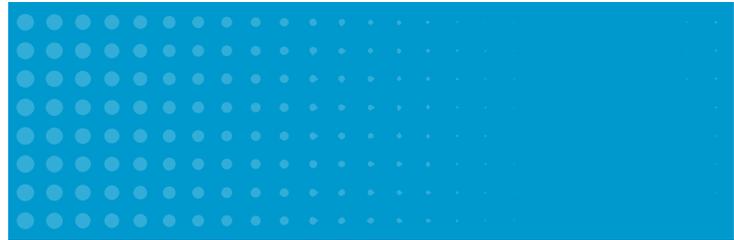


2025 POWER SENSORS 1.1

SENSORS



1.1 Power Sensors

Thermal Sensors

As described in the general introduction, the thermopile sensor has a series of bimetallic junctions. A temperature difference between any two junctions causes a voltage to be formed between the two junctions. Since the junctions are in series and the «hot» junctions are always on the inner, hotter side, and the «cold» junctions are on the outer, cooler side, radial heat flow on the disc causes a voltage proportional to the power input. Laser power impinges on the center of the thermopile sensor disc (on the reverse side of the thermopile), flows radially and is cooled on the periphery. The array of thermocouples measures the temperature gradient, which is proportional to the incident or absorbed power. In principle, the reading is not dependent on the ambient temperature since only the temperature difference affects the voltage generated and the voltage difference depends only on the heat flow, not on the ambient temperature. Since all the heat absorbed flows through the thermocouples (as long as the laser beam is inside the inner circle of hot junctions), the response of the detector is almost independent of beam size and position. If the beam is close to the edge of the inner circle, some thermocouples become hotter than others but since the sum of all of them is measured, the reading remains the same. Generally, Ophir specifies $\pm 2\%$ uniformity of reading over the surface or better.

Using Power Sensors to Measure Single Shot Energy

Although Ophir Thermal power sensors are used primarily to measure power, they can measure single shot energy as well, where they integrate the power flowing through the disc over time and thus measure energy. Since the typical time it takes for the disc to heat up and cool down is several seconds, these Thermal sensors can only measure one pulse every several seconds at most. Thus they are suitable for what is called “single shot” measurement. Although the response time of the sensor discs is slow, there is no limit to how short the pulses measured are since the measurement is of the heat flowing through the disc after the pulse.

Types of Thermopile Discs

There is no single absorber which meets the needs of all applications. Ophir has developed several types for different applications, such as long pulses (0.1-10ms), short pulses ($<1\mu\text{s}$) and continuous radiation. Absorbers optimized for long pulses and CW are characterized by thin, refractory materials, since the heat can flow through the coating and into the disc during the pulse. On the other hand, heat cannot flow during short pulses, and all the energy is deposited in a thin (typically $0.1\mu\text{m}$) layer near the surface. This causes vaporization of the surface which ruins the absorber. Instead, a volume absorber that is partially

transparent and absorbs over a distance of $50\mu\text{m}$ -3mm is used. This spreads the heat over a larger volume allowing much higher energies.

Ophir thermopiles can measure from tens of microwatts to Kilowatts. Nevertheless, the Thermal range of operation of the discs is limited. If the difference between the hot and cold junction temperature exceeds tens of degrees, the constant heating/cooling of the junctions can cause premature failure in the junctions. In order to accommodate different power ranges, discs of different thicknesses and sizes are used, thick ones for high powers and thin ones for low powers.

The response time of the discs is dependent on their size and shape: larger diameters and thicker discs are slower than thin small diameter ones. The response time is in general dependent on the mass of material which has to heat up in the thin absorber region of the disc vs. the speed the heat flows out of the same region. The response time is approximately proportional to the aperture, i.e. a 50mm aperture disc is three times as slow as an 18mm aperture disc.

Thermal Surface Absorbing Sensors

A surface absorber typically consists of an optically absorbing refractory material deposited on a heat conducting substrate of copper or aluminum. When a long pulse of several hundred μs or a continuous laser beam falls on such a surface absorber, the light is absorbed in a very thin layer of the surface – typically $0.1 - 1\mu\text{m}$ thickness (see illustration A). Although the light is absorbed in a thin layer and there converted into heat, the pulse is long enough so that while energy is being deposited into the surface layer, heat is also flowing out into the heat conducting substrate and therefore the surface does not heat up excessively. Ophir standard surface absorbers can stand up to 10 Joules/cm^2 for 2ms pulses and up to 28 kW/cm^2 for low power continuous lasers.

Surface Absorbers for High Power Lasers and Long Pulses

The traditional surface absorbers have a much lower damage threshold at $> 1000\text{ W}$, where they can damage at $2\text{-}3\text{ kW/cm}^2$. Ophir has developed coatings that improve the damage threshold for high power lasers. These coatings are denser and have higher heat conductivity than previous coatings. This LP2 coating also has a much higher damage threshold for long pulses reaching power damage thresholds of up to 10 kW/cm^2 and 300 J/cm^2 for 10ms pulses. Surface absorbers are suitable for pulses longer than $\sim 100\mu\text{s}$.

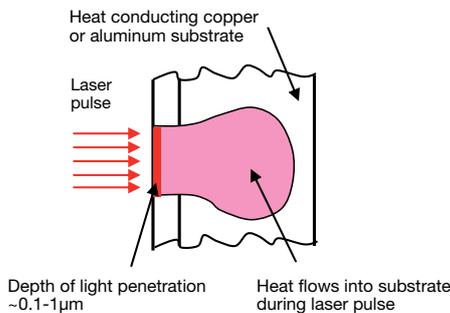
Surface vs. Volume Absorbers

When measuring a laser with short pulses of tens of μs or less, the heat is deposited in a short time and cannot flow during the pulse (see illustration B). Therefore a surface

absorber which absorbs the energy in a thin surface layer is not suitable. All the energy is deposited in a thin layer and that layer is vaporized. In this case, volume absorbers are used. These have traditionally consisted of a neutral density glass thermally bonded to a heat-conducting metallic substrate. The ND glass absorbs the light over a depth of 1-3 mm instead of fractions of a micrometer. Consequently, even with short pulses where there is no heat flow, the light and heat are deposited into a considerable depth of material and therefore the power/energy meter with a volume absorber is able to withstand much higher energy densities – up to 10 Joules/cm² (see illustration C). These ND glasses form the basis of the Ophir P type absorbers. In addition to the P absorbers, Ophir has PF and SV absorbers that can stand up to higher average powers and power densities as well as EX absorbers for the UV.

