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THORLABS

S310C - May 07, 2018

Item # S310C was removed from our e-commerce site on May 07, 2018. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

THERMAL POWER SENSORS (C-SERIES)

- Power Ranges Covering 10 µW to 200 W
- Wavelength Ranges Covering 190 nm to 25 µm
- Broadband Coatings with High Damage Thresholds
- Sensors Designed for Microscopes and Pulsed Lasers

S425C
Featuring Removab
Heat Sink and Show
with a Fiber Adapte
(Sold Below) a

S350C
For Excimer Lasers

S401C
High Sensitivity
Down to 10 µW

S175C
18 mm x 18 mm Aperture Size
for Use with Microscopes

OVERVIEW

Features

- Broad Spectral Ranges with Relatively Flat Spectral Responses (See Plots Below)
- Individually Calibrated with NIST- and PTB-Traceable Certificate of Calibration
- Free-Space and Fiber-Based Applications Supported
  - All Sensors Accept Free Space Input
  - Majority Accept Fiber Adapter (Available Below) for Fiber-Based Input
- C-Series Connector
  - Enables Quick Sensor Connection to Our Power Meter Consoles
  - Embedded EEPROM Contains Sensor and Calibration Data
- Ten Models Feature Over-Temperature-Alert Sensor (See *Specs* Tab for Details)

Click to Enlarge
S401C Connected to the PM100D Console

Click to Enlarge

Click to Enlarge

Internal SM05 (0.535"-40) threading on the S405C's aperture (left) accepts the included external SM05 to SM1 (1.035"-40) thread adapter (right). Most sensors include an SM1 externally threaded adapter that allows accessories like fiber adapters to be mounted.

Thorlabs' C-Series Thermal Power Sensors are collectively able to detect power ranges from 10 µW to 200 W and wavelength ranges from 190 nm to 25 µm. These thermopile-based sensors are ideal choices for measuring broadband spectra from amplified spontaneous emission (ASE) sources, light emitting diodes (LEDs), filament lamps, swept-wavelength lasers, and other sources. In addition, thermal power sensors do not saturate, which makes them well suited to measuring pulsed sources with high pulse peak powers or long-duration pulses. These thermal power sensors also exhibit low dependency on the angle and position of the incident light beam. They are preferred for applications that cannot tolerate the strong wavelength dependencies and/or saturation thresholds of photodiode sensors. However, thermal power sensors generally have lower power resolutions and longer response times. We offer a wide range of thermal power sensors, with each including different design features.

Mounting
The sensors sold here (except the S175C) can be mounted on our Ø1/2" Posts using an 8-32, M4, or M6 tap. A 60 mm or 75 mm tall post is included with select sensors. Additionally, many of our thermal sensors are compatible with 30 mm cage systems, Ø1" lens tube systems, and our fiber adapters (sold below). Please refer to the *Specs* tab for more information.

Calibration
Each sensor head is individually calibrated and is shipped with a NIST- and PTB-Traceable Calibration Certificate. The calibration and identification data is stored in the electrically erasable programmable read-only memory (EEPROM) built into the connector of the sensor and is downloaded automatically to the connected power meter console. The EEPROM also contains sensor model and serial numbers, wavelength range, information on the built-in thermistor (when present), and the calibration date. For more information on sensor calibration, please see the *Calibration* tab on our Power Meter and Sensor Tutorial. Thorlabs offers specific recalibration services for all our thermal power sensors. To ensure accurate measurements, we recommend recalibrating the sensors annually. Please contact our tech support team for recalibration information and pricing.

Power Meter Compatibility
All sensors are connected to the power meter console via the C-Series connector, which offers quick sensor exchange. These sensors are compatible with our current power meter console offering but cannot be used with our previous generation of consoles. For our sensors with natural response times greater than 1 second, these power meters can use the data stored in the connector to predict the incident power after a single time constant of the sensor. Please see the *Operation* tab for more information.

Sensor Upgrade and Service
All C-Series Sensors are incompatible with former generation power meter consoles with non-C-Series connectors. We offer a sensor upgrade service if you want to use your existing sensors with a new power meter console with a C-Series connector. Note: upgraded sensors will be incompatible with old power meter consoles with non-C-Series connectors. Please contact our tech support team for details.

Thermal Power Sensors Selection Guide					
Type	**High Resolution**	**Max Power: 5 W to 10 W**	**Max Power: 40 W to 200 W**	**High Max Power Density for Pulsed Lasers**	**Microscope Slide Thermal Sensor**
Wavelength Range[a]	190 nm - 25 µm[a]	190 nm - 25 µm	190 nm - 20 µm	250 nm - 10.6 µm	300 nm - 10.6 µm
Optical Power Range[a]	10 µW - 5 W[a]	2 mW - 10 W	10 mW - 200 W	100 µW - 10 W	100 µW - 2 W
Max Optical Power Density[a]	200 - 1500 W/cm² (Avg.)	200 - 1500 W/cm² (Avg.)	2 - 4 kW/cm² (Avg.)	35 W/cm² (Avg.); 100 GW/cm² (Peak, 1 ns Pulse)	200 W/cm²
Resolution[a]	1 µW - 5 µW	100 µW - 200 µW	100 µW - 5 mW	10 µW - 250 µW	10 µW

- a. Combined Range for All Sensors in the Respective Category
- b. Combined Range for All Sensors for YAG Lasers

S P E C S

Thorlabs' Thermal Power Sensors (C-Series)

Click on the links in the following list or Selection Guide to move to the inicated specification tables.

- High Resolution
- Max Power: 5 W to 10 W
- Max Power: 40 W to 200 W
- High Max Power Density for Pulsed Lasers
- Microscope Slide Thermal Sensor

High Resolution

Item #	S401C	S302C	S405C

Detection Specifications			
Detector Type	Thermal Surface Absorber with Background Compensation (Axial Thermopile)	Thermal Surface Absorber (Axial Thermopile)	
Wavelength Range	190 nm - 20 µm	190 nm - 25 µm	190 nm - 20 µm
Optical Power Range	10 µW - 1 W	100 µW - 2 W	100 µW - 5 W
Max Average Optical Power Density	500 W/cm²	200 W/cm²	1.5 kW/cm²
Max Pulse Energy Density	0.2 J/cm² (1 µs Pulse), 2 J/cm² (1 ms Pulse)	0.2 J/cm² (1 µs Pulse), 2 J/cm² (1 ms Pulse)	0.3 J/cm² (1 ns Pulse), 5 J/cm² (1 ms Pulse)
Max Intermittent Power[a]	3 W	2.5 W	-
Linearity	±0.5%	±1%	±0.5%
Resolution[b]	1 µW	1 µW	5 µW
Measurement Uncertainty[c] **(Calibration Uncertainty)**	±3% @ 1064 nm ±5% @ 190 nm - 10.6 µm	±3% @ 1064 nm ±5% @ 190 nm - 25 µm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm
Response Time[d]	1.1 s	12 s (3 s from 0 - 90%)	1.1 s
General Information			
Suggested Application	Low Power Lasers and LEDs	Low Power Lasers and LEDs	Low Power Lasers and LEDs
Absorber	High-Power Broadband Coating	Black Broadband Flat Coating	High-Power Broadband Coating
Cooling	Convection (Passive)		
Temperature Sensor (In Sensor Head)	NTC Thermistor	N/A	NTC Thermistor
Console Compatibility	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB		
Mechanical Specs			
Housing Dimensions (Without Adapter)	33.0 m x 43.0 mm x 15.0 mm (1.30" x 1.69" x 0.59")	Ø40 mm x 41 mm (Ø1.57" x 1.61")	40.6 mm x 40.6 mm x 16.0 mm (1.60" x 1.60" x 0.63")
Sensor Input Aperture	Ø10 mm	Ø10 mm with Adapter, Ø12 mm Without	Ø10 mm
Active Detector Area	10 mm x 10 mm	Ø12 mm	10 mm x 10 mm
Distance to Detector[e]	3 mm	15 mm	5 mm
Cable Length	1.5 m		
Connector	D-Sub 9 Pin Male		
Weight	0.05 kg (0.11 lb)	0.2 kg (0.44 lb)	0.11 kg (0.24 lb)
Mounting and Accessories			
Post	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)	M4, 60 mm Long Ø1/2" Post Included	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)
Cage System Mounting	N/A	N/A	30 mm Cage Systems via Two 4-40 Tapped Holes; Two Ø6 mm Through Holes for ER Series Rods
Aperture Thread	Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	Internally M14 x 1-Threaded Aperture Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	Internally SM05-Threaded Aperture Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters
Fiber Adapters (Available Below)	S120 Series Fiber Adapters		

- a. Two minute maximum exposure time for the S302C, and twenty-minute maximum exposure time for the S401C. The S405C saturates for optical input powers >5 W.
- b. Measurement taken with the PM200 console for the S401C, the PM100D console for the S302C, and the PM400 console for the S405C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- c. Measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.

