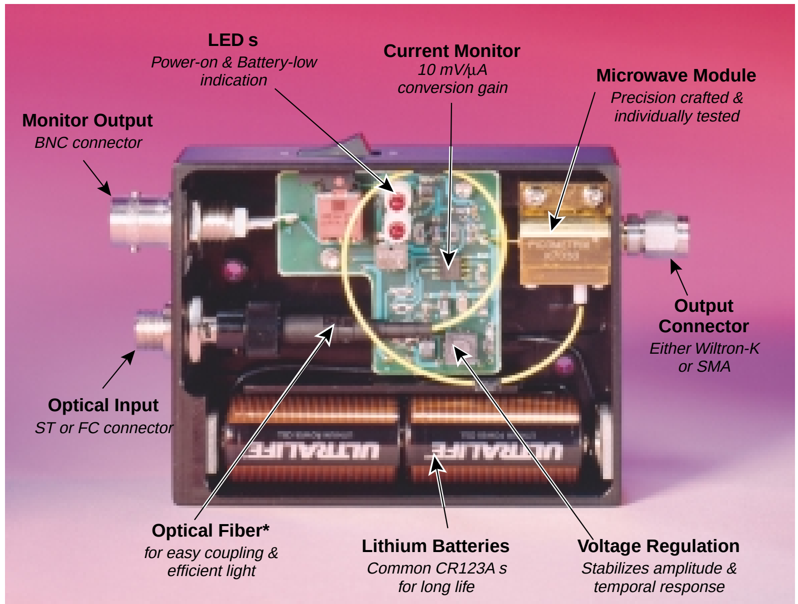
These products can also be used for free-space applications by simply using the open end of a fiber optic patch cord as the point of light collection. 50 µm and 62.5 µm core fibers offer collection numerical apertures of 0.2 and 0.3 in a very flexible, compact form that can easily be positioned inside virtually any experimental setup.

The complete line of D and AD Series high-speed detectors were developed for Newport by Picometrix®, Inc., Ann Arbor, Michigan. Picometrix is dedicated to the development and manufacture of state-of-the art picosecond optoelectronic devices and instrumentation. Clean-pulse™ technology is a trademark of Picometrix.

Time-domain or Frequency-domain?

Time-domain products employ Clean-pulse™ technology which assures exceedingly clean pulse responses with minimal ringing or tails. This is highly desirable for all diagnostic applications, especially digital communications, where an exact temporal replica of the signal under study is required. All of our products (except the DG-15ir) are designed for time-domain applications.

Frequency-domain products (DG-15ir) are typically well-suited for analog, microwave applications where a flat-frequency response is more desirable than a clean-temporal pulse. Microwave applications typically benefit from this type of frequency response, because the responsivity of the detector essentially remains constant over the entire usable frequency band. As a result of this frequency response shape, the pulse or time-domain performance is compromised resulting in a pulse that rings slightly (see plots and Tutorial).



* 9 µm, 50 µm and 62.5 µm optical fibers are used—see specifications table.

Detector Construction

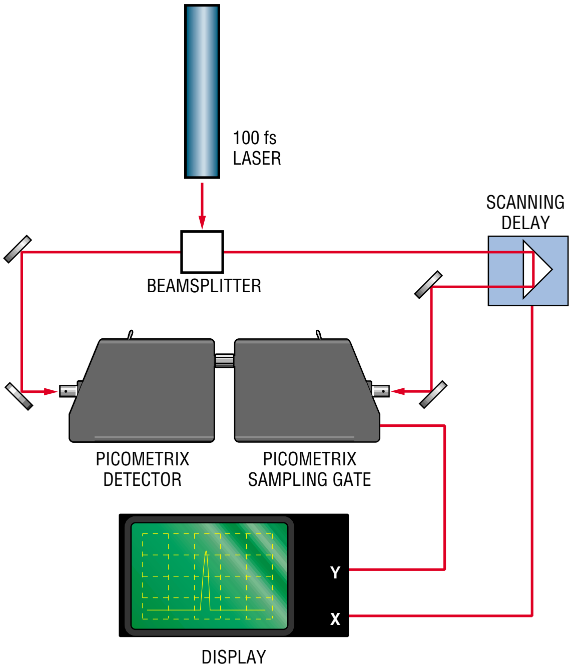
Newport's high-speed detectors come in rugged, self-contained, instrument-style cases that can be directly connected to a measurement instrument for high-speed performance or mounted in almost any convenient location.

Unamplified models (D-Series) come with internal battery power (long-life lithium) for greatest flexibility. Amplified models utilize an external wall-mounted power supply (included) that simply plugs into the side of the case.

In all models, a precision, gold-plated microwave module houses the detector element. The module is directly anchored to the exterior housing, and is rigidly integrated with the fiber input and the output connector. The sealed and shielded module is then packaged in a black-anodized housing that contains all the required power conditioning and current monitor circuitry.

Each unit contains internal voltage regulation and a battery monitor (D Series) that lights an LED when batteries need replacement. The current monitor circuit provides a voltage output that is linear with the average photocurrent produced by the detector element, and has a transimpedance gain of 10 mV/µA. This feature allows the user to monitor exactly how much light is impinging on the detector element by simply connecting it to a standard voltmeter. The PX-D7 case has all the same internal features as the D-Series case, but comes in a slightly smaller design.

All models are internally fiber-coupled with a choice of either FC or ST external fiber connector (specify at time of order). A front panel BNC connector (PX-D7 has a Lemo connector) provides the current monitor output and a top-mounted switch provides easy on/off operation.



Detector Testing

All detector models are individually tested using state-of-the-art time-domain sampling techniques using subpicosecond optical pulses as the input. Those individual test results are then included in the manual with every product.

Because the optical input pulse is always much shorter than the response time of the detector, the output pulse is actually the true impulse response of the detector. Frequency domain information is obtained by performing a Fast Fourier Transform (FFT) of the impulse response and then deconvolving, if necessary, the response of the sampling system.

The PX-D7 is faster than any commercial sampling system, so alternate methods must be used to obtain its true impulse response. Picometrix has developed a proprietary, laser-based sampling technique that achieves a temporal resolution of 4 ps. This technique, coupled with FFT techniques allows even the fastest of detectors to be fully tested with excellent accuracy.

Termination k Ω or 50 Ω?

All unamplified (D-Series) products (except DG-15ir) normally come internally terminated at the output with a 1 kΩ resistor. This provides the highest conversion gain when attached to a 50 Ω measuring instrument, such as an oscilloscope or a spectrum analyzer, because virtually all of the detector's output current is delivered to the 50 Ω load. In many cases a 1 kΩ termination also enables the cleanest pulse response.

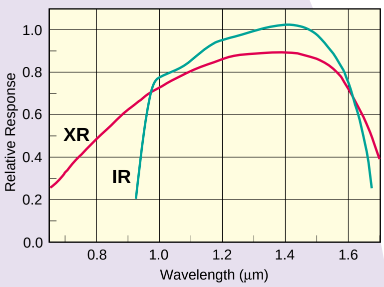
However, there are measurement situations where reflections between the detector and its load need to be minimized. This is especially true in analog, microwave applications, or where very long time-domain signals need to be accurately measured. In these cases, a 50 Ω termination is preferred, in spite of the fact that only half of the output current is made available to the load, thus reducing the conversion gain by 50%.

All of the unamplified communications detectors are available with a 50 Ω termination option. This option must be requested at time of order.

Note that the 50 Ω termination does affect the pulse and bandwidth performance of the detector by shortening the pulse duration and increasing the bandwidth to some degree. Contact Newport's Application Sales Engineers for specific details.

Communications Detectors

Communications Detector Spectral Response



Key Features

Unamplified

- *Models from 100 ps (4 GHz) to 10 ps (40 GHz)*
- *950–1650 nm and 700–1650 nm versions*
- *DG-15ir for frequency domain applications to 20 GHz*
- *Optimized for maximum responsivity*
- *Self-contained, battery operated units*

Amplified

- *Models from 200 ps (2.5 GHz) to 50 ps (10 GHz)*
- *950–650 nm and 700–1650 nm versions*
- *AD-70xr fastest 780/850 nm, 62.5 µm input detector available*
- *Integrated transimpedance amplifiers provide high conversion gains of up to 800 V/W*
- *Built-in current monitor*

Communications detectors are designed to meet the rigorous standards of the telecom and data communications industry. The product line is targeted to the needs of communication systems developers both at bit-rate speeds as well as diagnostic speeds. As such they have optimized performance in narrower wavelength bands. Two different wavelength ranges are available, denoted by the suffixes **-ir** and **-xr**. The "**-ir**" versions are optimized for the longer telecom wavelengths in the 950–1650 nm range, while the "**-xr**" series offers an extended range of 700–1650 nm, for both telecom and datacom wavelengths. The DG-15ir is a frequency domain product for analog, microwave applications that has a flat power bandwidth up to 20 GHz.