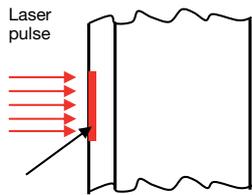
Long laser pulse (>100µs) or continuous

(A) Surface absorber

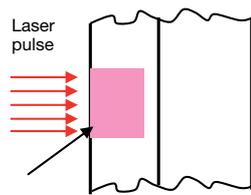


Short laser pulse <10µs

(B) Surface absorber



(C) Volume absorber

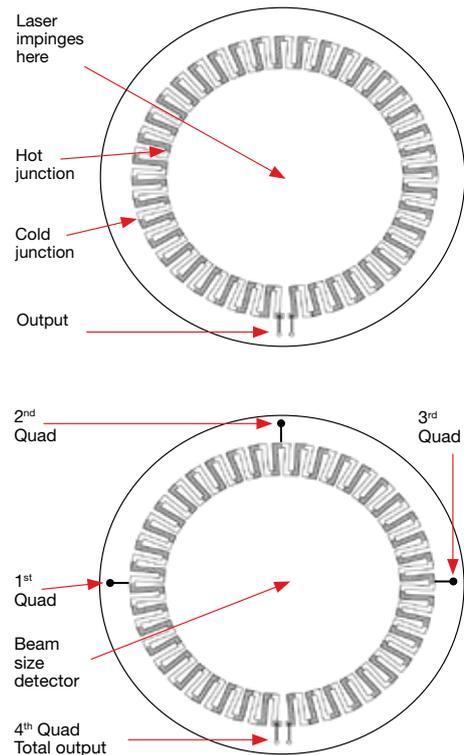


Surface absorbers work best when measuring power or energy for long laser pulses (A). Volume absorbers can measure pulses with much higher energies than surface absorbers (B), (C) can measure.

BeamTrack Power / Position / Size sensors

The BeamTrack Thermal sensors can measure beam position and beam size as well as power. This innovative device provides an additional wealth of information on your laser beam – centering, beam position and wander, beam size as well as power and single shot energy. The BeamTrack sensor is illustrated schematically here and works as follows: the signal coming from the sensor is now divided into 4 quadrants so by measuring and comparing the output from the 4 sections we can determine the position of the center

of the beam to a high degree of accuracy. In addition to the 4 quadrants, there is now a special proprietary beam size detector. After processing outputs from these various detectors, the user is presented with the beam position as well as beam size. Note that the beam size is calibrated only for a Gaussian beam of >3mm but for other beams it will give relative size information and will indicate if the beam is changing size. For more information on the BeamTrack sensors, please see section 1.1.3.



Calorimetric sensors

Ophir's calorimetric sensors are water cooled sensors which use the water flow rate and the temperature difference between the sensor's inlet (or measurement unit) and the sensor's outlet (or measurement unit) to calculate the power. The response of the detector is almost independent to beam size if the beam is properly set according to the sensor's spec.

Calibration

At Ophir's ISO/IEC 17025:2017 accredited laboratory each thermopile sensor is calibrated in a two-stage process against a NIST calibration standard. In the first stage, the responsivity of the sensor is measured and stored and in the second stage, the calibration is tested using several lasers to ensure the accuracy of the first stage. The total measurement uncertainty, expressing the accuracy of the sensor under regular operating conditions and the calibration uncertainty, which defines the uncertainty of the final calibration stage (comparing against a NIST master using lasers) are given in the specifications of each sensor.

Introduction to High Power Water Cooled Sensors

Ophir has many years of experience in supplying measurement systems for high power industrial lasers and has the highest power measuring equipment available on the market – up to 120 kilowatts. Ophir meters also have the highest damage threshold available – up to 10kW/cm² at 10kW. Ophir supplies water cooled sensors from 250W up to 120kW (and air-cooled sensors up to 1100W).

Sensors supplied by Ophir are tested at up to full power and their linearity verified over the entire power range. This is done by measuring the reading over the power range against a higher power sensor that has been previously measured and verified by NIST or PTB. The accuracy, linearity and damage specifications have been carefully verified over many years of development and use by the largest existing user base. In cases of unique and/or extreme user parameters (such a sultra high-power levels, pulse energies, unique beam profiles) Ophir has advanced simulation capabilities both thermal and optical to validate the functionality of its sensors. In addition to power meters for high powers, Ophir also has beam profilers, beam dumps and protective enclosures for industrial lasers.

Calibration Method and Estimated Accuracy for Ophir High Power Sensors

Ophir high-power sensors (models 5000W, 10K-W, IPM-10KW, 15K-W, 20K-W, Comet 10K, 30K-W, 120K-W and 150K-W) are ordinarily calibrated using moderate-power lasers, not exceeding 6000W (though in certain cases, sensors can be calibrated at up to 15,000W). In other words, we calibrate high-power sensors using laser powers that are in many cases much lower than the power rating of the sensors being calibrated. This raises the question of calibration accuracy. The following brief explanation will clarify how we know that these highest power sensors are indeed accurate to $\pm 5\%$ over their entire measurement range as specified.

Basing high-power calibration accuracy on lower power calibration measurements is valid, subject to the condition that the sensors are linear all across the full power range.

The calibration measurements themselves (using the moderate-power lasers) are all based on NIST-calibrated master references.