- d. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). See the *Operation* tab for additional information.
- e. Distance is measured from the detector to the front face of the housing.

Max Power: 5 W to 10 W

Item #	S305C	S415C	S310C	S425C
Detection Specifications				
Detector Type	Thermal Surface Absorber (Radial Thermopile)	Thermal Surface Absorber (Axial Thermopile)	Thermal Surface Absorber (Radial Thermopile)	Thermal Surface Absorber (Axial Thermopile)
Wavelength Range	190 nm - 25 µm	190 nm - 20 µm	190 nm - 25 µm	190 nm - 20 µm
Optical Power Range	10 mW - 5 W	2 mW - 10 W	10 mW - 10 W	2 mW - 10 W
Max Average Optical Power Density	200 W/cm²	1.5 kW/cm²	200 W/cm²	1.5 kW/cm²
Max Pulse Energy Density	0.2 J/cm² (1 µs Pulse), 2 J/cm² (1 ms Pulse)	0.3 J/cm² (1 ns Pulse), 5 J/cm² (1 ms Pulse)	0.2 J/cm² (1 µs Pulse), 2 J/cm² (1 ms Pulse)	0.3 J/cm² (1 ns Pulse), 5 J/cm² (1 ms Pulse)
Max Intermittent Power[a]	10 W	20 W	15 W	20 W
Linearity	±1%	±0.5%	±1%	±0.5%
Resolution[b]	100 µW	100 µW	200 µW	100 µW
Measurement Uncertainty[c] (Calibration Uncertainty)	±3% @ 1064 nm ±5% @ 190 nm - 2940 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm	±3% @ 1064 nm ±5% @ 190 nm - 1064 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm
Response Time[d]	1.5 s (<1 s from 0 to 90%)	0.6 s	2.7 s (<1 s from 0 to 90%)	0.6 s
General Information				
Suggested Application	Low Power Lasers and LEDs	Low and Mid-Power Lasers & LEDs	Low Power Lasers and LEDs	Low and Mid-Power Lasers & LEDs
Absorber	Black Broadband Flat Coating	High-Power Broadband Coating	Black Broadband Flat Coating	High-Power Broadband Coating
Cooling	Convection (Passive)			
Temperature Sensor (In Sensor Head)	NTC Thermistor			
Console Compatibility	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB			
Mechanical Specs				
Housing Dimensions (Without Adapter)	40.6 mm x 40.6 mm x 15 mm (1.60" x 1.60" x 0.59")	50.8 mm x 50.8 mm x 35.0 mm (2.00" x 2.00" x 1.38")	55 mm x 55 mm x 54.5 mm (2.17" x 2.17" x 2.15")	50.8 mm x 50.8 mm x 35.0 mm (2.00" x 2.00" x 1.38")
Sensor Input Aperture	Ø10 mm	Ø15 mm	Ø20 mm	Ø25.4 mm
Active Detector Area	Ø10 mm	Ø15 mm	Ø20 mm	Ø27 mm
Distance to Detector[e]	11 mm (8 mm without Adapter)	5 mm	15 mm	4.6 mm
Cable Length	1.5 m			
Connector	D-Sub 9-Pin Male			
Weight	0.36 kg (0.79 lb)	0.22 kg (0.49 lb)	0.2 kg (0.44 lb)	0.22 kg (0.49 lb)
Mounting and Accessories				
Post	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)	M6, 75 mm Long Ø1/2" Post Included	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)
Cage System Mounting	30 mm Cage Systems via Three 4-40 Tapped Holes	N/A	30 mm Cage Systems via Four 4-40 Tapped Holes	N/A
	Internally M14 x 1-Threaded Aperture	Internally SM1- Threaded Aperture	Externally SM1-	Internally SM1-Threaded (1.035"-40) with External

Aperture Thread	Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	External SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters
Fiber Adapters (Available Below)	S120 Series Fiber Adapters			

- a. Two Minute Maximum Exposure Time
- b. Measurement taken with the PM100D console for the S305C and S310C and with the PM400 for the S415C and S425C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- c. Measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- d. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). As the natural response times of the S415C and S425C are fast, these do not benefit from accelerated measurements and this function cannot be enabled. See the *Operation* tab for additional information.
- e. Distance is measured from the detector to the front face of the housing.

Max Power: 40 W to 200 W

Item #	S314C	S350C	S425C-L	S322C
Detection Specifications				
Detector Type	Thermal Surface Absorber (Radial Thermopile)	Thermal Surface Absorber (Radial Thermopile)	Thermal Surface Absorber (Axial Thermopile)	Thermal Surface Absorber (Radial Thermopile)
Wavelength Range	250 nm - 11 µm	190 nm - 1.1 µm, 10.6 µm	190 nm - 20 µm	250 nm - 11 µm
Optical Power Range	10 mW - 40 W	10 mW - 40 W	2 mW - 50 W	100 mW - 200 W
Max Average Optical Power Density	2 kW/cm²	2 kW/cm²	1.5 kW/cm²	4 kW/cm²
Max Pulse Energy Density	0.5 J/cm² (1 ns Pulse), 10 J/cm² (1 ms Pulse)	0.7 J/cm² (1 ns Pulse), 10 J/cm² (1 ms Pulse)	0.3 J/cm² (1 ns Pulse), 5 J/cm² (1 ms Pulse)	0.5 J/cm² (1 ns Pulse), 10 J/cm² (1 ms Pulse)
Max Intermittent Power[a] (2 Minute Max)	60 W	60 W	75 W	250 W
Linearity	±1%	±1%	±0.5%	±1%
Resolution[b]	1 mW	1 mW	100 µW	5 mW
Measurement Uncertainty[c] (Calibration Uncertainty)	±3% @ 1064 nm ±5% @ 250 nm - 2940 nm	±3% @ 351 nm ±5% @ 190 nm - 1100 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm	±3% @ 1064 nm ±5% @ 266 nm - 1064 nm
Response Time[d]	4 s (<1 s from 0 to 90%)	9 s (1 s from 0 to 90%)	0.6 s	5 s (1 s from 0 to 90%)
General Information				
Suggested Application	Mid-Power Lasers	High Power Excimer Lasers	Mid-Power Lasers	Mid-Power Lasers
Absorber	High-Power Broadband Coating	Excimer Coating	High-Power Broadband Coating	High-Power Broadband Coating
Cooling	Convection (Passive)			Forced Air with Fan[e]
Temperature Sensor (In Sensor Head)	NTC Thermistor			
Console Compatibility	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB			
Mechanical Specs				
Housing Dimensions (Without Adapter, if Applicable)	100.0 mm x 100.0 mm x 54.2 mm (3.94" x 3.94" x 2.13")	100 mm x 100 mm x 54.2 mm (3.94" x 3.94" x 2.13")	100.0 mm x 100.0 mm x 58.0 mm (3.94" x 3.94" x 2.28")	100 mm x 100 mm x 86.7 mm (3.94" x 3.94" x 3.41")
Sensor Input Aperture	Ø25 mm	Ø40 mm	Ø25.4 mm	Ø25 mm
Active Detector Area	Ø25 mm	Ø40 mm	Ø27 mm	Ø25 mm

Distance to Detector[f]	13 mm	13 mm	4.6 mm	15 mm
Cable Length	1.5 m			
Connector	D-Sub 9-Pin Male			
Weight	1 kg (2.20 lb)	1 kg (2.20 lb)	0.71 kg (1.57 lb)	0.75 kg (1.65 lb)
Mounting and Accessories				
Post	M6, 75 mm Long Ø1/2" Post Included	M6, 75 mm Long Ø1/2" Post Included	Ø1/2" Post via Universal 8-32 & M4 Tap (Post Not Included)	M6, 75 mm Long Ø1/2" Post Included
Cage System Mounting	30 mm Cage Systems via Four 4-40 Tapped Holes	N/A	N/A	30 mm Cage Systems via Four 4-40 Tapped Holes
Aperture Thread	Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	Unthreaded	Internally SM1-Threaded Aperture with External SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters
Fiber Adapters (Available Below)	S120 Series Fiber Adapters			

- a. Two Minute Maximum Exposure Time
- b. Measurement taken with the PM100D console, except for the S425C-L in which the PM400 wase used. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- c. Measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- d. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s) for the S314C, S350C, and S322C. As the natural response time of the S425C-L is fast, the S425C-L does not benefit from acceleration and this function cannot be enabled. See the *Operation* tab for additional information.
- e. 12 VDC power supply included.
- f. Distance is measured from the detector to the front face of the housing.