All communication detectors are based on proprietary, high-performance PIN photodiode structures that yield maximum speed and sensitivity for each model. In addition, these products have other features such as fiber diameter, optical return loss and risetimes that meet or exceed the specifications set by commercial communications standards for telecom and datacom.

Unamplified D-Series detectors are available with either a 1 kΩ internal termination for maximum conversion gain (standard), or an optional 50 **Ω** termination for low reflection (VSWR) applications.

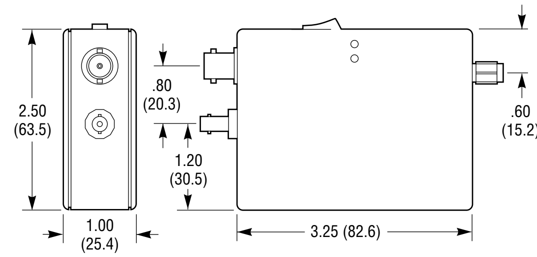
Amplified AD-Series detectors offer high conversion gain with 10 GHz and 2.5 GHz bandwidths respectively, which enable them to be used for testing OC-192 and OC-48 speed systems at the receiving end of the link.

The DG-15ir detector is specifically designed to be an analog, frequency-domain detector for communications and other long-wavelength (950–1650 nm) applications where a flat frequency response (±1 dB) from DC to 20 GHz is required. This unit is also battery powered and is fully self-contained.

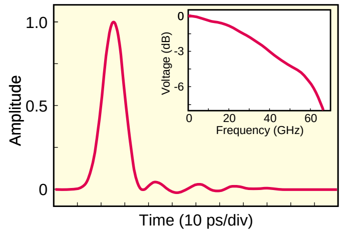
Microwave applications typically benefit from this type of frequency response, where the responsivity of the detector must remain constant over the entire usable 20 GHz band. As a result of this frequency response shape, the pulse or time-domain performance is compromised resulting in a pulse that rings slightly (see plots and application note).

As with all the D-Series communications detectors, the detector element is optimized for maximum responsivity and the optical return loss is better than 30 dB with a single-mode fiber input. Output termination is fixed at 50 **Ω** for low reflection (VSWR) performance.

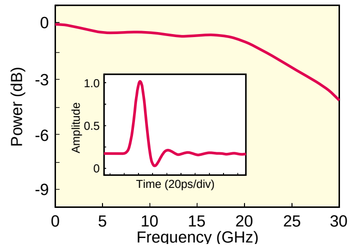
Dimensions



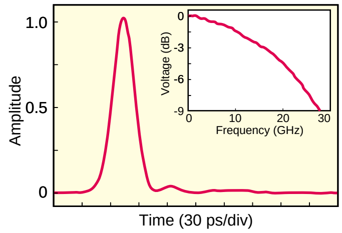
Detector Impulse Response



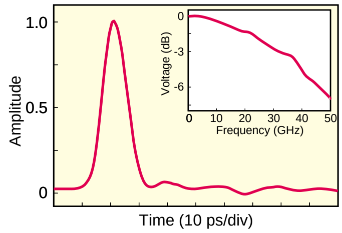
Time and frequency plots for the D-10ir



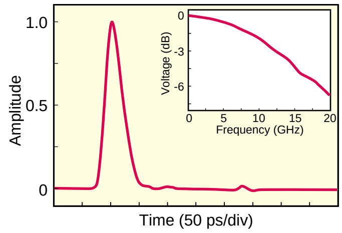
Time and frequency plots for the DG-15ir



Time and frequency plots for the D-30ir



Time and frequency plots for the D-15ir



Time and frequency plots for the D-50ir

Communications Applications Product Selector

This grid is designed to assist the digital communications user in selecting the correct product based on their actual communication system application.

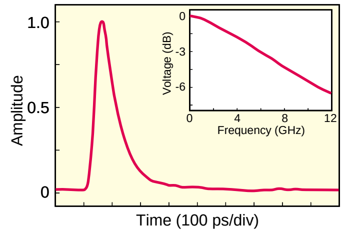
Both "**receive**" applications as well as "**diagnostic**" applications are addressed. "**Receive**" products have adequate bandwidth for data stream reception only. "**Diagnostics**" products have bandwidth two to three times the bit rate for investigating faster features in the optical waveform.

Communications products fall in two wavelength categories indicated by the model number suffixes, "**ir**" and "**xr**". "**ir**" products are designed for the 950–1650 nm range and are optimized for telecom wavelengths of 1310 and 1550 nm. "**xr**" products have extended range towards shorter wavelengths with good sensitivity down to 700 nm, and therefore include the major datacom wavelengths of 780 and 850 nm.

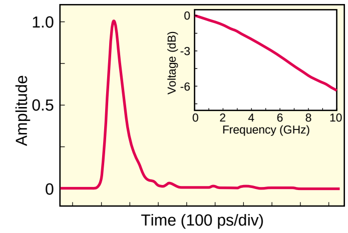
Note: None of these product are reference receivers.

Note

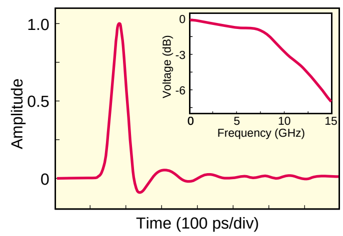
All unamplified communications detectors are available with a 50 Ω termination option, upon request. The 50 Ω termination affects the pulse and bandwidth performance of the detector by shortening the pulse duration and increasing the bandwidth to some degree. Please contact Newport's Application Sales Engineers for more information.



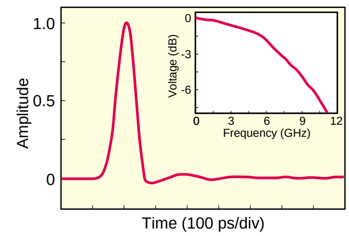
Time and frequency plots for the D-70xr



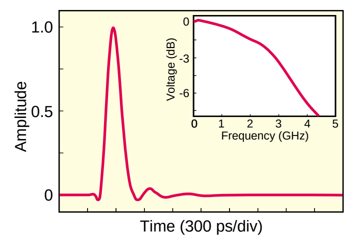
Time and frequency plots for the D-100ir



Time and frequency plots for the AD-50ir



Time and frequency plots for the AD-70xr



Time and frequency plots for the AD-200ir and AD-200xr

Specifications

Communications, Unamplified

Model	D-10ir	D-15ir	DG-15ir	D-30ir	D-50ir	D-70xr	D-100ir
Spectral Response	950–1650 nm	950–1650 nm	950–1650 nm	950–1650 nm	950–1650 nm	700–1650 nm	950–1650 nm
Impulse Response, Maximum[1]	10 ps	15 ps	Freq. Domain	30 ps	50 ps	70 ps	100 ps
Rise Time typ. (10-90%)	10 ps	15 ps	13 ps	30 ps	45 ps	90 ps	100 ps
Voltage Bandwidth, -3 dB Typical[2]	40 GHz	29 GHz	29 GHz	15 GHz	10 GHz	6 GHz	4 GHz
Power Bandwidth, -3 dB Typical[3]	28 GHz	21 GHz	20GHz (-1 dB)	11 GHz	7.5 GHz	4.5 GHz	3.5 GHz
Responsivity, Minimum @ 1310 nm	0.3 A/W	0.6 A/W	0.6 A/W	0.8 A/W	0.9 A/W	0.8 A/W	0.9 A/W
Conversion Gain (into 50Ω)	15 V/W	30 V/W	15 V/W	40 V/W	45 V/W	40 V/W	45 V/W
Dark Current, Maximum (at 25°C)	20 nA	20 nA	20 nA	20 nA	20 nA	20 nA	20 nA
NEP, Maximum[4]	60 pW/√Hz	30 pW/√Hz	30 pW/√Hz	23 pW/√Hz	20 pW/√Hz	23 pW/√Hz	23 pW/√Hz
Maximum Average Power	1 mW	1 mW	1 mW	1 mW	1 mW	1 mW	1 mW
Input Fiber Diameter	9 dB	9 dB	9 dB	9 dB	9 dB	62.5 dB	62.5 dB
Optical Return Loss, Maximum	-30 dB	-30 dB	-30 dB	-30 dB	-30 dB	-14 dB	-14 dB
Ouput Termination, Nominal	1 kΩ	1 kΩ	50 kΩ	1 kΩ	1 kΩ	1 kΩ	1 kΩ
Output Connector	Wiltron-K	Wiltron-K	Wiltron-K	Wiltron-K	Wiltron-K	Wiltron-K	Wiltron-K