At the lower powers, the reference sensors are based on Photodiode detectors; Photodiode detectors are well known to be highly linear.

At the higher powers, Thermal sensors are used as the reference. A series of detailed tests have confirmed that indeed these sensors are highly linear, all the way up to the highest powers for which they are rated.



Since the Thermal sensors have been shown to be linear over the entire range of powers, it follows that if the calibration is correct at low powers, it will remain correct at high powers as well.

Some additional points:

- An additional issue is zero offset; although the output may be linear at low powers, there may be a zero offset that, due to the relatively low output at low powers, will cause an error in calibration. For example, if calibration is performed at 200W and the output of the sensor is 10 μ V/W (a typical value) and there is a zero offset of only 1 μ V, this will cause a calibration error of 10%. Ophir's calibration method includes measuring the difference between the reading with power applied and without power applied, thus eliminating error due to zero offset. This measurement is taken several times to insure accuracy.
- The above measurement method assures that the calibration inaccuracy due to measurement errors is less than 1%, comparable to the expected errors in our lower powered sensors. In order to verify this, all of our high power sensors have been measured by comparison to various calibration standards. These measurements have shown Ophir sensors to be well within the claimed limits of linearity.
- The Comet 10K series measures the heat rise of the absorbing puck when irradiated by the laser for 10s. In order to calibrate the Comet 10K, we simply irradiate with a lower power laser for longer e.g. 150W for 60s. Thus the heating effect is similar to that of a higher power laser. Tests of the Comet calibrated by this method vs. NIST traceable high power sensors have shown that it is accurate and reproducible.

For more information on calibration, please read tutorial on our website at www.ophiropt.com

Note regarding water cooling:

Most Ophir high power sensors are water cooled. Customers often have questions about our water cooled sensors such as the correct flow rate and pressure under various conditions and the quality of the water required. For further information on water cooled sensors, please see our tutorial on the subject on our website <http://www.ophiropt.com>

Photodiode Sensors

A Photodiode sensor is a semiconductor device that produces a current proportional to light intensity and has a high degree of linearity over a large range of light power levels - from fractions of a nW to about 2mW. Above that light level, corresponding to a current of about 1mA, the electron density in the Photodiode becomes too great and its efficiency is reduced causing saturation and a lower reading. Most Ophir PD sensors have a built-in filter that reduces the light level on the detector and allows measurement up to 30mW without saturation. Most sensors have an additional removable filter allowing measurement to 300mW or 3W depending on the model.

Principle of Operation

When a photon source, such as a laser, is directed at a Photodiode detector, a current proportional to the light intensity and dependent on the wavelength is created. Since many low power lasers have powers on the order of 5 to 30mW, and most Photodiode detectors saturate at about 2mW, the PD300 sensor has been constructed with a built-in filter so the basic sensor can measure up to 30mW without saturation. With the removable extra filter, the PD300 sensors series can measure up to 300mW or 3W depending on the model.

The Ophir power meter unit amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the Ophir power meters, the noise level is very low and the PD300 series sensors with Ophir power meter have a large dynamic range from picowatts to watts. The PD300 is shown schematically below. The PD300 and PD300-1W have the exclusive patented dual

detectors connected back to back which eliminate any signal illuminating both detectors equally (background light).

Calibration and Accuracy

The sensitivity of various photodiode sensors varies from one sensor to another as well as with wavelength. At Ophir's ISO/IEC 17025:2017 accredited laboratory each photodiode sensor is calibrated in a two-stage process against a NIST photodiode calibration standard. In the first stage the photodiode is calibrated using a monochromator over its entire spectral range, and in the second stage the calibration is tested using several lasers to ensure the accuracy of the first stage. As an example, total measurement uncertainty of $\pm 2\%$ (expressing the accuracy of the sensor under regular operating conditions) is achieved for PD300-UV at 420-980nm. The Calibration Uncertainty, which defines the uncertainty of the final calibration stage (comparing against a NIST master using lasers) is given in the following table:

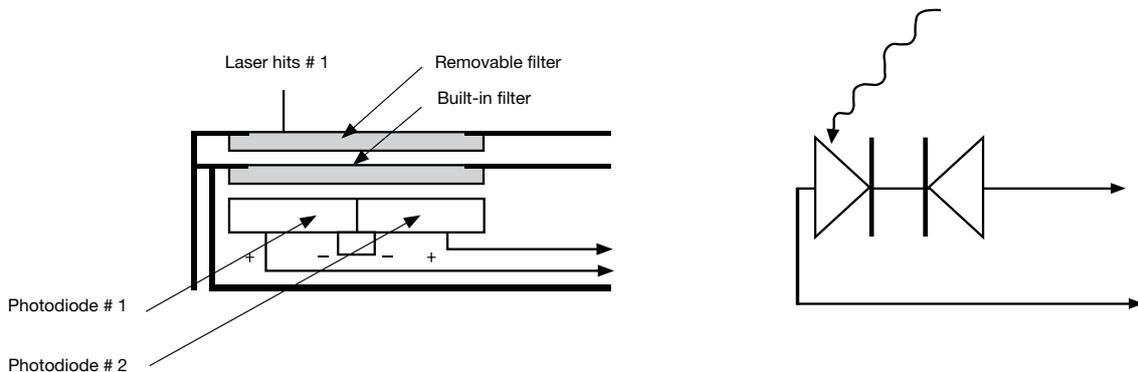
	UV & VIS Photodiode Sensors	IR Photodiode Sensors	Radiometric Sensors (PD300RM)
Calibration Uncertainty	200 to 300nm 3.2% 300 to 430nm 1.65% 430 to 1000nm 1.1% 1035 to 1065nm 4.3%	700 to 1430nm 2.4% 1430 to 1600nm 2.6%	250 to 300nm 4.5% 300 to 400nm 3.6% 400 to 1000nm 3.4%

Photodiode detectors are linear by nature, and as long as they are not operated close to saturation, measurement errors due to non-linearity can be ignored.