High Max Power Density for Pulsed Lasers

Item #	S370C	S470C
Detection Specifications		
Detector Type	Thermal Volume Absorber (Axial Thermopile)	Thermal Volume Absorber (Axial Thermopile)
Wavelength Range	0.4 - 5.2 µm	0.25 - 10.6 µm
Optical Power Range	10 mW - 10 W	100 µW - 5 W
Max Power Density	35 W/cm² (Avg); 100 GW/cm² (Peak, 1 ns Pulse)	35 W/cm² (Avg); 100 GW/cm² (Peak, 1 ns Pulse)
Max Pulse Energy Density	1 J/cm² (1 ns pulse) 10 J/cm² (1 ms pulse)	1 J/cm² (1 ns Pulse)
Max Intermittent Power[a]	15 W	-
Linearity	±1%	±0.5%
Resolution[b]	250 µW	10 µW
Measurement Uncertainty[c] (Calibration Uncertainty)	±3% @ 1064 nm ±5% @ 400 - 1064 nm	±3% @ 1064 nm ±5% @ 250 nm - 10.6 µm
Response Time[d]	45 s (3 s from 0 to 90%)	6.5 s (<2 s from 0 to 90%)

Microscope Slide Thermal Sensor

Item #	S175C
Detection Specifications	
Detector Type	Thermal Absorber (Axial Thermopile)
Wavelength Range	0.3 - 10.6 µm
Optical Power Range	100 µW - 2 W
Max Power Density	200 W/cm^2
Max Pulse Energy Density	0.1 J/cm² (1 µs pulse) 1 J/cm² (1 ms pulse)
Max Intermittent Power	-
Linearity	±0.5%
Resolution[a]	10 µW
Measurement Uncertainty[b] (Calibration Uncertainty)	±3% @ 1064 nm ±5% @ 300 nm - 10.6 µm
Response Time[c]	3 s (<2 s from 0 to 90%)

General Information		
Suggested Application	High Peak Power Lasers	High Peak Power, Low Average Power Lasers
Absorber	Broadband Volume Absorber (Schott NG1 Filter)	Broadband Volume Absorber (Schott NG1 Filter)
Cooling	Convection	Convection
Temperature Sensor (In Sensor Head)	N/A	N/A
Console Compatibility	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB
Mechanical Specs		
Housing Dimensions (Without Adapter, if Applicable)	75 mm x 75 mm x 51.2 mm (2.95" x 2.95" x 2.02")	45.0 mm x 45.0 mm x 18.0 mm (1.77" x 1.77" x 0.71")
Input Aperture Size	Ø25 mm	Ø15 mm
Active Detector Area[e]	Ø25 mm	>Ø15 mm
Distance to Detector[f]	13 mm	5.1 mm
Cable Length	1.5 m	1.5 m
Connector	Sub-D 9-Pin Male	Sub-D 9-Pin Male
Weight	0.5 kg (1.10 lb)	0.1 kg (0.22 lb)
Mounting and Accessories		
Post	M6, 75 mm Long Post Included	Universal 8-32 / M4 Tap, Post Not Included
Cage System Mounting	4 x 4-40 Threads for 30 mm Cage Compatibility	N/A
Aperture Thread	Externally SM1-Threaded Adapter for Ø1" Lens Tubes and Fiber Adapters	External SM1-Threaded Aperture for Ø1" Lens Tubes and Fiber Adapters
Fiber Adapters (Available Below)	S120 Series Fiber Adapters	S120 Series Fiber Adapters

- a. Two Minute Maximum Exposure Time
- b. Measurement taken with the PM100D console for the S370C and with the PM200 for the S470C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- c. Measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- d. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <2 s). See the *Operation* tab for additional information.
- e. Input aperture size is the same as the active sensor area for the S370C. The S470C uses a Schott glass volume absorber that is designed to be slightly larger than the entrance aperture to make it easier to detect a beam that is entering the sensor at an angle.
- f. Distance is measured from the detector to the front face of the housing.

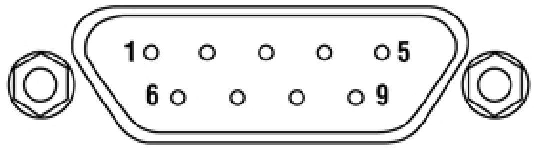
General Information	
Suggested Application	Light Measurement on the Microscope Objective Plane
Absorber	Broadband Coating
Cooling	Convection
Temperature Sensor (In Sensor Head)	N/A
Console Compatibility	PM400, PM200, PM100D, PM100A, PM320E, and PM100USB
Mechanical Specs	
Housing Dimensions	76 mm x 25.2 mm x 4.8 mm (2.99" x 0.99" x 0.19")
Input Aperture Size	18 mm x 18 mm
Active Detector Area	18 mm x 18 mm
Distance to Detector[d]	1.1 mm
Cable Length	1.5 m
Connector	Sub-D 9-Pin Male
Weight	0.05 kg (0.11 lb)
Mounting and Accessories	
Post	N/A
Cage System Mounting	N/A
Aperture Thread	N/A
Fiber Adapters (Available Below)	N/A

- a. Measurement taken with the PM200 console with the acceleration circuit switched off. Resolution performance will be similar with our other power meter consoles.
- b. Measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- c. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). See the *Operation* tab for additional information.
- d. Distance is measured from the detector to the front face of the housing.

PIN DIAGRAMS

C-Series Sensor Connector

D-Type Male



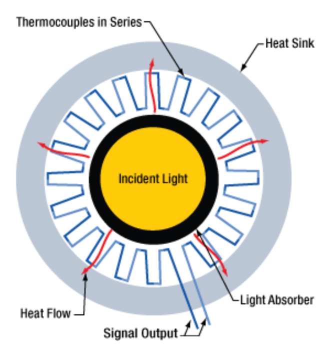
Pin	Connection
1	Not Used
2	EEPROM Data
3	Sensor and NTC Ground
4	Not Used
5	Not Used
6	EEPROM Ground
7	NTC
8	Sensor Signal
9	Not Used

OPERATION

Operational Principle

Thorlabs' Thermal Power Sensors are based on thermopiles. The top layer of the sensor consists of a light-absorbing material. A region filled with multiple thermocouples, which are connected in series, is immediately adjacent to the absorber. Thermocouples are made by bringing two dissimilar metals into contact, and their point of contact is called a junction. On the other side of the thermocouples is a heat sink. The thermocouples are connected in series, and the placement of the junctions alternates from being in close proximity to the absorber to being in close proximity to the heat sink.

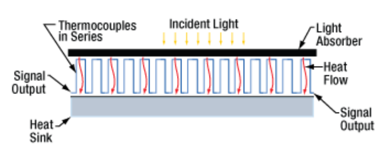
The absorber converts incident light energy into heat. The heat flows from the absorber, across the thermocouples, and to the heat sink, where it dissipates. The temperatures of the thermocouple junctions placed close to the absorber are higher than those the adjacent junctions placed close to the heat sink. This arrangement takes advantage of the thermoelectric (Seebeck) effect, in which a temperature difference between the adjacent junctions generates a proportional voltage difference. By connecting multiple thermocouples in series, the magnitude of the generated voltage is increased. The thermocouples are often arranged in a radial (also called a disk) configuration, as illustrated in Figure 1, or in an axial (also called a matrix) configuration, which is diagrammed in Figure 2. Thermal power sensors with both types of configurations are available from Thorlabs.



Click to Enlarge
Figure 1: A thermal sensor with radially configured thermocouples, which is depicted as seen from the top. Light is incident on the absorbing layer at the center, and heat flows through the thermocouples to the heat sink.

Radial Configuration of Thermocouples

A diagram of a thermal power sensor with a radial thermopile is shown in Figure 1, viewed from the top. This construction places the light absorber at the center. It is surrounded by a concentric ring of thermocouples connected in series, which are surrounded by a concentric heat sink. Light incident on the absorber generates heat that flows in a radial direction through the thermocouples and towards the heat sink. The heat sink must be specially designed so that it is in good mechanical contact with the outer ring of thermocouple junctions, without being in thermal contact with the light absorber or the inner ring of thermocouple junctions. The area behind the absorber cannot be in thermal contact with anything that will divert the heat flow from its intended radial path of flow.



Click to Enlarge
Figure 2: A thermal sensor with axially configured thermocouples, which is depicted as seen from the side. Light is incident on the top, and heat flows down through the thermocouple layer and dissipates in the heat sink below.

A benefit of the radial construction is that sensors can be designed to measure power levels as high as kilowatts. This high upper limit is made possible both by the thickness of the sensor disk and by displacing the thermocouples from the absorber, which protects them from the conditions in the laser impact area. Disadvantages of the radial thermopiles include the use of a heat sink with a special design, which adds complexity when customizing the sensor head, and a sensor head which is generally a least twice the diameter of the active detector area. Resolution for radial thermal power sensors is typically limited to around 10 mW.

Thorlabs' thermal power sensors featuring a radial configuration include the S305C, S310C, S314C, S350C, and S322C, which are all designed for mid-power range applications.