Communications, Amplified

Model	AD-50ir*	AD-70xr*	AD-200ir	AD-200xr
Spectral Response	950–1650 nm	700–1650 nm	950–1650 nm	700–1650 nm
Impulse Response, Maximum(1)	50 ps	70 ps	200 ps	200 ps
Rise Time typ. (10-90%)	45 ps	70 ps	200 ps	200 ps
Voltage Bandwidth, -3 dB Typical(2)	10 GHz	6 GHz	2.5 GHz	2.5 GHz
Power Bandwidth, -3 dB Typical(3)	7.5 GHz	4.5 GHz	1.8 GHz	1.8 GHz
Conversion Gain, Minimum (into 50Ω) @ 1310 nm	425 V/W	340 V/W	800 V/W	700 V/W
Sensitivity @ BER = 10^{-9}	-18 dBm	-18 dBm	-22 dBm	-22 dBm
NEP, Maximum(4)	25 pW/√Hz	25 pW/√Hz	15 pW/√Hz	15 pW/√Hz
Maximum Average Power	0.3 mW	0.3 mW	0.7 mW	0.7 mW
Input Fiber Diameter	9 dB	62.5 dB	9 dB	62.5 dB
Optical Return Loss, Maximum	-30 dB	-14 dB	-30 dB	-14 dB
Ouput Impedance, Nominal	50 Ω	50 Ω	50 Ω	50 Ω
Output Connector	SMA	SMA	SMA	SMA

1) Full duration at half-max
2) Often termed “optical” bandwidth
3) Often termed electrical bandwidth
4) Limited by thermal noise of external 50 Ω load resistor
5) 50 Ω termination availble as special order

For 220V version append /220 to part number of the AD detectors.
*AC-coupled, cannot detect signals that vary less than 10 kHz.

For definition of specifications, please see the Tutorial Section, page 160.

Ordering Information

Model	Description
Unamplified	
D-10ir	Communications Detector
D-15ir	Communications Detector
D-30ir	Communications Detector
D-50ir	Communications Detector
D-70xr	Communications Detector
D-100ir	Communications Detector
Amplified	
AD-50ir	Communications Detector
AD-70xr	Communications Detector
AD-200ir	Communications Detector
AD-200xr	Communications Detector

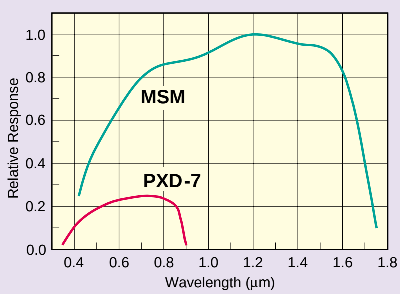
Select detector of choice from specification table and add the -ST or -FC suffix to complete the Model number for ST or FC connector input option, respectively.

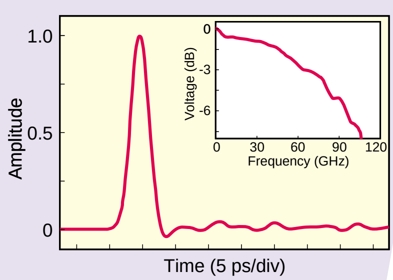
Examples:

D-15ir-ST—15 ps detector with ST connector input.

D-30xr-FC—30 ps detector with FC connector input.

General Research Detectors





Time and frequency plots for the PX-D7

General Research detectors are based on interdigitated MSM type photodiode detector structures that enable use in the widest variety of applications. They have exceptionally broad wavelength sensitivity from 400–1700 nm (except the PX-D7) and large (at least 50 micron), multimode fiber optic inputs.

The MSM detector design is unique in that it can achieve very high-speed (up to 60 GHz or 7 ps) with a large 50 µm active area. As a result, the 50 µm optical input fiber makes these products much easier to use than comparable single-mode products. A 50 µm fiber can provide up to 100 times more light gathering capacity than single-mode fibers in certain measurement situations. The multimode fiber also effectively reduces back reflections into single-mode systems because of the large difference in core areas. Detectors with either ST or FC input connector styles are offered. These features, coupled with the full spectral sensitivity of 400–1700 nm make these products a great value for general high-speed research.

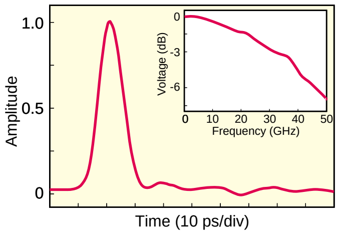
The Amplified AD-Series General Research detectors offer the same broad spectral range and large input fibers as their unamplified counterparts, and also include a transimpedance amplification stage that boosts their conversion gain to at least 200 V/W. To effectively minimize parasitics and to shield the amplifier components from outside noise sources, both the detection element and the amplifier are integrated on a common substrate contained in the microwave module.

Newport's fastest photodetector, the PX-D7, offers 7 picosecond response time (FDHM) from 400–900 nm and is the world's fastest commercially available photodetector with a frequency response from DC to 60 GHz. This unique photoconductive detector represents a unique class of detector that offers ultrafast speed and 50 µm core diameter fiber optic input that makes it remarkably easy to use.

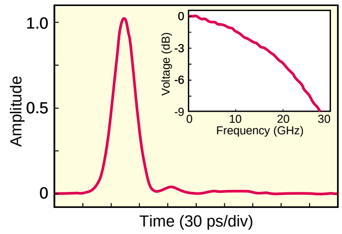
Over 100 times more light gathering capacity than single mode fibers used in many measurement situations is offered by the detector's 50 µm core, multimode, graded-index fiber.

High-performance is achieved by using the latest advances in photo detector design and fabrication. The photoconductive detector element itself is an interdigitated structure fabricated on a GaAs:As epilayer which produces a detector whose speed is intrinsic to the semiconducting material, and offers low dark-current and high breakdown-field strength. The result is a more robust and reliable detector.

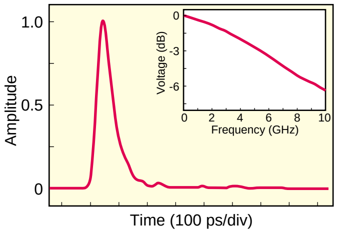
Detector Impulse Response



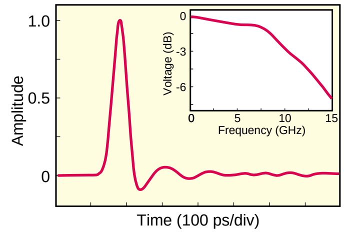
Time and frequency plots for the D-15



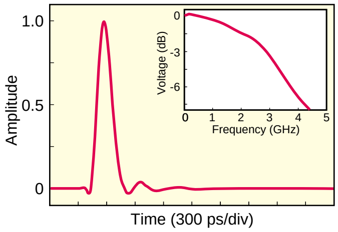
Time and frequency plots for the D-30



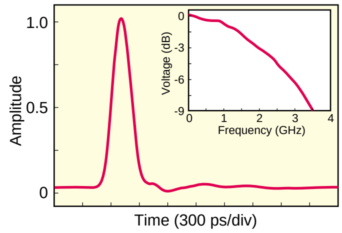
Time and frequency plots for the D-100



Time and frequency plots for the AD-50



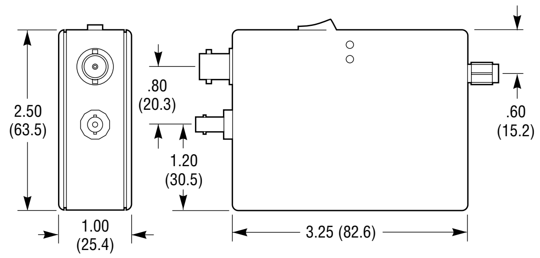
Time and frequency plots for the AD-200



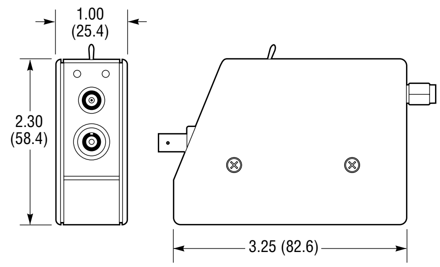
Time and frequency plots for the AD-300

Dimensions

D/AD-Series



PX-D7



Key Features

Unamplified

- *Models from 100 ps (4 GHz) to 7 ps (60 GHz)*
- *400–1700 nm spectral range (except PX-D7)*
- *Large 50 µm or greater input fiber diameter*
- *Self-contained, battery operated*
- *Built-in current monitor*

Amplified

- *Models from 300 ps (1.5 GHz) to 50 ps (10 GHz)*
- *200 V/W conversion gain*
- *Built-in DC-coupled transimpedance amplifiers*
- *Wall mount power supply included*
- *Built-in current monitor*

Model PX-D7 Applications

The extraordinary combination of speed, sensitivity, and collection efficiency of the PX-D7 photodetector offers more than simply enhanced performance.