For more information on calibration accuracy please see our tutorial on our website:

www.ophiropt.com

All Ophir power and energy sensors come with a mounting stand.



1.1.1 Photodiode Power Sensors

1.1.1.1 Standard Photodiode Sensors

50pW to 3W

Features

- Very large dynamic range
- Swivel mount for hard to measure places
- Comes with filter in / filter out options
- Patented automatic background subtraction
- Fiber optic adapters available

PD300 with filter off



PD300 with filter installed



Model	PD300			PD300-1W			PD300-3W			PD300-TP		
Use	General			Powers to 1W			Powers to 3W			Thin profile for tight fit		
Detector Type	silicon			silicon			silicon			silicon		
Aperture	10x10mm			10x10mm			10x10mm			10x10mm		
Calibration Uncertainty ±%	1.1 430-1000nm ^(b)			1.1 430-1000nm ^(b)			1.1 430-1000nm ^(b)			1.1 430-1000nm ^(b)		
Filter Mode	Filter out	Filter in		Filter out	Filter in		Filter out	Filter in		Filter out	Filter in	
Spectral Range nm	350-1100	430-1100		350-1100	430-1100		350-1100	430-1100		350-1100	400-1100	
Power Range	500pW to 30mW	2μW to 300mW		500pW to 30mW	2μW to 1W		5nW to 100mW	2μW to 3W		50pW to 3mW	2μW to 1W	
Power Scales	30mW to 30nW and dBm	300mW to 300μW and dBm		30mW to 30nW and dBm	1W to 300μW and dBm		100mW to 300nW and dBm	3W to 300μW and dBm		3mW to 3nW and dBm	1W to 300μW and dBm	
Resolution nW	0.01	NA		0.01	NA		0.1	NA		0.001	1	
Maximum Power vs. Wavelength	nm	mW	mW	nm	mW	mW	nm	mW	mW	nm	mW	mW
	<488	30	300	<488	30	1000	<488	100	3000	350-400	3	NA
	633	20	300	633	20	1000	633	100	3000	400-500	3	1000
	670	13	200	670	13	1000	670	100	2000	600	2.5	1000
	790	10	100	790	10	600	790	100	1200	700	2	500
	904	10	100	904	10	700	904	100	1200	800-950	1.5	300
1064	25	250	1064	25	1000	1064	100	2200	1064	3	500	

Accuracy (including errors due to temp. variations)

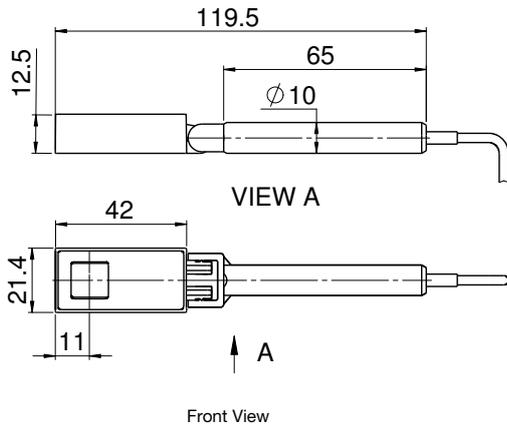
% error vs Wavelength nm	±10 360-400	NA	±10 360-400	NA	±10 360-400	NA	±7 350-400	NA	
	±3 400-980	±5 430-980	±3 400-950	±5 430-950	±3 400-950	±5 430-950	±3 400-450	±5 400-450	
	±5 980-1100	±7 980-1100	±4 950-1030	±6 950-1030	±4 950-1030	±6 950-1030	±2 450-950	±3 450-950	
			±6 1030-1100	±7 1030-1100	±6 1030-1100	±7 1030-1100	±6 950-1100	±7 950-1100	
Damage Threshold W/cm ²	10	50	10	10 ^(a)	10	30	10	50	
Max Pulse Energy μJ	3	30	3	200	30	400	1	100	
Noise Level for filter out pW	20		20		200		±2		
Response Time with Meter s	0.2		0.2		0.2		0.2		
Beam Position Dependence	±2%		±2%		±2%		±3%		
Background Subtraction	95-98% of background is cancelled automatically under normal room conditions, even when changing continuously					N.A.		N.A.	
Fiber Adapters Available (see page 33)	ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC		N.A.		
Compliance	CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS		
Version					V1				
Part Number	7Z02410		7Z02411A		7Z02426		7Z02424		

Notes: (a) Maximum power density above which sensor may not read correctly. There will be no permanent damage until 50W/cm²
 (b) For calibration uncertainty of wavelengths outside of this range see table on page 24