Axial Configuration of Thermocouples

A diagram of a thermal power sensor with an axial configuration of thermocouples is shown in Figure 2. In this design, the thermocouples are arranged between two flat layers. One layer is the light absorber, and the other is the heat sink. As the heat flows directly from the front surface to the back side, the dimensions of these sensor packages can be made compact. The sensor housing can be approximately the same size as the active detector area.

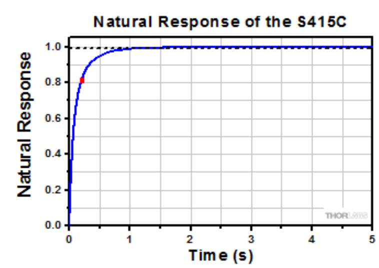
The new generation of axially-designed sensors achieves high resolutions in the microwatt range while providing relatively fast response times. These sensors detect optical powers up to several Watts, which limited mostly by the thickness of the absorbing material. The performance of the newly designed sensors, which includes the S401C and S405C, contrasts with sensors of previous generations, which have slower response times.

Heat sink shapes and dimensions are much less constrained for axially, as compared with radially, configured thermopiles. Heat sinks for axial designs can be as simple as a block of aluminum attached with thermal glue, or as sophisticated as a metal-core PCB that is soldered to the sensor. Our S415C, S425C, and S425C-L thermal power sensors have heat sinks can be easily removed and replaced. This enables the user to upgrade the heat sink, potentially to one with fans or water cooling, or to integrate the sensor into a custom setup. Please note that the heat sink must provide heat dissipation adequate for the application.

Volume Absorbers for Pulsed Lasers

Volume absorbers are alternatives to surface absorbers, which sustain damage when subjected to highly energetic and short pulses of nanosecond duration. Unlike surface absorbers, which suffer damage as a consequence of absorbing the pulse energy within a localized region, volume absorbers collect the heat from the light pulse and distribute it throughout a volume. Heat generated throughout the volume flows across the thermocouples and dissipates in the heat sink. Thorlabs offers two thermal power sensors with volume absorbers, S370C and S470C, which are both designed for the detection of Nd:YAG laser pulses, among other applications. In these axially-constructed sensors, the Schott glass volume absorber replaces the surface absorber of the other axial sensors. The response times of sensors with volume absorbers are slower than those with surface absorbers, as the thermal mass of the volume absorber is larger. The S470C is faster than the S370C, as its glass volume is smaller and other design changes have resulted in a faster response of the axial thermopile.

Natural Responses, the Sensor Time Constant, and Power Measurement Predictions



Click to Enlarge

Figure 3: Natural response of the S415C with the dotted line at 99% and the red square indicating the point on the curve corresponding to a single sensor time constant.

The typical **natural response** of the S415C thermal sensor to an instantaneous transition from darkness to being steadily illuminated is shown in Figure 3. This step function illumination stimulus produces a response that can be modeled using an exponential function and is similar to the function describing the rate at which a capacitor charges.

The **sensor time constant** is defined in terms of how long it takes for the sensor response to reach 99% of its maximum response. When the sensor has reached the 99% level, a time period equal to five sensor time constants has elapsed. In Figure 3, the dotted line corresponds to the 99% level and the red square to the response after a single sensor time constant has elapsed.

When the sensor's natural response characteristic function is known, it is possible to use it to model and **predict the final power reading** well before the sensor reading has stabilized. Thorlabs' power meter consoles calculate and display predictions of the stabilized power reading when Thorlabs sensors with sensor time constants ≥0.5 s (natural response times >1 s) are connected. Prediction is implemented using the sensor information stored in the EEPROM built into the C-Series connectors. The S415C, S425C, and S425C-L are fast enough, with sensor time constants <0.2 s (natural response times <0.6 s), that prediction is not necessary and is not enabled. Prediction is enabled for the other sensors.

When prediction is active, the first prediction is made after a time duration equal to a single sensor time constant, and this prediction is updated at time intervals of one sensor time constant until a total time duration of seven sensor time constants has elapsed. Prediction is then turned off; the power reading after seven time constants is 99.9% of the final reading. As there is uncertainty associated with the predicted measurements, they can exhibit some ripple. The faster the sensor, the less the uncertainty. After prediction is turned off, the gradient of the power reading is monitored, and prediction is re-enabled if an increase is detected which exceeds a defined threshold.

Protect Thermal Power Sensors from Thermal Disturbances

For the most accurate results, thermal power sensors should be protected from air flow and other thermal disturbances during operation. Otherwise, measurements will drift. This is of particular importance for low power sensors with high resolution. Handheld use is not recommended for any of the thermal power sensors, as body heat transferred to the sensor or heat sink can negatively impact the accuracy of the measurements.

Thermal power sensors operate by measuring a temperature differential, which is converted to a voltage signal. The sensor design assumes that heat generated in the absorber flows towards the heat sink. If the operator is in contact with the sensor housing during operation, body heat may transfer to the sensor and make spurious contributions to the power measurement. For example, if the sensor is held by the heat sink, heat transferred from the hand to the heat sink will flow towards the absorber. If no light is incident on the absorber, this will result in a negative power reading. If there is light incident on the absorber, it will result in an inaccurate power reading.

CONSOLE SELECTION

Thorlabs offers a wide selection of power and energy meter consoles, ranging from the touch screen PM400 to the analog PM100A. Key specifications of all of our power meter consoles are presented below to help you decide which device is best for your application. We also offer self-contained wireless power meters.

When used with our C-series sensors, Thorlabs' power meter consoles recognize the type of connected sensor and measure the current or voltage as appropriate. Our C-series sensors have responsivity calibration data stored in their connectors. The console will read out the responsivity value for the user-entered wavelength and calculate a power or energy reading.

- Photodiode sensors deliver a current that depends on the input optical power and the wavelength. The current is fed into a transimpedance amplifier, which outputs a voltage proportional to the input current. The photodiode's responsivity is wavelength dependent, so the correct wavelength must be entered into the console for an accurate power reading. The console reads out the responsivity for this wavelength from the connected sensor and calculates the optical power from the measured photocurrent.
- Thermal sensors deliver a voltage proportional to the input optical power. Based on the measured sensor output voltage and the sensor's responsivity, the console will calculate the incident optical power.
- Energy sensors are based on the pyroelectric effect. They deliver a voltage peak proportional to the pulse energy. If an energy sensor is recognized, the console will use a peak voltage detector and the pulse energy will be calculated from the sensor's responsivity.

The sensors are also capable of displaying the current or voltage delivered by the sensor. Alternatively, a current or voltage equivalent to the measured value is provided at the analog output.

Item #	PM100A	PM100D	PM100USB	PM200	PM400	PM320E
(Click Photo to Enlarge)						
Description	Analog Power Meter Console	Digital Power and Energy Meter Console	USB Power and Energy Meter Interface	Touchscreen Power and Energy Meter Console	Touchscreen Power and Energy Meter Console with Multi-Touch	Dual-Channel Benchtop Power and Energy Meter Console
Compatible Sensors	Photodiode and Thermal	Photodiode, Thermal, and Pyroelectric				
Housing Dimensions (H x W x D)	7.24" x 4.29" x 1.61" (184 mm x 109 mm x 41 mm)	7.09" x 4.13" x 1.50" (180 mm x 105 mm x 38 mm)	3.67" x 2.38 " x 1.13" (93.1 mm x 60.4 mm x 28.7 mm)	6.70" x 4.93" x 1.48" (170.2 mm x 125.1 mm x 37.5 mm)	5.35" x 3.78" x 1.16" (136.0 mm x 96.0 mm x 29.5 mm)	4.8" x 8.7" x 12.8" (122 mm x 220 mm x 325 mm)
Channels	1					2
External Temperature Sensor Input (Sensor not Included)	-	-	-	-	Instantaneous Readout and Record Temperature Over Time	-
External Humidity Sensor Input (Sensor	-	-	-	-	Instantaneous Readout and Record Humidity Over Time	-

not Included)						
GPIO Ports	-			4, Programmable	4, Programmable	-
Source Spectral Correction	-	-	-	✔	✔	-
Attenuation Correction	-	-	-	✔	✔	-
External Trigger Input	-	-	-	✔	-	✔
Display						
Type	Mechanical Needle and LCD Display with Digital Readout	320 x 240 Pixel Backlit Graphical LCD Display	No Built-In Display Controlled via GUI for PC	Resistive Touchscreen with Color Display	Protected Capacitive Touchscreen with Color Display	240 x 128 Pixels Graphical LCD Display
Dimensions	Digital: 1.9" x 0.5" (48.2 mm x 13.2 mm) Analog: 3.54" x 1.65" (90.0 mm x 42.0 mm)	3.17" x 2.36" (81.4 mm x 61.0 mm)	-	4.65" x 3.48" (118.0 mm x 88.5 mm)	3.7" x 2.1" (95 mm x 54 mm)	3.7" x 2.4" (94.0 mm x 61.0 mm)
Refresh Rate	20 Hz		Up to 500 Hz (PC Dependent)	100 Hz	10 Hz (Numerical) 25 Hz (Analog Simulation)	20 Hz
Measurement Views[a]						
Numerical	✔	✔	Requires PC[b]	✔	✔	✔
Mechanical Analog Needle	✔	-	-	-	-	-
Simulated Analog Needle	-	✔	Requires PC[b]	✔	✔	✔
Bar Graph	-	✔	Requires PC[b]	✔	✔	✔
Trend Graph	-	✔	Requires PC[b]	✔	✔	✔
Histogram	-	✔	Requires PC[b]	-	-	✔
Statistics	✔	✔	Requires PC[b]	✔	✔	✔
Memory						
Type	-	SD Card	-	NAND Flash	NAND Flash	-
Size	-	2 GB	-	128 MB	4 GB	-
Power						
Battery	LiPo 3.7 V 1300 mAh		-	LiPo 3.7 V 2600 mAh	LiPo 3.7 V 2600 mAh	-
External	5 VDC via USB or Included AC Adapter		5 VDC via USB	5 VDC via Included Power Supply	5 VDC via USB	Selectable Line Voltage: 100 V, 115 V, 230 V (±10%)