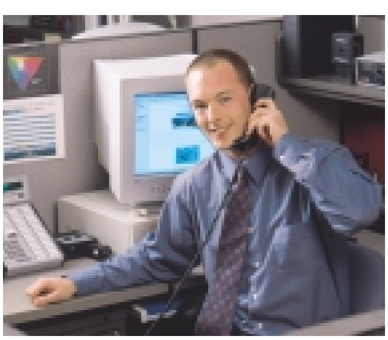
Experiments can now be carried out that may otherwise require an expensive streak camera. For example, with its high-speed and large numerical aperture the PX-D7 photodetector can be used for time-resolved picosecond spectroscopy and photo-luminescence studies. Time-of-flight applications, such as submillimeter-resolution rangefinding and profilometry or high-resolution optical time-domain reflectometry, are also possible. The PX-D7 detector, with the appropriate laser, can be configured as an efficient source of either picosecond electrical pulses or CW high frequency signals. In this mode, electrical signals can be generated for applications in millimeter-wave, radar and spectroscopy, or simply as an ultrafast electrical pulse for use in your experiment.

Specifications

General Research	Unamplified				Amplified		
Model	**PX-D7**	**D-15**	**D-30**	**D-100**	**AD-50***	**AD-200**	**AD-300**
Spectral Response[1]	400–900 nm	400–1700 nm	400–1700 nm	400–1700 nm	400–1700 nm	400–1700 nm	400–1700 nm
Impulse Response, Maximum	7 ps	15 ps	30 ps	100 ps	50 ps	200 ps	300 ps
Voltage Bandwidth, -3 dB Typical	60 GHz	29 GHz	15 GHz	4 GHz	10 GHz	2.5 GHz	1.5 GHz
Power Bandwidth, -3 dB Typical	45 GHz	21 GHz	11 GHz	2.8 GHz	7.5 GHz	1.8 GHz	1.1 GHz
Responsivity, Minimum @ 1310 nm	0.05 A/W[2]	0.2 A/W	0.2 A/W	0.2 A/W			
Conversion Gain, (into 50Ω) @ 1310 nm	1.7 V/W	10 V/W	10 V/W	10 V/W	100 V/W	200 V/W	200 V/W
Dark Current, Maximum (at 25°C)	10 nA	50 nA	50 nA	50 nA			
NEP, Maximum	360 pW/√Hz[3]	90 pW/√Hz[3]	90 pW/√Hz[3]	90 pW/√Hz[3]	150 pW/√Hz	60 pW/√Hz	60 pW/√Hz
Maximum Average Power	1 mW	1 mW	1 mW	1 mW	0.5 mW	1 mW	1 mW
Input Fiber Diameter	50 µm	50 µm	50 µm	50 µm	50 µm	50 µm	50 µm
Ouput Termination, Nominal	100 kΩ	1000 kΩ	1000 kΩ	1000 kΩ	50 kΩ	50 kΩ	50 kΩ
Output Connector	Wiltron-V	Wiltron-K	Wiltron-K	Wiltron-K	SMA	SMA	SMA

1) Full duration at half-max
2) Measured at 670 nm
3) Limited by thermal noise of external 50 Ω load resistor

*AC-coupled, cannot detect signals that vary less than 10 kHz



Ordering Information

Model	Model
PX-D7	General Research Detector
D-15	General Research Detector
D-30	General Research Detector
D-100	General Research Detector
AD-50	General Research Detector
AD-200	General Research Detector
AD-300	General Research Detector

Select detector of choice from above ordering information table and add the -ST or -FC suffix to complete the Model number for ST or FC connector input option, respectively.

Examples:

D-15-ST—15ps detector with ST connector input.

D-30-FC—30ps detector with FC connector input.

Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Biased Detectors

Stands sold separately

818-BB Series photodetectors are cost effective diagnostic tools suitable for a variety of applications such as viewing of Q-switched and mode-locked laser pulses, picosecond laser alignment, and viewing of rapidly modulated laser and laser diode signals.

Standard detector modules consist of free-space, small and large area Si and InGaAs detectors, with rise times ranging from 175 ps–30 ns. An FC style fiber optic connector input is provided on one of the units for use in applications involving fiber pigtailed light sources. Each unit includes a built-in bias supply consisting of standard 3 V lithium cells and a BNC connector output, to be terminated into a 50 ohm oscilloscope input. The batteries are easily replaced and their lifetime can be extended by disconnecting the detector from the oscilloscope input when not in use.

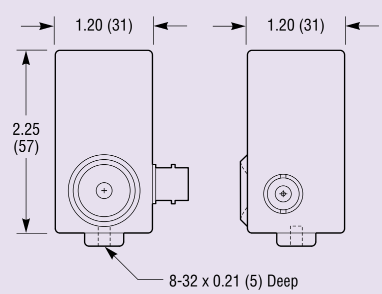
The 818-BB-22 UV Enhanced Detector module consists of a silicon detector with an enhanced ultraviolet response, making it well suited for viewing the output of fourth harmonic Nd:YAG, YLF or Glass lasers and excimer lasers. Additionally, its large active area and fast response time make it an excellent general purpose photodetector for the 200 to 1100 nm wavelength region. To attain its fast response, this detector uses a 48 VDC external power supply, provided with the unit.

The 818-BB-21A/30A Amplified Detector modules consist of Si and InGaAs detectors having a built-in amplifier that provides approximately 26 dB of gain. It is excellent for viewing rapid modulation of laser diodes, low-power CW lasers or other light sources in the μW regime. The detectors are AC coupled and feature a bandwidth ranging from 75 kHz up to 1.5 GHz. A wall plug-in style power supply is provided with these units.

Key Features

- *Silicon and InGaAS photodetectors available*
- *Rise times as low as 175 ps*
- *Amplified versions provide up to 26 dB gain*
- *Built-in bias supply on unamplified versions (except for BB-22 and BB-40)*

Dimensions



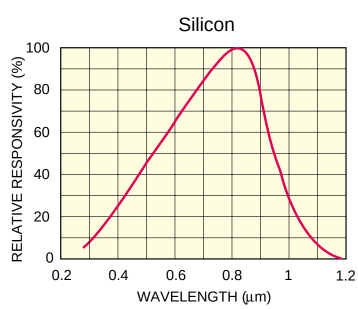
Specifications

Model	818-BB-20[3]	818-BB-21[3]	818-BB-21A[6] 818-BB-21A/220	818-BB-22[6] 818-BB-22/220	818-BB-30[3]	818-BB-30A[6] 818-BB-30A/220	818-BB-31[3]	818-BB-40[6]
Spectral Range	0.3–1.1 µm	0.3–1.1 µm	0.36–1.1 µm	0.2–1.1 µm	1.0–1.6 µm	1.0–1.6 µm	1.0–1.6 µm	0.3–1.1 µm
Material	Silicon	Silicon	Silicon	Silicon	InGaAs	InGaAs	InGaAs	Silicon
Rise Time	<350 ps	<300 ps	<500 ps	<1.5 ps	<175 ps	<400 ps	<225 ps	<30 ns
Fall Time	<350 ps	<300 ps	<500 ps	<1.5 ps	<175 ps	<400 ps	<225 ps	<30 ps
Responsivity @ 830 nm	0.4 A/W	0.4 A/W	500 V/W[2]	0.5 A/W				0.5 A/W
Responsivity @ 1.3 µm					0.8 A/W	400 V/W[2]	0.8 A/W[1]	
Bias Voltage	3 V	9 V	24 V	48 V	6 V	24 V	6 V	24 V
Impedance, Load	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω
Cut Off Frequency	>1.5 GHz	>1.2 GHz	>1.2 GHz[4,5]	>100 MHz	>2 GHz	>1.5 GHz[4,5]	>1.5 GHz	>25 MHz
Active Area mm	6 x 10^{-3} mm	0.12 mm	0.12 mm	5.1 mm	7.9 x 10^{-3} mm	7.9 x 10^{-3} mm	7.9 x 10^{-3} mm	20 mm
Dark Current, Maximum (at 25°C)	<1 nA	<0.1 nA		10 nA	<1 nA		<1 nA	<20 nA
Junction Capacitance pF	<4 pF	<1.5 pF		<10 pF	<0.75 pF		<1.25 pF	<45 pF
Reverse Breakdown	40 V	20 V			25 V		25 V	50 V
Acceptance Angle	25°	10°	10°	30°	20°	20°		41°
Dynamic Range for 2 V Across 50 ohm Resistor	60 dB	60 dB	30 dB	60 dB	60 dB	30 dB	60 dB	60 dB
Saturation Current	50 mA	10 mA	10 mA	10 mA	10 mA	10 mA	10 mA	10 mA
NEP	<1 x 10^{-13} W/√Hz	<1.5 x 10^{-15} W/√Hz	<5 x 10^{-11} W/√Hz	<1 x 10^{-12} W/√Hz	<1 x 10^{-13} W/√Hz	<3.5 x 10^{-11} W/√Hz	<1 x 10^{-13} W/√Hz	<1.6 x 10^{-13} W/√Hz
Output Connector	BNC	BNC	BNC	BNC	BNC	BNC	BNC	BNC
Mounting (tapped hole)	8-32 and M4	8-32 and M4	8-32 and M4	8-32 and M4	8-32 and M4	8-32 and M4	8-32 and M4	8-32 and M4
Fiber Optic Connector							FC	