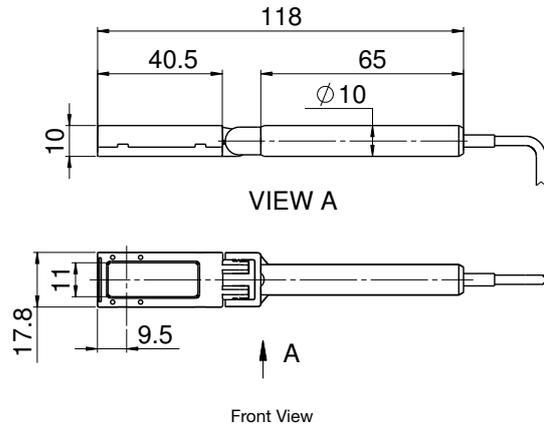
* For graphs see page 31-32

* For drawings please see page 26

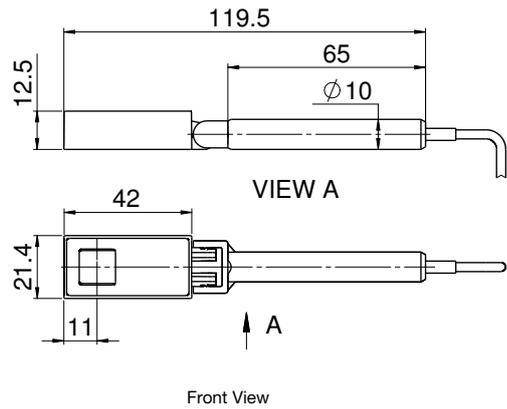
PD300 / PD300-1W filter installed



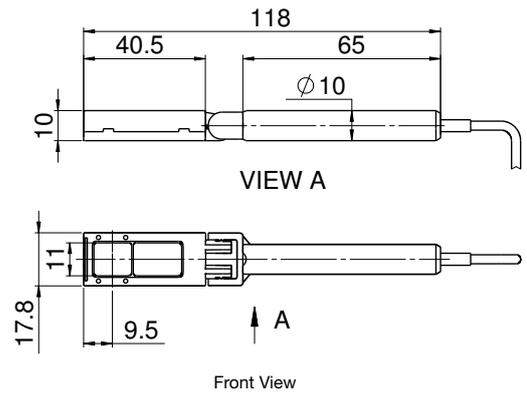
PD300 / PD300-1W filter off



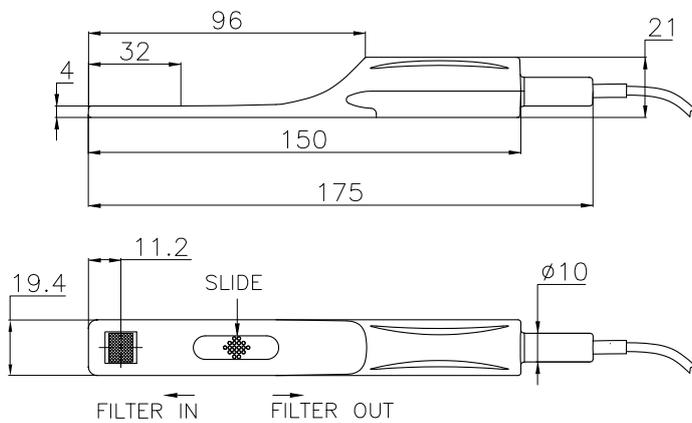
PD300-3W filter installed



PD300-3W filter off



PD300-TP



1.1.1.1 Standard Photodiode Sensors

20pW to 300mW

Features

- Spectral range including UV and IR
- Very large dynamic range
- Swivel mount for hard to measure places
- Comes with filter in / filter out options
- Fiber optic adapters available

PD300-UV / PD300-IR
with filter off



PD300-UV / PD300-IR
with filter installed



PD300-IRG with
fiber input



Model	PD300-UV/ PD300-UV-193			PD300-IR			PD300-IRG		
Use	Lowest powers from 200-1100nm			Low powers from 700-1800nm			Telecom wavelength fiber and free space measurements		
Detector Type	silicon			Germanium			InGaAs		
Aperture	10x10mm			Ø5mm			Ø5mm for free space beams		
Calibration Uncertainty ±%	1.1 430-1000nm ^(c)			2.4 700-1430nm ^(c)			2.4 900-1430nm ^(c)		
Filter Mode	Filter out	Filter in		Filter out	Filter in		Filter out	Filter in	
Spectral Range nm	200 - 1100	220 - 1100		700-1800	700-1800		900 - 1630	950 - 1630	
Power Range	20pW to 3mW	2µW to 300mW		5nW to 30mW	2µW to 300mW		20pW to 800µW	1µW to 200mW	
Power Scales	3mW to 3nW and dBm	300mW to 300µW and dBm		30mW to 30nW and dBm	300mW to 300µW and dBm		800 µW to 800pW and dBm	300mW to 30µW and dBm	
Resolution nW	0.001	100		0.01	NA		0.0001	1	
Maximum Power vs. Wavelength	nm	mW	mW	nm	mW	mW	nm	mW	mW
	250 - 350	3	300	800	12	120	<1000	0.8	200
	400	3	300	1000-1300	30	300	1100	0.8	200
	600	3	300	1400	30	250	1200	0.8	200
	800 - 950	2.5	150	1500	30	100	1300	0.8	200
1064	3	300	1600	30	100	1550	0.8	200	
>1600			1800	30	300	>1600	0.8	200	

Accuracy (including errors due to temp. variations)

% error vs Wavelength nm ^(b)	±10	200-230	±10	220-300	±5	700-800	±6	700-900	±3	1000-1600	±6	1000-1600
	±7	230-300	±4	300-420	±4	800-1700	±5	900-1700	±5 ^(a)	900-1000 & 1600-1630	±8 ^(a)	900-1000 & 1600-1630
	±3	300-420	±3	420-980	±7	1700-1800	±9	1700-1800				
	±2	420-980	±7	980-1100								
	±7	980-1100										
Damage Threshold W/cm ²	10	50		10	50		5	50				
Max Pulse Energy µJ	1	50		0.75	2		1	100				
Noise Level for filter out pW	±1			200			±300fW at 1550 nm and 1s average					
Response Time with Meter s	0.2			0.2			0.2					
Beam Position Dependence	±2%			±2%			±1% over 80% of aperture					
Fiber Adapters Available (see page 33)	ST, FC, SMA, SC			ST, FC, SMA, SC			FC, FC/APC, SMA					
Compliance	CE, UKCA, China RoHS			CE, UKCA, China RoHS			CE, UKCA, China RoHS					
Version							V2					
Part Number	7Z02413/7Z02413A ^(a)			7Z02412			7Z02495					

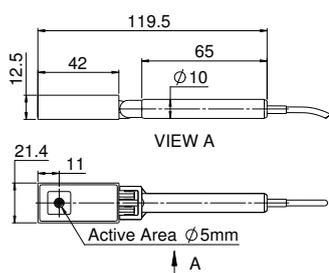
Notes: (a) Assuming temperature range between 18-26 degrees – outside of this range add additional error per temperature dependence graph