- a. These are the measurement views built into the unit. All of our power meter consoles except the PM320E can be controlled using the Optical Power Monitor software package. The PM320E has its own software package.
- b. The PM100USB does not have a built-in monitor, so all data displays are through the Optical Power Meter Software GUIs.

SENSOR SELECTION

This tab outlines the full selection of Thorlabs' Power and Energy Sensors. Our photodiode and thermal sensors are compatible with all of Thorlabs' current line of power meter consoles, while our pyroelectric sensors are compatible with all of our current power meter consoles except for the PM100A Analog Power Meter Console. In addition to the power and energy sensors listed below, Thorlabs also offers all-in-one, wireless, handheld power meters and compact USB power meter interfaces that contain either a photodiode or a thermal sensor, as well as power meter bundles that include a console, sensor head, and post mounting accessories.

Click to Enlarge
The PM160 wireless power meter, shown here with an iPad mini (not included), can be remotely operated using Apple mobile devices.

Thorlabs offers three types of sensors:

- **Photodiode Sensors:** These sensors are designed for power measurements of monochromatic or near-monochromatic sources, as they have a wavelength dependent responsivity. These sensors deliver a current that depends on the input optical power and the wavelength. The current is fed into a transimpedance amplifier, which outputs a voltage proportional to the input current.
- **Thermal Sensors:** Constructed from material with a relatively flat response function across a wide range of wavelengths, these thermopile sensors are suitable for power measurements of broadband sources such as LEDs and SLDs. Thermal sensors deliver a voltage proportional to the input optical power.
- **Pyroelectric Energy Sensors:** Our pyroelectric sensors produce an output voltage through the pyroelectric effect and are suitable for measuring pulsed sources, with a repetition rate limited by the time constant of the detector. These sensors will output a peak voltage proportional to the incident pulse energy.

Power and Energy Sensor Selection Guide

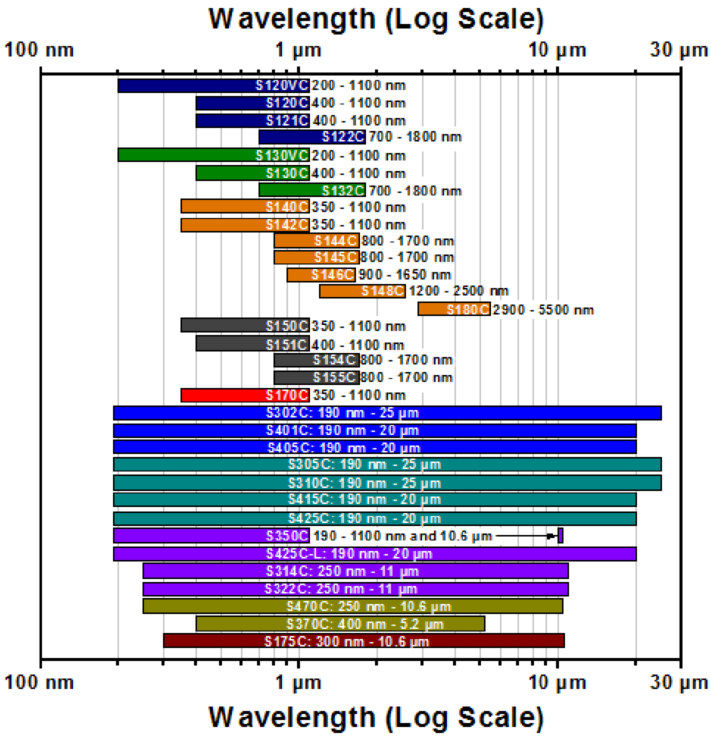
There are two options for comparing the specifications of our Power and Energy Sensors. The expandable table below sorts our sensors by type (e.g., photodiode, thermal, or pyroelectric) and provides key specifications.

Alternatively, the selection guide graphic further below arranges our entire selection of photodiode and thermal power sensors by wavelength (left) or optical power range (right). Each box contains the item # and specified range of the sensor. These graphs allow for easy identification of the sensor heads available for a specific wavelength or power range.

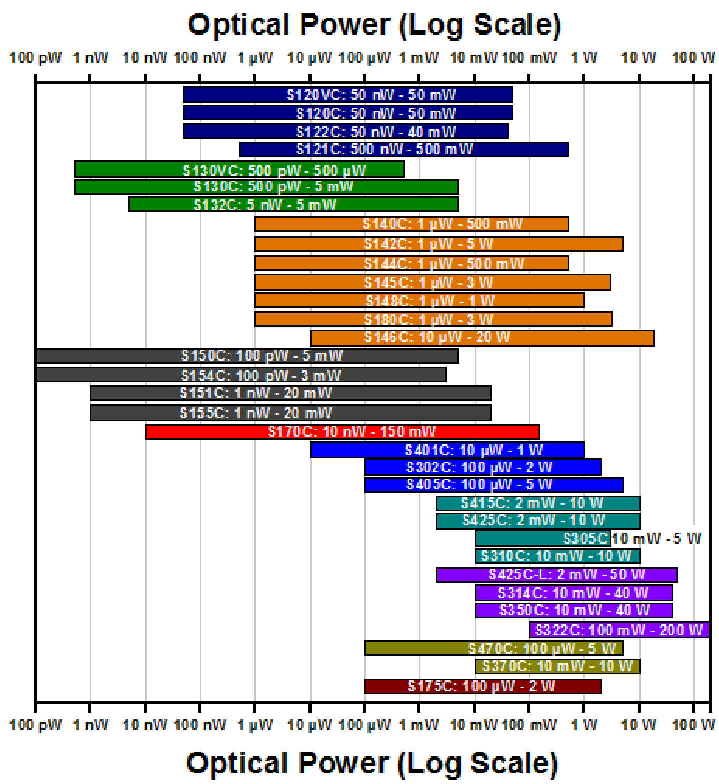
Photodiode Power Sensors	More [+]
Thermal Power Sensors	More [+]
Pyroelectric Power Sensors (Not Compatible with PM100A)	More [+]

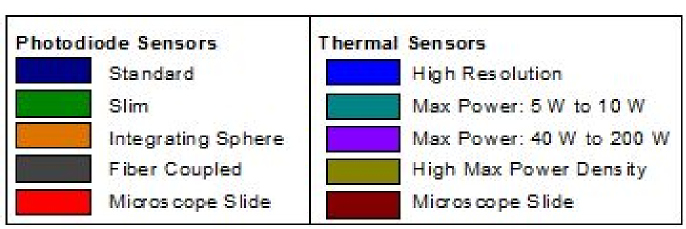
- The response time of the photodiode sensor. The actual response time of a power meter using these sensors will be limited by the update rate of your power meter console.
- Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s) when the natual response time is approximately 1 s or greater. As the natural response times of the S415C, S425C, and S425C-L are fast, these do not benefit from accelerated measurements and this function cannot be enabled. For more information, see the *Operation* tab here.
- With intermittent use: maximum exposure time of 20 minutes for the S401C, otherwise maximum exposure time is 2 minutes.
- All pyroelectric sensors have a 20 ms thermal time constant, τ. This value indicates how long it takes the sensor to recover from a single pulse. To detect the correct energy levels, pulses must be shorter than 0.1τ and the repetition rate of your source must be well below 1/τ.