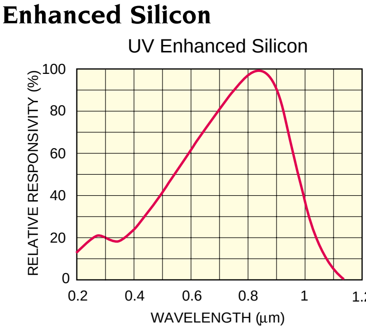
1) Measurement made with a GI type fiber having a core diameter of 50 µm and an NA of 0.2.
2) Detector has maximum output voltage of 500 mV.
3) Batteries are included.
4) AC coupled detector requiring input of >75 kHz.
5) If the full bandwidth is not needed, use lowpass, bandpass or highpass filters to remove excess noise.
6) Includes 110 V AC/DC adaptor. For 220 V AC/DC adaptor, specify /220 Model number—call for price.

Detector Responsivity

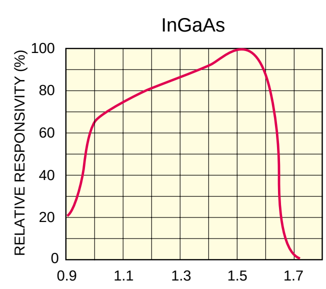
Silicon



UV Enhanced Silicon



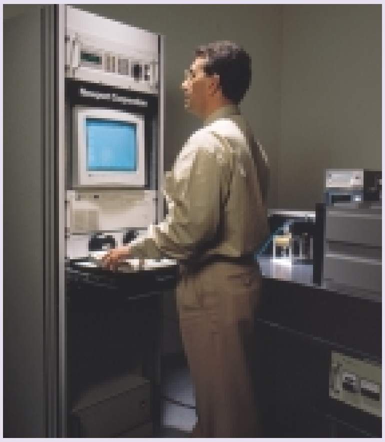
InGaAs



Ordering Information

Model	Description
818-BB-20	Biased Detector
818-BB-21	Biased Detector
818-BB-21A	Biased Detector
818-BB-21A/220	Biased Detector
818-BB-22	Biased Detector
818-BB-30	Biased Detector
818-BB-30A	Biased Detector
818-BB-30A/220	Biased Detector
818-BB-31	Biased Detector
818-BB-40	Biased Detector

Optical Detector Calibration Services



Newport maintains an advanced calibration facility to meet all of your NIST traceability needs. Computer-automated testing allows us to include a complete calibration report with every detector and matching attenuator we sell. In-house reference standards are directly recertified at every wavelength on state-of-the-art cryogenic calorimeters traceable to the National Institute of Science and Technology (NIST). Our comprehensive testing and direct traceability gives you the highest-accuracy calibrations with results you can trust.

Because NIST-traceability and MIL-45662A compliance require yearly recalibration, we've taken the hassle out of recertifying your detectors. Our **Detector Calibration Service** is optimized to provide fast-turnaround recalibration of all Newport detectors. With each calibration service, you receive a full calibration report (for recertification of any Newport optical meter accompanying the order, see page 127). To ensure quality, Newport always inspects your detector for artifacts which could affect the accuracy of your recalibration.

A calibration table is sent out with each low-power detector undergoing Newport's Detector Calibration Service. The table lists the measured responsivity at 10 nm intervals across the spectral range specified for the particular detector in the Newport Catalog. If a Newport attenuator is included, calibration certification tables are provided for the detector with and without the attenuator. If your detector and meter use a Newport "/CM" calibration module (Figure 1) or 835-PROM (for 835 optical meters only), then be sure to return the calibration module (or PROM) with your detector. The calibration module (or PROM) will be reprogrammed or replaced with the new calibration data.

Key Features

- NIST-*traceable calibration*
- *Fast-turnaround service*
- *Calibration of detectors and meters*

Ordering Information

Contact Newport's customer service department to receive a return authorization number for your detector prior to ordering a recalibration.

Model	Description
RCAL-01	Detector recalibration
RCAL-02	Detector recalibration with /CM upgrade
RCAL-03	Detector recalibration with 835-PROM upgrade
RCAL-04	Detector recalibration with /CM and 835-PROM upgrade
RCAL-05	Detector/Integrating Sphere recalibration
RCAL-06	Detector/Integrating Sphere recalibration with /CM upgrade
RCAL-07	Detector/Integrating Sphere recalibration with 835-PROM upgrade

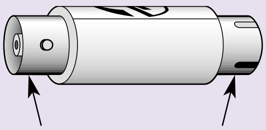


Figure 1. /CM Calibration Module, Patent Pending

All Newport 818-Series Low and High Power Detectors are calibrated to NIST traceable standards. Taking into account both NIST's and Newport's standard uncertainties and standard deviations resulting from the calibration process, we specify the accuracy of our detectors with a 95% confidence level.

For more information on calibration services, please contact Newport's Applications Sales Engineers.

Tutorial

Optical Meters and Detectors

Photodiode Basics

When a photon hits the photodiode material it may generate an electron-hole pair, depending on the quantum efficiency of the device. Quantum efficiency is dependent on many factors, but in general if the energy of the photon, E = hν, is less than the energy gap of the device, then the photon will pass through the device without being absorbed. On the other hand, if the energy of the photon is greater than the energy gap of the device, these photons will be absorbed very near the surface where the recombination rate is high and will not contribute to the photocurrent. It is the quantum efficiency that is responsible for the wavelength dependency of the photodiode's spectral response. Semiconductor materials such as silicon and InGaAs possess different energy gaps; consequently they exhibit different quantum efficiencies at different wavelengths, resulting in spectral responsivity profiles unique to the specific material type.

Semiconductor photodiodes are ideal for making measurements of low-level light due to their high sensitivity and low noise characteristics. Most photodiode manufacturers specifically design their diodes to be used in either the photoconductive (reverse biased) or the photovoltaic (no bias) mode, both having advantages and disadvantages. Newport's low-power **818 and 918 Series** photodiodes are used in the *photovoltaic* mode to take advantage of the reduced noise performance.

The two primary noise sources from the diode alone are Johnson noise and shot noise. In the photovoltaic mode with no light striking the photodiode surface, the photodiode is in thermal equilibrium producing random thermal noise known as Johnson current noise, given by

$$I_{Johnson} = \sqrt{\frac{4kTB}{R_{sh}}} \quad [A],$$

where k is Boltzman's constant, T is the temperature in Kelvin, B is the bandwidth of the detector/amplifier, and R_{sh} is the shunt resistance of the photodiode. It can also be seen from this equation that a photodiode with a high shunt resistance is desired to reduce the Johnson noise.

Shot noise is the noise produced by the flow of current in the diode and is given by,

$$I_{shot} = \sqrt{2qB(I_{dark} + I_{photo})} \quad [A],$$

where *q* is the charge of an electron, I_{dark} is the dark current, and I_{photo} is the photocurrent. When a photodiode is used in the *photovoltaic* mode the voltage across the diode is kept at zero volts. Consequently this almost eliminates the dark current altogether. Because there is negligible dark current, the shot noise contributed by the dark current is also eliminated. To put these effects in perspective, if a detector were biased as in the photoconductive mode, the dark current would be about three decades larger than the noise equivalent current of an unbiased detector.