(b) Same as above with additional calibration point at 193nm accuracy ±6%

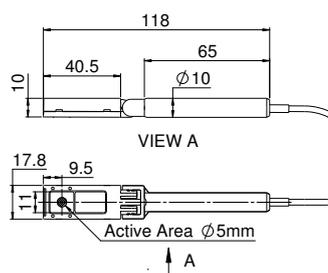
(c) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For graphs see page 31-32

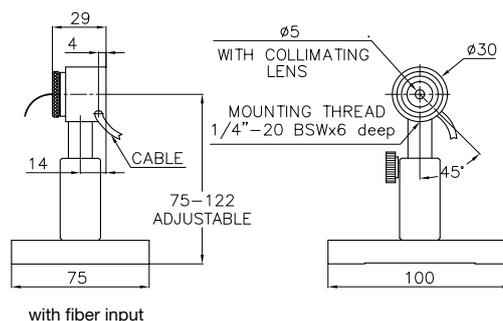
PD300-UV / PD300-IR filter installed
(Ø5mm for PD300-IR only)



PD300-UV / PD300-IR filter off
(Ø5mm for PD300-IR only)



PD300-IRG



1.1.1.2 Round Photodiode Sensors

20pW to 3W

Features

- Round geometry for easy centering
- Threaded to fit standard SM1 bench equipment
- Same performance as standard PD300 sensors
- Comes with removable filter as standard
- • Fiber optic adapters available

PD300R Filter Off



PD300R Filter installed



Model	PD300R		PD300R-3W		PD300R-UV		PD300R-IR				
Use	General		Powers to 3W		Lowest powers from 200-1100nm		IR wavelengths 700-1800nm				
Detector Type	silicon		silicon		silicon		Germanium				
Aperture	Ø10mm		Ø10mm		Ø10mm		Ø5mm				
Calibration Uncertainty ±%	1.1 430-1000nm ^(a)		1.1 430-1000nm ^(a)		1.1 430-1000nm ^(a)		2.4 700-1430nm ^(a)				
Filter Mode	Filter out	Filter in	Filter out	Filter in	Filter out	Filter in	Filter out	Filter in			
Spectral Range nm	350-1100	430-1100	350-1100	430-1100	200 -1100	220 -1100	700-1800	700-1800			
Power Range	500pW to 30mW	2µW to 300mW	5nW to 100mW	2µW to 3W	20pW to 3mW	2µW to 300mW	5nW to 30mW	2µW to 300mW			
Power Scales	30mW to 30nW and dBm	300mW to 300µW and dBm	100mW to 300nW and dBm	3W to 300µW and dBm	3mW to 3nW and dBm	300mW to 300µW and dBm	30mW to 30nW and dBm	300mW to 300µW and dBm			
Resolution nW	0.01		0.1		0.001		0.01				
Maximum Power vs. Wavelength	nm	mW	nm	mW	nm	mW	nm	mW			
	<488	30	300	<488	100	3000	250 - 350	3	300		
	633	20	300	633	100	3000	400	3	300		
	670	13	200	670	100	2000	600	3	300		
	790	10	100	790	100	1200	800 - 950	2.5	150		
	904	10	100	904	100	1200	1064	3	300		
	1064	25	250	1064	100	2200			1800	30	300

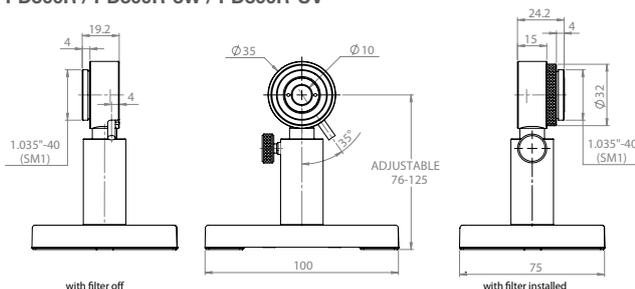
Accuracy (including errors due to temp. variations)

% error vs Wavelength nm	±10	360-400	NA	±10	360-400	NA	±10	200-230	±10	220-300	±5	700-800	±6	700-900
	±3	400-980	±5	430-980	±3	400-950	±5	430-950	±7	230-300	±4	300-420	±4	800-1700
	±5	980-1100	±7	980-1100	±4	950-1030	±6	950-1030	±3	300-420	±3	420-980	±7	1700-1800
				±6	1030-1100	±7	1030-1100	±2	420-980	±7	980-1100			
Damage Threshold W/cm ²	10	50	10	30	10	50	10	50	10	50	10	50	10	50
Max Pulse Energy µJ	3	30	30	400	3	30	1	50	0.75	2	0.75	2	0.75	2
Noise Level for filter out pW	20		200		±1		200		200		200		200	
Response Time with Meter s	0.2		0.2		0.2		0.2		0.2		0.2		0.2	
Beam Position Dependence	±2%		±2%		±3%		±2%		±2%		±2%		±2%	
Fiber Adapters Available (see page 33)	ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC							
Compliance	CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS							
Version														
Part Number: Standard Sensor	7Z02436		7Z02437		7Z02438 (1.5m cable)		7Z02439		7Z02438 (1.5m cable)		7Z02439		7Z02439	
Sensor with different cable length							7Z02438C (10m cable)							

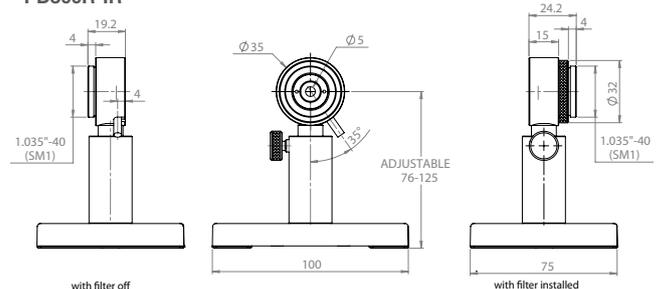
Note: (a) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For graphs see page 31-32

PD300R / PD300R-3W / PD300R-UV



PD300R-IR



1.1.1.3 Special Photodiode Sensors

3μW to 1W

Features

- PD300-MS for measurement of optical intensity after the microscope objective.
- Low angular dependence for high N.A. objectives.
- Can be used with air, water or oil immersion objectives.