Sensor Options
(Arranged by Wavelength Range)



Sensor Options
(Arranged by Power Range)

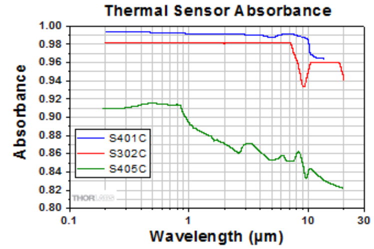




High Resolution

- High Resolution of 1 µW or 5 µW
- S401C and S405C Have Thermistors Used to Monitor Temperature of Sensor Head
- S401C: Background Compensation for Low-Drift Measurements
- S302C: Extra Insulation Minimizes Measurement Drift
- S405C: Accommodates Average Optical Power Densities up to 1.5 kW/cm²

Click to Enlarge
S401C Thermal Sensor with Included Light Shield



Click to Enlarge
The S302C has the same absorption curve as the S305C and S310C. The S405 shares the same absorption curve with the S415C, S425C, and S245C-L. (All are sold below.)

Thorlabs offers three broadband thermal power sensors designed to measure low optical power sources with high resolution. Each thermal sensor's broadband coating has a flat spectral response over a wide wavelength range, as shown in the plot to the right.

Aperture sizes from Ø9.3 mm to Ø12 mm allow easy alignment and measurement of large-spot-size laser sources. For easy integration with Thorlabs' lens tube systems and SM1-threaded (1.035"-40) fiber adapters (available below), each sensor has either external SM1 threading or includes an externally SM1-threaded adapter.

The S401C uses active thermal background compensation to provide low-drift power measurements. This is implemented through the use of two similar sensor circuits. One sensor circuit is the type all thermal power sensors share: it measures heat flow from light absorber to heat sink. The other sensor circuit monitors the ambient temperature. It is located within the housing and measures heat flow from heat sink towards the absorber. The measurements of the two sensor circuits are subtracted, which minimizes the effect of thermal drift on the laser power measurement. (For information about how the external thermal disturbances can affect thermal power sensor readings, see the *Operation* tab.) The broadband coating used on this thermal sensor offers high absorption at wavelengths between 0.19 and 20 µm (shown in the graph), which makes the sensor ideal for use with aligning and measuring Mid-IR Quantum Cascade Lasers (QCLs). The included, internally SM05-threaded (0.535"-40) light shield is shown in the photo to the right.

The S302C includes more thermal shielding than our other thermal power sensors. This insulation mitigates the effect of external thermal disturbances on the power measurement. However, the insulation also results in the sensor cooling down more slowly than our other sensors after becoming hot.

The S405C has internal SM05 (0.535"-40) threading that is directly compatible with SM05 lens tubes, and it can also connect directly to Thorlabs' 30 mm Cage Systems.

Item #[a]	S401C	S302C	S405C
Sensor Image (Click the Image to Enlarge)			
Wavelength Range	190 nm - 20 µm	190 nm - 25 µm	190 nm - 20 µm
Optical Power Range	10 µW - 1 W (3 W[b])	100 µW - 2 W (2.5 W[b])	100 µW - 5 W
Input Aperture Size	Ø10 mm	Ø10 mm with Adapter, Ø12 mm Without	Ø10 mm
Active Detector Area	10 mm x 10 mm	Ø12 mm	10 mm x 10 mm
Max Optical Power Density	500 W/cm² (Avg.)	200 W/cm² (Avg.)	1.5 kW/cm² (Avg.)
Detector Type	Thermal Surface Absorber (Thermopile) with Background Compensation	Thermal Surface Absorber (Thermopile)	
Linearity	±0.5%	±1%	±0.5%
Resolution[c]	1 µW	1 µW	5 µW
Measurement Uncertainty[d]	±3% @ 1064 nm ±5% @ 190 nm - 10.6 µm	±3% @ 1064 nm ±5% @ 190 nm - 25 µm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm
Response Time[e]	1.1 s	12 s (3 s from 0 to 90%)	1.1 s
Cooling	Convection (Passive)		
Housing Dimensions (Without Adapter)	33.0 m x 43.0 mm x 15.0 mm (1.30" x 1.69" x 0.59")	Ø40 mm x 41 mm (Ø1.57" x 1.61")	40.6 mm x 40.6 mm x 16.0 mm (1.60" x 1.60" x 0.63")

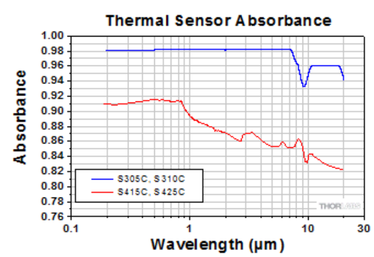
Temperature Sensor (In Sensor Head)	NTC Thermistor	N/A	NTC Thermistor
Cable Length	1.5 m		
Post Mounting	Universal 8-32 / M4 Taps (Post Not Included)	M4 Threaded Tap, Includes Ø1/2" Post, 60 mm Long	Universal 8-32 / M4 Taps (Post Not Included)
30 mm Cage Mounting	-	-	Two 4-40 Tapped Holes & Two Ø6 mm Through Holes
Aperture Threads	-	Internal M14 x 1	Internal SM05
Accessories	Externally SM1-Threaded Adapter Light Shield with Internal SM05 Threading	Externally SM1-Threaded Adapter	Externally SM1-Threaded Adapter
Compatible Consoles	PM400, PM200, PM100D, PM100A, PM100USB, and PM320E		

- a. For complete specifications, please see the *Specs* tab.
- b. For conditions of intermittent use, with a maximum exposure time of 20 minutes for the S401C and 2 minutes for the S302C. The S405C saturates for optical input powers >5 W.
- c. Measurement taken with the PM200 console for the S401C, the PM100D console for the S302C, and the PM400 console for he S405C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- d. Defined as the measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- e. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). See the *Operation* tab for additional information.

Part Number	Description	Price	Availability
S401C	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 20 µm, 1 W, Ø10 mm**	**$740.52**	**Today**
S302C	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 25 µm, 2 W, Ø12 mm**	**$740.52**	**Today**
S405C	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 20 µm, 5 W, Ø10 mm**	**$704.00**	**Lead Time**

Max Power: 5 W to 10 W

- Optical Power Resolution of 100 µW or 200 µW
- Thermistors Used to Monitor Temperature of Sensor Head
- S415C and S425C Feature Removable Heat Sinks
- S305C and S310C Have 4-40 Taps for Use with Our 30 mm Cage Systems



Click to Enlarge
The absorption curves of each of the thermal power sensors designed for use with low and medium power optical sources.

These thermal power sensors are designed for general broadband power measurements of low and medium power light sources. All include an externally SM1-threaded (1.035"-40) adapter, with threading concentric with the input aperture. The adapters are useful for mounting Ø1" Lens Tubes and Fiber Adapters (available below). The housing of the S305C features an aperture with internal SM05 (0.535"-40) threading, the apertures of the S415C and S425C have internal SM1 threading, and the aperture of the S310C is not threaded.

The S305C has slim profile, and a sensor housing that has virtually the same dimensions as a 30 mm cage plate, which makes it particularly useful in tight spaces.

The S415C and S425C operate with fast (<0.6 s) natural response times, and their removable heat sinks provide a high degree of flexibility to those interested in integrating them into custom setups or replacing the included heat sink with one that is water or fan cooled. If replacing the heat sink, please note that the replacement must provide heat dissipation adequate for the application.

The S310C has 4-40 taps at three corners that are compatible with our 30 mm cage systems.

Item #[a]	S305C	S415C	S310C	S425C
Sensor Image (Click Image to Enlarge)				

				
Wavelength Range	190 nm - 25 µm	190 nm - 20 µm	190 nm - 25 µm	190 nm - 20 µm
Optical Power Range	10 mW - 5 W (10 W[b])	2 mW - 10 W (20 W[b])	10 mW - 10 W (15 W[b])	2 mW - 10 W (20 W[b])
Input Aperture Size	Ø10 mm	Ø15 mm	Ø20 mm	Ø25.4 mm
Active Detector Area	Ø10 mm	Ø15 mm	Ø20 mm	Ø27 mm
Max Optical Power Density	200 W/cm² (Avg.)	1.5 kW/cm² (Avg.)	200 W/cm² (Avg.)	1.5 kW/cm² (Avg.)
Detector Type	Thermal Surface Absorber (Thermopile)			
Linearity	±1%	±0.5%	±1%	±0.5%
Resolution[c]	100 µW	100 µW	200 µW	100 µW
Measurement Uncertainty[d]	±3% @ 1064 nm ±5% @ 190 nm - 2940 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm	±3% @ 1064 nm ±5% @ 190 nm - 1064 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm
Response Time[e]	1.5 s (<1 s from 0 to 90%)	0.6 s	2.7 s (<1 s from 0 to 90%)	0.6 s
Cooling	Convection (Passive)			
Housing Dimensions (Without Adapter)	40.6 mm x 40.6 mm x 15 mm (1.60" x 1.60" x 0.59")	50.8 mm x 50.8 mm x 35.0 mm (2.00" x 2.00" x 1.38")	55 mm x 55 mm x 54.5 mm (2.17" x 2.17" x 2.15")	50.8 mm x 50.8 mm x 35.0 mm (2.00" x 2.00" x 1.38")
Temperature Sensor (In Sensor Head)	NTC Thermistor			
Cable Length	1.5 m			
Post Mounting	Universal 8-32 / M4 Tap (Post Not Included)	Universal 8-32 / M4 Taps (Post Not Included)	M6 Threaded Taps, Includes Ø1/2" Post, 75 mm Long	Universal 8-32 / M4 Taps (Post Not Included)
30 mm Cage Mounting	Three 4-40 Tapped Holes	-	Four 4-40 Tapped Holes	-
Aperture Threads	Internal M14 x 1	Internal SM1	-	Internal SM1
Removable Heatsink	-	Yes	-	Yes
Accessories	Externally SM1-Threaded Adapter	Externally SM1-Threaded Adapter	Externally SM1-Threaded Adapter	Externally SM1-Threaded Adapter
Compatible Consoles	PM400, PM200, PM100D, PM100USB, PM100A, and PM320E			