The photocurrent produced by the photodiode is measured directly by the power meter using an operational amplifier circuit known as a *transimpedance amplifier.* Typically measurements can be made down to the sub-picoampere regime with good reproducibility, even at room temperatures. An exception to this rule is when the shunt resistance of the photodiode is small as with the Germanium photodiode (818-IR). Because of its low shunt resistance (50 kΩ typical), tens of picoamperes can be resolved at best.

Thermopile Basics

A thermopile consists of an array of thermocouples connected together in a series in order to increase the voltage output to more easily measured levels (millivolts vs. microvolts). It may be formed by a dissimilar metal junction, or from semiconductor (Peltier) junctions. In use, absorption of a laser beam creates heat at the receiver area of the power probe. The amount of heat, and thus the temperature rise at the receiver, is determined by the power level of the laser beam. The heat flows to either an air- or water-cooled radiator which is nearly at a constant ambient temperature (unless the probe power rating is greatly exceeded!). The radiator will be referred to as a heat sink. The thermopile *hot* junctions are located at or near the laser receiver, while the *cold* junctions are located at the heat sink. The probe's voltage output results from the temperature rise between the hot and cold junctions produced by the absorbed laser energy. The two types of thermopile probes in use today are distinguished by using *radial* or *axial* heat flow paths from receiver to heat sink.

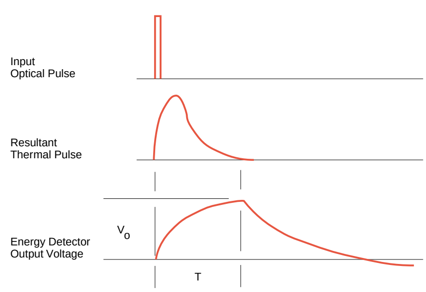
Probes constructed with dissimilar metal junctions use a *radial flow* heat path from the center to the outside of a thermal disk assembly. The heat sink is attached to the outside circumference of a metal disk which has the laser absorbing element attached (or coated) in its central area. This approach gives a response time on the order of one second to register changes of laser input power. It is also easy to scale up to kilowatt power levels by using a thicker disk and/or going to copper instead of aluminum as the disk material. Dissimilar metals are vacuum deposited on the back of the disk in a pattern such that the hot junctions form a closed ring around the laser absorbing area, and an equal number of cold junctions are located around the outside of the disk. If thermopile junctions, thermal disk and mechanical interface to the heat sink are uniform, the voltage responsivity (mV/W) is near constant regardless of where the laser is positioned on the disk. In some older thermal disk designs, non-uniformity was inherent, thereby forcing the user to carefully center the laser beam for any measurement.

Semiconductor based thermopile probes employ a more traditional *axial flow path* for absorbed heat. In this case a layered construction is used to assemble the probe. The heat sink is positioned behind a disc-shaped laser absorbing element, and Peltier junctions are sandwiched between the absorber and heat sink. The junctions are tiled together to match the size of the absorber. The heat flows straight back (axially) from the absorber as opposed to a radial (outward) direction. This has the advantage of scaling easily to very large absorber areas. However, a slow time constant (on the order of 30 seconds) results from the thermal impedance of the junction assemblies.

Thermopile Basics section authored by Dr. J. Buck and B. Mooney.

Pyroelectric Basics

Pyroelectric detectors are designed to measure the energy of short optical pulses that have a ***maximum*** width of 5 µs–400 µs, depending on the detector design. These detectors are made of a ferroelectric crystal which has a permanent dipole moment. When subjected to an optical pulse, the crystal is heated and causes the dipole moment to change. The changing of this dipole moment causes a current to flow, which is converted to a voltage in the detector head that can be measured by the optical power meter or oscilloscope.



Typical signal behavior of a Pyroelectric detector is shown above.

As shown in Figure 1, the resultant thermal pulse is broadened relative to the short optical pulse. During this thermal pulse the current flows through the ferroelectric crystal, creating a voltage that increases in amplitude. The optical power meter has circuitry that measures the difference in voltage between when the output voltage just starts to increase and when the output voltage reaches its peak amplitude. This voltage difference is then numerically multiplied by the detectors responsivity, which is in units of Joule/Volt, resulting in the energy of the pulse in units of Joules.

Most of Newport's pyroelectric detectors require termination into a 1 MΩ input impedance, however, some have built-in amplifiers that require a 50 Ω input impedance. Our optical meters that use a calibration module provide the correct impedance automatically, but care must be taken to select the correct impedance when using an oscilloscope.

When using pyroelectrics, care must be taken not to exceed the maximum pulse width or the maximum repetition rate. If either of these specifications is exceeded, your measurement accuracy will degrade due to the electrical bandwidth limitation of the detector.

Photodiode Spectral Calibration

Newport Corporation performs its photodiode spectral calibration at their facility in Irvine, CA. The calibrations are done using a double monochromator in order to minimize stray optical noise, especially in the ultraviolet. Three gratings and two light sources are used by the monochromator to maximize the signal to noise performance over the 190 nm–1800 nm wavelength ranges. A deuterium lamp is used in the ultraviolet range up to 310 nm and a tungsten lamp is used thereafter in the visible and near infrared.

Newport uses two standard detectors that are sent to NIST for calibration on an annual basis. One of the standard detectors is used for the wavelengths between 190–1100 nm and the other for 780–1800 nm. The absolute responsivity accuracy of NIST's standard detectors is based on a cryogenic radiometer which has a relative expanded uncertainty (k=2) to absolute SI units of 0.2%.

Prior to calibrating a manufacturing lot of detectors, the optical flux from the monochromator is measured in 10 nm steps using the NIST traceable standard detector throughout the wavelength range in which the detector-under-test (DUT) is to be calibrated. Since we know from NIST the responsivity of the standard detector, we calculate the optical flux of the monochromator using the following relationship:

$Flux_{mono}$ ([W] = $i_{measured}$ [A] / $Responsivity_{Std\ Det}$ ([A/W]),

where $i_{measured}$ is the measured current of the standard detector.

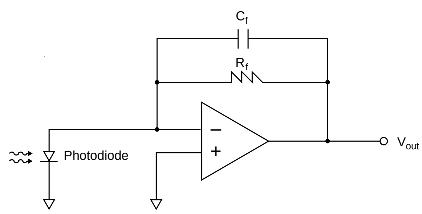
Knowing the flux coming from the monochromator, we measure the photocurrent of the DUT in 10 nm steps and divide this current by the monochromator flux to get the spectral responsivity of the detector in units of A/W.

Because the responsivity of a photodiode is temperature sensitive, especially near the ends of its usable wavelength range, we maintain the temperature of the standard detector and DUTs at the temperature where NIST calibrated the standard detector. This temperature control is critical for an accurate calibration. For example, silicon's temperature dependency induces a responsivity change of approximately 10% at 1100 nm with a 5°C change near room temperature.

After a manufacturing lot of detectors has been calibrated, we perform a single-wavelength check on ***every*** detector, with and without the OD3 attenuator, to insure that nothing went wrong with the calibration. This check is done using a different working standard and test equipment in order to isolate any systematic problems.

Power Meter Basics

Although most people want to make measurements in units of dBm or Watts, an optical power meter is only capable of measuring either the current or the voltage generated by a photodetector. When interfacing with a photodiode, the quantity that must be measured is current. There are numerous techniques in measuring this current, but only one will yield the detectivity, signal-to-noise, and accuracy that is expected from a semiconductor photodiode. A circuit known as a transimpedance amplifier is the circuit of choice when using a photodiode (Figure 2).



Transimpedance Amplifier

The advantage that the transimpedance amplifier has over almost any other amplifier configuration is that it does not bias the photodiode with a voltage as the current starts to flow from the photodiode. Typically one lead of the photodiode is tied to the ground and the other lead is kept at virtual ground by means of the minus input of the transimpedance amplifier. The resultant bias across the photodiode is then kept at virtually zero volts, a condition that helps minimize dark current and noise, and helps increase linearity and detectivity.

Effectively the transimpedance amplifier causes the photocurrent to flow through the feedback resistor which creates a voltage, V = iR, at the output of the amplifier. Since the meter knows the value of the precision feedback resistor, the current can be calculated with very good accuracy.

When interfacing with a thermopile or pyroelectric detector, voltage is the quantity that the optical meter must measure. There is, however, a considerable difference in how the measurement must be made between the two types of detectors. The optical meter's circuitry must be designed and configured to accommodate the two different types of voltage sources.