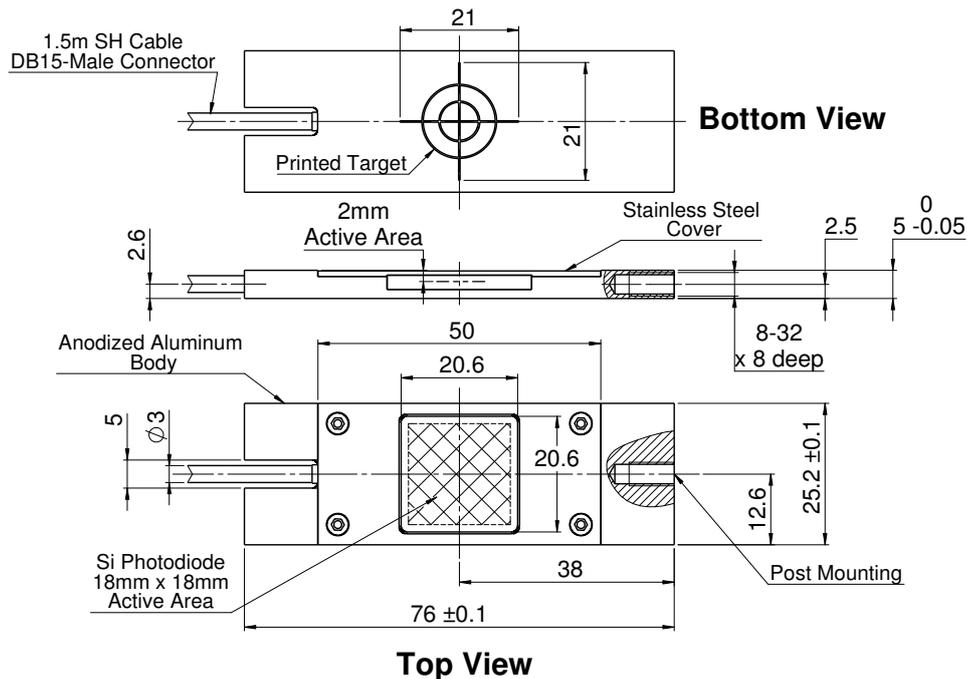
PD300-MS



Model	PD300-MS	
Use	Measurement of light intensity at microscope slide plane	
Detector Type	Silicon with filter	
Aperture	18x18mm	
Spectral Range nm	350-1100	
Power Range	3μW to 1W (see wavelength dependency below)	
Power Scales	100μW to 1W and dBm	
Resolution μW	0.1	
Calibration Uncertainty ±%	1.1 430-1000nm ^(b)	
Maximum Power vs. Wavelength	Wavelength, nm	Power Range
	350 - 650	6μW to 1W
	650 - 800	3μW to 800mW
	800 - 1000	3μW to 600mW
Accuracy (including errors due to temp. variations)	>1000	6μW to 700mW
	±7 350 - 400	
% error vs Wavelength nm ^(a)	±5 400 - 1100	
Linearity	1%	
Additional Error with Converging Beam	3% for N.A. 0.9	
Damage Threshold W/cm ²	20	
Noise Level	300nW at 350nm, 150nW at 960nm	
Response Time with Meter s	0.2	
Compliance	CE, UKCA, China RoHS	
Version		
Part Number	7Z02482	

Note: (a) For beam centered on sensor ±2 mm
 (b) For calibration uncertainty of wavelengths outside of this range see table on page 24

PD300-MS



1.1.1.3 Special Photodiode Sensors

Features

- PD300-BB for broadband light sources - radiometry (PD300-BB-50mW option up to 50mW)
- PD300-CIE for human visual perception Lux measurements
- BC20 for measuring scanned beams such as bar code light sources



Model	PD300-BB	PD300-BB-50mW	PD300-CIE ^(a)	BC20
Use	Radiometry-broad spectrum	Same as PD300-BB with removable attenuator for use to 50mW	Eye adjusted measurement in Lux	Scanned beams e.g. bar code with continuous wavelength curve
Detector Type	Silicon with special filter	Silicon with special filter	Silicon with special filter	Silicon with peak and hold circuit
Aperture	10x10mm	10x10mm	Active area 2.4 x 2.8mm	10x10mm
Spectral Range nm	430 - 1000 (see graph)	430 - 1000 (see graph)	400 - 700 (see graph)	400 - 1100 (see graph) ^(c)
Calibration Uncertainty $\pm\%$	1.1 430-1000nm ^(d)	1.1 430-1000nm ^(d)	NA	NA
Filter Mode		Filter out	Filter in	
Power Range	50pW to 4mW	50pW to 4mW	1nW to 50mW	20mLux to 200kLux
Power Scales	4mW to 8nW and dBm	4mW to 8nW and dBm	50mW to 80nW and dBm	200kLux to 200mLux
Resolution	1pW	1pW	10pW	1mLux
Accuracy	Maximum deviation from flat spectrum (see graph) $\pm 10\%$	Maximum deviation from flat spectrum (see graph) $\pm 10\%$	Maximum deviation from flat spectrum (see graph) 430-910nm, $\pm 12\%$ flatness (see graph)	$\pm 3\%$ for $>10\%$ of full scale. Deviation from calibration -3% at 30,000 inch/s scan rate on sensor
Damage Threshold W/cm ²	10	10	100	10
Max Pulse Energy μ J	1	1	10	1
Noise Level pW	2	2	30	± 1 mLux
Response Time with Meter s	0.2	0.2	0.2	0.2
Beam Position Dependence	$\pm 2\%$ for broadband light sources	$\pm 2\%$ for broadband light sources	$\pm 3\%$ for broadband light sources	NA – source overfills detector
Background Subtraction	NA	NA	NA	NA
Fiber Adapters Available (see page 33)	NA	ST, FC, SMA, SC	NA	NA
Compatible Meter / Interface	All Meters & Interfaces	All Meters & Interfaces	Centauri, StarBright, Vega, Nova II, Juno, Juno+, Juno-RS, LaserStar and Nova	StarBright, Vega, Nova II, Juno, Juno+, LaserStar and Nova
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version				V1
Part Number	7Z02405	7Z02440	7Z02406	7Z02481 ^(b)