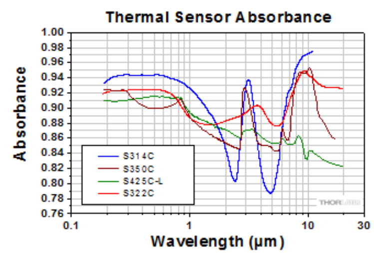
- a. For complete specifications, please see the *Specs* tab.
- b. Two Minute Maximum Exposure Time
- c. Measurement taken with the PM100D console for the S305C and S310C and with the PM400 for the S415C and S425C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- d. Defined as the measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- e. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). As the natural response times of the S415C and S425C are fast, these do not benefit from accelerated measurements and this function cannot be enabled. See the *Operation* tab for additional information.

Part Number	Description	Price	Availability
S305C	**Customer Inspired! Thermal Power Sensor Head, Surface Absorber, 0.19 - 25 µm, 5 W, Ø10 mm**	**$740.52**	**Today**
S415C	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 20 µm, 10 W, Ø15 mm**	**$726.00**	**Today**

S310C	Thermal Power Sensor Head, Surface Absorber, 0.19 - 25 µm, 10 W, Ø20 mm	$740.52	Today
S425C	Thermal Power Sensor Head, Surface Absorber, 0.19 - 20 µm, 10 W, Ø25.4 mm	$792.00	Today

Max Power: 40 W to 200 W

- Thermistors Used to Monitor Temperature of Sensor Head
- S314C and S322C Have 4-40 Taps for Use with Our 30 mm Cage Systems
- S350C Has Ø40 mm Aperture Well Suited to Excimer and Other Lasers with Large Spot Sizes
- S425C-L Features Removable Heat Sink
- S322C is Fan Cooled with an Optical Power Range up to 200 W



Click to Enlarge
The absorption curves of each of the thermal power sensors designed for use with low and medium power optical sources.

These thermal power sensors are designed for general broadband power measurements of low and medium power light sources. With the exception of the S350C, all include an adapter with external SM1 (1.035"-40) threading concentric with the input aperture. This allows the sensors to be integrated into existing Ø1" lens tube systems in addition to being compatible with fiber adapters (available below). The aperture of the S425C-L has internal SM1 threading.

The S425C-L operates with a fast (<0.6 s) natural response time and has a removable heat sink, which provides a high degree of flexibility to those interested in integrating them into custom setups or replacing the included heat sink with one that is water or fan cooled. If replacing the heat sink, please note that the replacement must provide heat dissipation adequate for the application.

Item #[a]	S314C	S350C	S425C-L	S322C
Sensor Image (Click Image to Enlarge)				
Wavelength Range	250 nm - 11 µm	190 nm- 1.1 µm, 10.6 µm	190 nm - 20 µm	250 nm - 11 µm
Optical Power Range	10 mW - 40 W (60 W[b])	10 mW - 40 W (60 W[b])	2 mW - 50 W (75 W[b])	100 mW - 200 W (250 W[b])
Input Aperture Size	Ø25 mm	Ø40 mm	Ø25.4 mm	Ø25 mm
Active Detector Area	Ø25 mm	Ø40 mm	Ø27 mm	Ø25 mm
Max Optical Power Density	2 kW/cm² (Avg.)	2 kW/cm² (Avg.)	1.5 kW/cm² (Avg.)	4 kW/cm² (Avg., CO_2)
Detector Type	Thermal Surface Absorber (Thermopile)			
Linearity	±1%		±0.5%	±1%
Resolution[c]	1 mW	1 mW	100 µW	5 mW
Measurement Uncertainty[d]	±3% @ 1064 nm ±5% @ 250 nm - 2940 nm	±3% @ 351 nm ±5% @ 190 nm - 1100 nm	±3% @ 1064 nm ±5% @ 250 nm - 17 µm	±3% @ 1064 nm ±5% @ 266 nm - 1064 nm
Response Time[e]	4 s (<1 s from 0 to 90%)	9 s (1 s from 0 to 90%)	0.6 s	5 s (1 s from 0 to 90%)
Cooling	Convection (Passive)			Forced Air with Fan[f]
Housing Dimensions (Without Adapter, if Applicable)	100.0 mm x 100.0 mm x 54.2 mm (3.94" x 3.94" x 2.13")	100 mm x 100 mm x 54.2 mm (3.94" x 3.94" x 2.13")	100.0 mm x 100.0 mm x 58.0 mm (3.94" x 3.94" x 2.28")	100 mm x 100 mm x 86.7 mm (3.94" x 3.94" x 3.41")
Temperature Sensor (In Sensor Head)	NTC Thermistor			
Cable Length	1.5 m			
Post Mounting	M6 Threaded Taps, Includes Ø1/2" Post, 75 mm Long	M6 Threaded Taps, Includes Ø1/2" Post, 75 mm Long	Universal 8-32 / M4 Taps (Post Not Included)	M6 Threaded Taps, Includes Ø1/2" Post, 75 mm Long

30 mm Cage Mounting	Four 4-40 Tapped Holes	-	-	Four 4-40 Tapped Holes
Aperture Threads	-	-	Internal SM1	-
Removable Heatsink	-	-	Yes	-
Accessories	Externally SM1-Threaded Adapter	-	Externally SM1-Threaded Adapter	Externally SM1-Threaded Adapter
Compatible Consoles	PM400, PM200, PM100D, PM100USB, PM100A, and PM320E			

- a. For complete specifications, please see the *Specs* tab.
- b. Two Minute Maximum Exposure Time
- c. Measurement taken with the PM100D console, except for the S425C-L in which the PM400 wase used. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- d. Defined as the measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- e. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s) for the S314C, S350C, and S322C. As the natural response time of the S425C-L is fast, the S425C-L does not benefit from acceleration and this function cannot be enabled. See the *Operation* tab for additional information.
- f. 12 VDC power supply is included.

Part Number	Description	Price	Availability
S314C	**Thermal Power Sensor Head, Surface Absorber, 0.25 - 11 µm, 40 W, Ø25 mm**	**$916.98**	**Today**
S350C	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 1.1 µm and 10.6 µm, 40 W, Ø40 mm**	**$1,095.48**	**Today**
S425C-L	**Thermal Power Sensor Head, Surface Absorber, 0.19 - 20 µm, 50 W, Ø25.4 mm**	**$858.00**	**Today**
S322C	**Thermal Power Sensor Head, Surface Absorber, 0.25 - 11 µm, 200 W, Ø25 mm, Fan Cooled**	**$1,356.60**	**Today**

High Max Power Density for Pulsed Lasers

Item #[a]	**S370C**	**S470C**
Sensor Image (Click the Image to Enlarge)		
Wavelength Range	400 nm - 5.2 µm	250 nm - 10.6 µm
Optical Power Range	10 mW - 10 W (15 W[b])	100 µW - 5 W (Pulsed and CW)
Input Aperture Size	Ø25 mm	Ø15 mm
Active Detector Area	Ø25 mm	Ø16 mm
Max Optical Power Density	35 W/cm² (Avg.); 100 GW/cm² (Peak)	
Detector Type	Thermal Volume Absorber (Thermopile)	
Linearity	±1%	±0.5%
Resolution[c]	250 µW	10 µW
Measurement Uncertainty[d]	±3% @ 1064 nm ±5% @ 400 nm - 1064 nm	±3% @ 1064 nm ±5% @ 250 nm - 10.6 µm
Response Time[e]	45 s (3 s from 0 to 90%)	6.5 s (<2 s from 0 to 90%)
Cooling	Convection (Passive)	
Housing Dimensions	75 mm x 75 mm x 51.2 mm	45.0 mm x 45.0 mm x 18.0 mm

- Designed for Optical Power Measurements of Nd:YAG Lasers
- Ideal for Applications with High Peak Pulse Powers
- S370C: Ø25 mm Aperture for Large-Spot-Size Beams
- S470C: High-Sensitivity for High-Peak-Power Pulses with Low Average Power

The S370C and S470C Thermal Sensors are designed to measure short and highly energetic laser pulses. All of these units are post-mountable for free-space applications and feature NIST-traceable data stored in the sensor connector.