Thermopile detectors produce very slow bandwidth voltages (≈1 Hz) that can be measured in the sub-millivolt levels. One of the main concerns when trying to resolve such low voltages is to compensate for, or eliminate, thermoelectric voltages caused by dissimilar metals, which are generated in the connections and printed circuit board. It is somewhat ironic that the desirable physical effect that generates the voltage in a thermopile detector is similar to the undesirable effects that are present in the connections and printed circuit board. Precautions must be taken when choosing the electrical components to help minimize the unwanted thermoelectric voltages. Additionally, to resolve accurately small voltages, the optical meter must be able to zero any offset voltage due to temperature drift of the components and the thermopile.

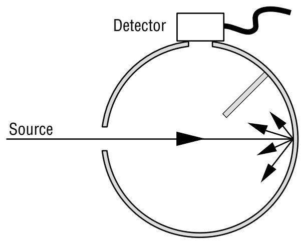
Pyroelectric detectors, in contrast, produce relatively fast rise-time signals in the microsecond regime (see the figure in the Pyroelectric Basics section). The circuitry in the optical meter must sample-and-hold both the baseline voltage and the peak amplitude of the pulse. These two voltages are then put into a differential amplifier; and it is this voltage difference that determines the amount of energy in the optical pulse by way of the responsivity of the detector. Precautions must be taken to avoid accidental triggering of the sample-and-hold circuit since these circuits are sensitive to noise. Because the faster pyroelectric detectors have narrow upper peaks, it is crucial that the bandwidth of the circuit is fast enough to capture the level of the upper peak without degradation of amplitude accuracy.

Newport Phone: 1-800-222-6440 • Fax: 1-949-253-1680

Integrating Spheres

Newport's general-purpose integrating spheres can be used to make a variety of measurements. Optional sphere accessories are also available to enhance their utility.

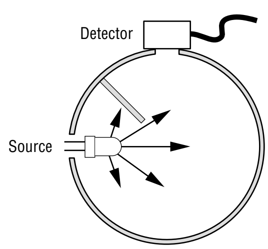
Beam Power



Beam Power

Measuring total collimated or uncollimated beam power (Figure 3), independent of polarization or beam alignment, is straightforward. The beam is admitted into the sphere and a detector, baffled from directly reflected radiation, measures the spatially integrated beam power. Integrating spheres are ideal for measuring the output power of divergent beams from laser diodes, lensed LEDs and lensed lamps.

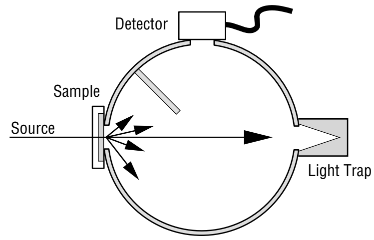
LED/Lamp Power



LED/Lamp Power

Total laser diode, LED, optical fiber or lamp output power—independent of directional characteristics—can be measured by introducing the light source into the sphere and measuring the spatially integrated output with a baffled detector (Figure 4).

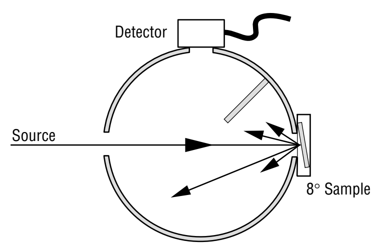
Transmittance



Diffuse Transmittance

Transmittance can be measured by using the integrating sphere to collect transmitted radiation from a sample held in one of the ports. The sample is irradiated, then compared with a direct source measurement made outside the sphere. A baffle is used to shield the detector from non-integrated transmission, and a light trap can be used to remove the unscattered component. Measurements of total integrated scatter, fluorescence, bulk scatter and forward and back scatter can also be made.

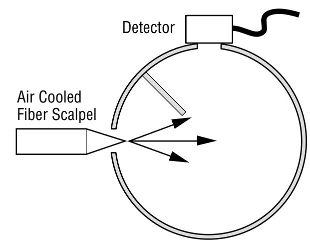
Reflectance



Specular + Diffuse Reflectance

To measure reflectance, a sample is held in one of the ports and irradiated by an incident beam. Total reflected radiation is spatially integrated by the sphere and measured by a baffled detector. The specular component of the reflective radiation can be eliminated by using the normal-incidence sample holder, which reflects the specular beam back out of the input port. An 8°-incidence sample holder allows measurement of the "specular plus diffuse" reflectance (Figure 6). The reflectance of a sample relative to a known standard can be calculated by measuring both and taking their ratio. The sample and standard should have a similar reflectance to avoid errors caused by sample reflectivity. A dual-beam system can be used to eliminate this potential source of measurement error.

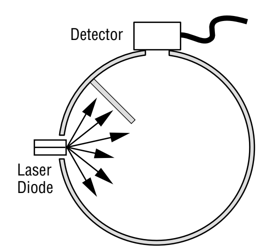
Fiber Optic Power Output



Fiber Scalpel Power

An integrating sphere also is ideal for measuring the output of optical fibers. In particular, this approach avoids the sensitivity of thermopiles to air currents and provides reliable NIST-traceable calibration of high-power, air-cooled fiber scalpels for surgical or ophthalmic applications.

Laser Diode Power



Laser Diode Power

An integrating sphere and calibrated detector setup is suitable for accurate, absolute value light power measurement of laser diodes. Your measurements will be insensitive to errors caused by detector positioning or problems associated with overfilling, or saturation, of the active area of the detector. A baffle, positioned between the input port and the detector port prevents the detector from directly viewing the emitting aperture of the laser or the direct area of illumination. In an integrating sphere the detected flux is always a small fraction of the incident flux. This attenuation, caused by light reflecting many times before reaching the detector, makes the integrating sphere an ideal tool for measurement of output light power of high-power lasers.

High-Speed Detector Terminology

Several terms are used to describe the performance of high-speed detectors, and are defined as follows:

Conversion Gain, CG: The sensitivity of a detector or amplified detector (usually into 50 ohms) converted to Volts/Watt via Ohm's Law.
CG = Responsivity x 50 ohms.

Dark Current: The DC current that flows through a detector when there is no light present. Usually measured in the nanoamp range.

dB: Logarithmic unit of relative measure [e.g. 3 dB = ratio of 2:1].

dBm: Logarithmic unit of absolute measure for power [0 dBm = 1 mW].

NEP: The amount of optical input power that produces the same output level as the inherent noise level of the detector/receiver, i.e. a signal-to-noise ratio of one. Usually given in picowatts per root bandwidth. Total noise level is calculated by multiplying the NEP by the square root of the full bandwidth.

Optical Return Loss, ORL: The amount of light reflected (lost) back out of the detector towards the light source. Measured in dB relative to the input power level. For commercial single-mode systems, typical ORL values for a detector must be less than -27 dB. For multimode systems, -14 dB is usually the maximum tolerable value.

Power Bandwidth, -3 dB: The frequency at which the electrical output power of the detector falls to 50% of its value at DC. Same as "electrical" bandwidth. Typically used for specifying analog microwave detector bandwidths.

Pulse Width: The full duration at half the maximum value (FDHM) of the output current pulse when the detector is illuminated by a negligibly short optical pulse.

Responsivity, R: The sensitivity of a detector element to light given in amps/watt, independent of load resistance.

Rise Time: The 10–90% rise time of the output voltage step when the detector is illuminated by a negligibly short optical step function. This is difficult to do in practice, so the measurement is simulated mathematically by integrating the pulse width (see above).

Sensitivity: The optical input power (in dBm) required to achieve a particular Bit Error Rate, BER (or signal to noise ratio) at the output of the detector/receiver. Usually specified for BERs of 10^{-9} (or a S/N of 6). BERs of 10^{-12} require a S/N=7.

Voltage Bandwidth, -3 dB: The frequency at which the output current or voltage of the detector falls to 50% of its value at DC. Same as optical bandwidth. Same value as the -6dB power bandwidth.

Impulse Response or Rise Time?

Detectors temporal performance is often specified by either impulse response or rise time. Which one of these parameters is appropriate for your application?

Impulse response is best used when you are actually measuring pulses, i.e. signals that turn on and then return to zero. The impulse response of a detector tells you the shortest pulse you could ever expect to see output from the detector. For good resolution, you need to select a detector whose FDHM is at least three times shorter than the pulse you expect to measure.

Rise time is the parameter of choice when you are measuring either rising or falling edges. This type of measurement is especially common in digital communications systems where bit streams are comprised of an endless series of rising and falling edges. The rise time of a detector should be at least three times shorter than the risetime you expect to measure.

Clearly, impulse response and rise time are related quantities. Mathematically, the rise time of a detector can be obtained by integrating its pulse response. Clean pulses without tails or ringing approximate a Gaussian shape. Such pulses have rise times (10–90%) that are only 10% longer than the FDHM. In this case, the difference between the two values is negligible.

However, when pulse shapes deviate from the ideal, the difference between impulse response and rise time can indeed become significant. Pulses with positive tails produce longer rise times (and have less bandwidth), while pulses with negative ringing produce shorter rise times (and have enhanced bandwidth). See application note for more discussion.

Time-Domain or Frequency-Domain?

There are many common parameters one considers when selecting a detector for a particular application. These include pulse width, bandwidth, responsivity, spectral sensitivity, noise level, linearity, power handling, bias voltage, power consumption, etc., to name several. However, with the explosion in optical communications, detector applications have evolved into two major groups that have significantly different requirements for the *shape* of either the temporal or frequency response. The particular response shape requirement is usually determined by whether the user has a time-domain, or a frequency-domain, application. Knowing this, what does one actually look for when making a selection?

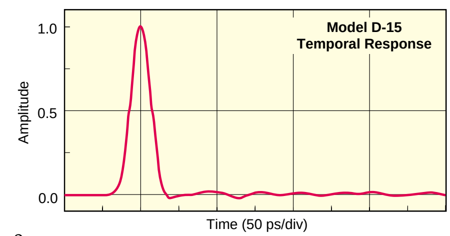
Figure 9a shows the 15 ps pulse response of a detector designed for time-domain applications. Figure 9b shows its corresponding frequency response curve. Note that in the time-domain the pulse is very "clean" showing very little tail or ringing. This type of Gaussian pulse response is ideal for applications where the temporal behavior of a waveform is under study, or where the temporal behavior of an optical signal must be converted to an electrical replica as accurately as possible. The most common applications are in signal diagnostics and receivers for digital communications, where temporal distortion can create bit-errors. Note that for this type of detector, the frequency response smoothly rolls off to a 3 dB point near 21 GHz that yields a Gaussian time-bandwidth product of 310 GHz-ps (power bandwidth).

Figure 10b shows the frequency response of another detector designed for frequency-domain applications. Figure 10a shows its corresponding temporal waveform.

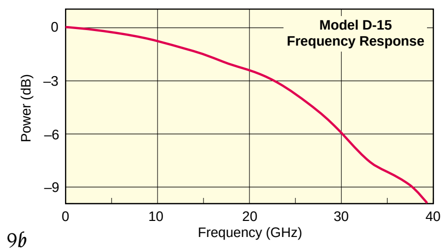
Note that in this case, the frequency response has been designed to be flat within 1 dB from DC to 20GHz. Beyond this, the response decays rapidly. This type of detector is ideal for many analog, microwave applications where a narrowband signal can be detected anywhere within the operating bandwidth with essentially the same sensitivity as at DC. Common applications include microwave communication links and radar arrays.

Note that the squared-off shape of the frequency response in Figure 10b results in significant ringing in its corresponding time-domain response. As a result, this type of detector would be a bad choice for time-domain applications. Similarly, frequency-domain users would be disappointed with a time-domain detector whose responsivity naturally drops by 3 dB at high frequencies, as shown in Figure 9b.

The nominal pulse width for these detectors might be specified as 15 ps for both products. However, it is the *shape* of either the temporal response or the frequency response that determines its usefulness for a particular application. Note that the pulse width is really only an accurate measure of comparison for time-domain detectors when there are no aritifacts on the waveform and the pulse shapes are the same.

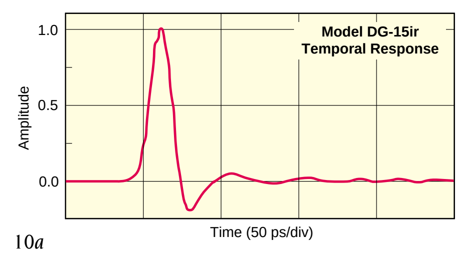


9a

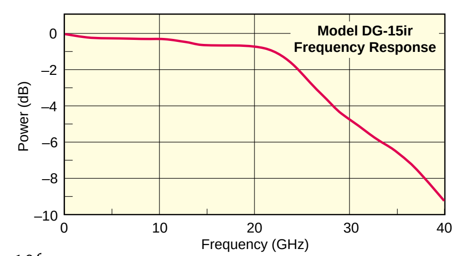


9b

Figure 9—Temporal response (9a) and frequency response (9b) of a time-domain photodetector (Newport D-15) having a nominal pulse-width of 15 ps (full duration at half maximum).



10a



10b

Figure 10—Temporal response (10a) and frequency response (10b) of a frequency-domain photodetector (Newport DG-15ir) having a nominal pulse width of 16.5 ps (full duration at half maximum).

Bandwith Terminology

There are many terms used to describe the bandwidth of a photodetector, but the two most common, "optical bandwidth" and "electrical bandwidth" also tend to be misleading, and often lead to some confusion when making detector comparisons. Let's attempt to clarify the nomenclature by describing a technique for measuring bandwidth.

A photodetector is a converter of optical power (mW) to electrical current (mA). This is why responsivity is specified in amps/Watt. High-speed detectors are simply designed to perform the optical to electrical conversion extremely quickly so when a short pulse of light arrives, the detector produces an exact replica of the input as a current pulse at the output. The shortest current pulse that can be produced at the output determines the speed of the detector.

The speed of a short-pulse detector can be determined by applying an extremely short optical pulse to the input, and then measuring the duration of the current pulse produced at the output. The output pulse is directed through a load resistor (usually 50 Ω) in order to generate a *voltage pulse* that can be displayed and measured on an oscilloscope. It is here that the pulse duration is determined.

The frequency response can be determined from the voltage pulse by mathematically transforming it to yield a voltage spectrum that shows how the response rolls off at higher frequencies (see Figure 11). The *bandwidth* of the detector is then defined as the frequency at which the response drops to 50% of its value at DC. On a log scale, this is the -3 dB point of the voltage spectrum, and it is referred to as the *voltage bandwidth*. It is this same measure of bandwidth that is referred to as *optical bandwidth* by other manufacturers.

"Voltage" Bandwidth = "Optical" Bandwidth

In analog, microwave applications the frequency response of a photodetector is often measured by using a microwave *power* meter, which gives a reading proportional to the *square* of the output voltage and therefore results in a *power* spectrum (see Figure 11). In this case, the bandwidth is defined as the point where the output *power* drops by 50% relative to its DC value. Once again, on a log scale, this is the -3 dB point of the *power* spectrum, and it is referred to as the *power bandwidth*. Historically, this has also been called the *electrical bandwidth*, in spite of the confusing fact that both voltage and power are electrical terms.

"Power" Bandwidth = "Electrical" Bandwidth

Newport's high-speed detectors are specified by both voltage and power bandwidth to avoid any confusion. The relationship between voltage and power spectra can be seen in Figure 11. The power spectrum simply goes as the square of the voltage spectrum, because power is proportional to the square of the voltage. On the log scale, this squared relationship appears as a factor of two difference in decibels (dB). Therefore you see that when the voltage spectrum has dropped to its -3 dB point, the corresponding power spectrum has dropped to its -6 dB point at exactly the same frequency.

Mathematically:

-3 dB voltage bandwidth = -6 dB power bandwidth

As a result, when comparing detectors, be sure you are comparing apples with apples, or in the case of detectors, the same measures of bandwidth. For most detectors, the voltage bandwidth is always greater than the power bandwidth, although the exact relationship is highly dependent on the shape of the individual detector's response curves.

In general:

-3 dB voltage bandwidth > -3 dB power bandwidth

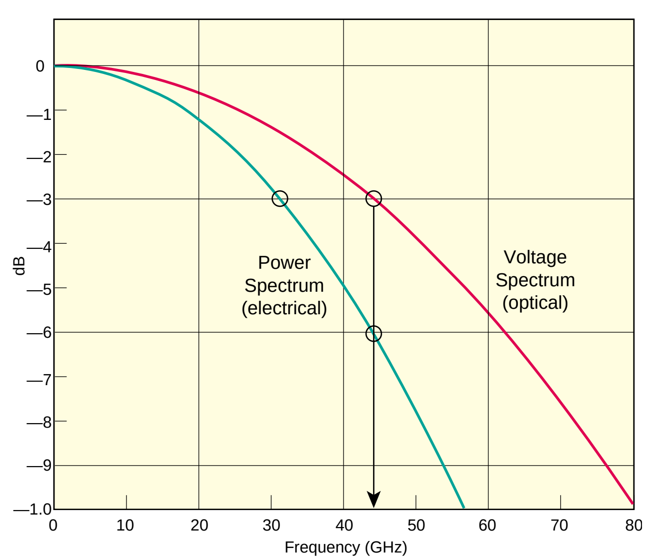


Figure 11—Frequency response of an ideal 10 ps detector