These thermal power sensors are unique in that they have thermal volume absorbers, where our other thermal power sensors have thermal surface absorbers. The volume absorber consists of a Schott glass filter. Incident pulses are absorbed and the heat is distributed throughout the volume. In this way, pulses that would have damaged the absorption coating of a thermal surface absorber are safely measured by these thermal volume absorbers.

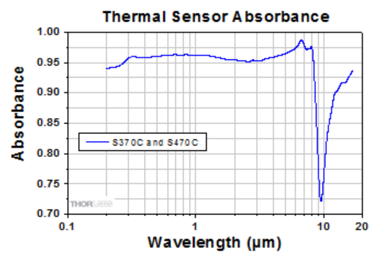
The S370C features a large Ø25 mm aperture ideal for large-spot-size beams, and it is compatible with average powers from 10 mW to 10

(Without Adapter, if Applicable)	(2.95" x 2.95" x 2.02")	(1.77" x 1.77" x 0.71")
Temperature Sensor (In Sensor Head)	N/A	N/A
Cable Length	1.5 m	
Post Mounting	M6 Threaded Taps, Includes Ø1/2" Post, 75 mm Long	Universal 8-32 / M4 Tap (Post Not Included)
30 mm Cage Mounting	Four 4-40 Tapped Holes	-
Aperture Threads	-	External SM1
Accessories	Externally SM1-Threaded Adapter	-
Compatible Consoles	PM400, PM200, PM100D, PM100A, PM100USB, and PM320E	

- a. For complete specifications, please see the *Specs* tab.
- b. Two Minute Maximum Exposure Time
- c. Measurement taken with the PM100D console for the S370C and with the PM200 for the S470C. In all cases, the acceleration circuit was switched off. Resolution performance will be similar with our other power meter consoles.
- d. Defined as the measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- e. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <2 s). See the *Operation* tab for additional information.

W (CW).

In comparison, the S470C is faster, as the glass absorber volume is reduced and other design parameters have been optimized for speed. This results in a different optical power range, with the ability to measure powers down to 100 µW. The Ø15 mm aperture is of the S470C is smaller, and it has a lower max average power of 5 W. Its 10 µW resolution is better than the 250 µW resolution of the S370C.



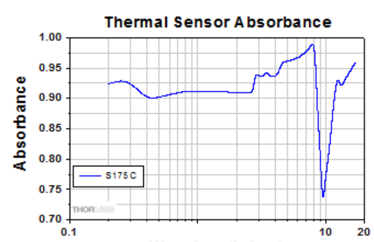
Click to Enlarge
This absorption curve is shown over a broader wavelength range than the sensors' operating ranges. See the table for the operating wavelength range of each sensor.

Part Number	Description	Price	Availability
S370C	**Thermal Power Sensor Head, Volume Absorber, 0.4 - 5.2 µm, 10 W, Ø25 mm**	**$1,137.30**	**Today**
S470C	**Thermal Power Sensor Head, Volume Absorber, 0.25 - 10.6 µm, 0.1mW - 5W, Ø15 mm**	**$1,157.70**	**Today**

Microscope Slide Thermal Sensor

Item #[a]	**S175C**
Sensor Image (Click Image to Enlarge)	
Wavelength Range	0.3 - 10.6 µm

- Designed to Measure Optical Power at the Sample Plane of a Microscope
- 76.0 mm x 25.2 mm Footprint Matches Standard Microscope Slides
- Wavelength Range: 300 nm - 10.6 µm
- Sensitive to Optical Powers from 100 µW to 2 W
- Information Stored in Connector



Click to Enlarge
Typical absorption curve for the S175C (glass and absorber). Note that this curve is representative, and the actual absorption across the spectrum will vary from unit to unit.

Power Range	100 µW - 2 W
Input Aperture Size	18 mm x 18 mm
Active Detector Area	18 mm x 18 mm
Detector Type	Thermal Surface Absorber (Thermopile)
Linearity	±0.5%
Resolution[b]	10 µW
Measurement Uncertainty[c]	±3% @ 1064 nm; ±5% @ 300 nm - 10.6 µm
Response Time[d]	3 s (<2 s from 0 to 90%)
Housing Dimensions	76 mm x 25.2 mm x 4.8 mm (2.99" x 0.99" x 0.19")
Temperature Sensor (In Sensor Head)	N/A
Cable Length	1.5 m
Housing Features	Integrated Glass Cover Engraved Laser Target on Back
Compatible Consoles	PM400, PM200, PM100D, PM100USB, PM100A, and PM320E

- a. For complete specifications, please see the *Specs* tab.
- b. Measured with PM200 Touch Screen Console
- c. Defined as the measurement uncertainty during calibration at the specified wavelengths for a beam diameter > 1 mm. The ±3% specification was determined by laser calibration, and the ±5% specification was determined through spectral calibration, in which values were interpolated using the laser calibration data and the absorption curve for the absorber. Calibration can be performed at 10.6 µm upon request.
- d. Typical natural response time (0 - 95%). Our power consoles can provide estimated measurements of optical power on an accelerated time scale (typically <1 s). See the *Operation* tab for additional information.

- Sensor Data
- NIST- and PTB-Traceable Calibration Data

Click to Enlarge
The back of the S175C housing is engraved with the sensor specifications and a target for centering the beam on the sensor.

The S175C Microscope Slide Thermal Power Sensor Head is designed to measure the power at the sample in microscopy setups. The thermal sensor can detect wavelengths between 300 nm and 10.6 µm at optical powers between 100 µW and 2 W. The sensor head's 76.0 mm x 25.2 mm footprint matches that of a standard microscope slide and is compatible with most standard upright and inverted microscopes.

The thermal sensor has an 18 mm x 18 mm active area and is contained in a sealed housing behind a glass cover. An immersion medium (water, glycerol, oil) may be placed over the glass cover plate.

As seen in the image to the right, the bottom of the sensor housing features a laser-engraved target to aid in aligning and focusing the beam. In standard microscopes, the target can be used for beam alignment before flipping the sensor head to face the objective for power measurements. In inverted microscopes, turn on the trans-illumination lamp and align the target on the detector housing with the beam; this will center the sensor in front of the objective.

Sensor specifications and the NIST- and PTB-traceable calibration data are stored in non-volatile memory in the sensor connector and can be read out by the latest generation of Thorlabs power meters. We recommend yearly recalibration to ensure accuracy and performance. Calibration may be ordered using the CAL-S200 recalibration service available below. Please contact technical support for more information.

The complete set of specifications are presented on the *Specs* tab above. Thorlabs also offers a Microscope Slide Sensor Head with a photodiode sensor for low-power, high-resolution measurements; the full presentation may be found here.

Part Number	Description	Price	Availability
S175C	**Customer Inspired! Microscope Slide Thermal Power Sensor, 300 nm - 10.6 µm, 2 W**	**$1,137.30**	**3-5 Days**

Internally SM1-Threaded Fiber Adapters

These internally SM1-threaded (1.035"-40) adapters mate connectorized fiber to any of our externally SM1-threaded components, including our photodiode power sensors, our thermal power sensors, and our photodetectors.

Please contact Tech Support if you are unsure if the adapter is mechanically compatible.

Item #	S120-FC	S120-SMA	S120-ST	S120-SC	S120-LC
Click Image to Enlarge					
Fiber Connector Type[a]	FC/PC[b]	SMA	ST	SC	LC
Thread	Internal SM1 (1.035"-40)				

- a. Other Connector Types Available upon Request

- b. In certain angle-independent applications, this adapter may also be used with FC/APC connectors.

Part Number	Description	Price	Availability
S120-FC	FC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Thread	$39.78	Today
S120-SMA	SMA Fiber Adapter Cap with Internal SM1 (1.035"-40) Thread	$39.78	Today
S120-ST	ST/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Thread	$39.78	Today
S120-SC	SC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Thread	$49.98	Today
S120-LC	LC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Thread	$49.98	Today

Recalibration Service for Thermal Power Sensors

Thorlabs offers calibration services for our thermal optical power sensors. To ensure accurate measurements, we recommend recalibrating the sensors annually. When returning a sensor for calibration, please also be sure to include the console used with it, as they will be calibrated together.

Compatible Thermal Sensors
S175C, S401C, S302C, S405C, S305C, S415C, S310C, S425C, S314C, S350C, S425C-L, S322C, S370C, S470C

The table to the right details which thermal sensors are available for this calibration service. Please enter the Part # and Serial # of the product that needs calibrating prior to Adding to Cart.

Part Number	Description	Price	Availability
CAL-S200	Recalibration Service for Thermal Sensors	$182.58	Lead Time