Notes: (a) The PD300-CIE sensor is not under ISO/IEC 17025:2017 accreditation

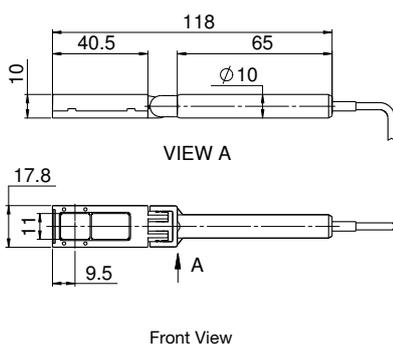
(b) Swivel stand for BC20 sensor P/N 1Z09004

(c) The user can select up to 5 wavelengths from the spectral range. When used with the Nova or LaserStar meters, the sensor will only have the discrete wavelengths 405nm, 633nm, 650nm, 675nm and 780nm

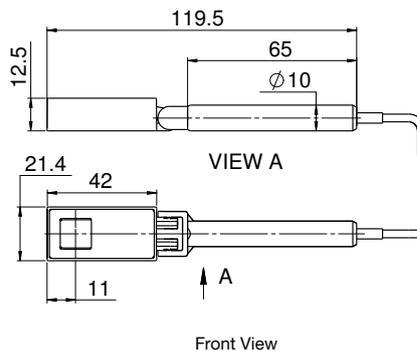
(d) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For graphs see page 31-32

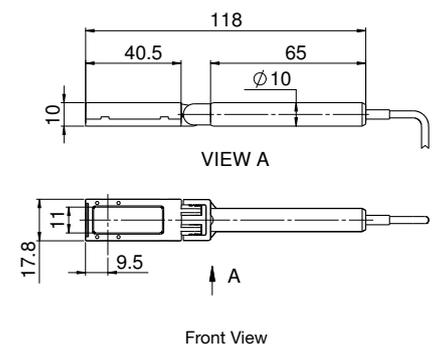
PD300-CIE / PD300-BB / PD300-BB-50mW with filter off



PD300-BB-50mW with filter installed

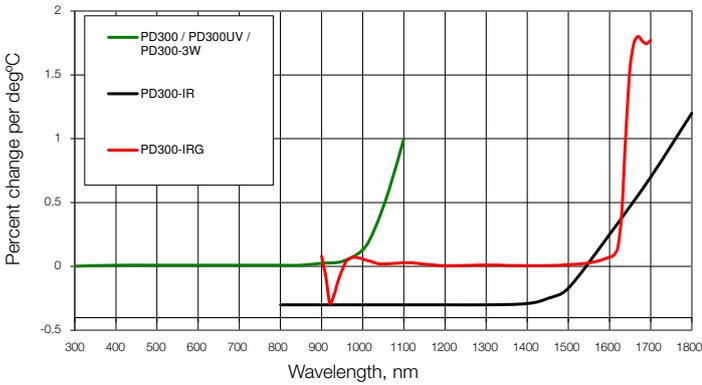


BC20

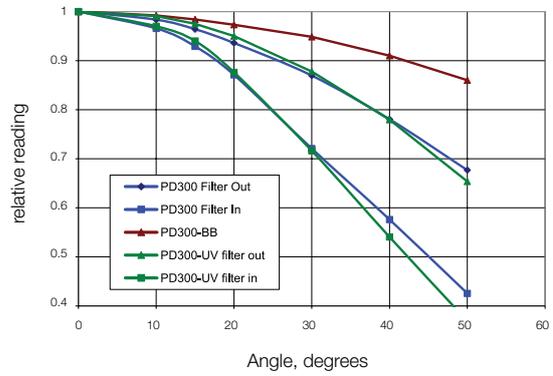


1.1.1.4 Graphs

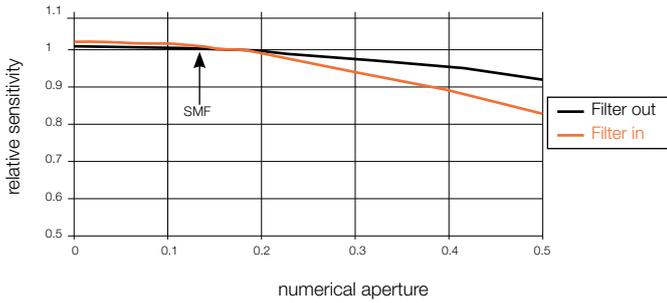
Temperature Coefficient of Sensitivity



PD300 Angle Dependence

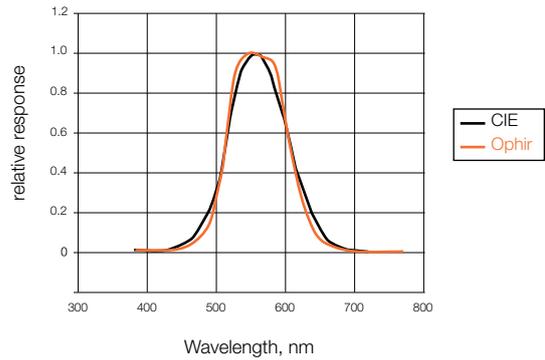


Dependence of Sensitivity on Numerical Aperture (PD300 - IRG)

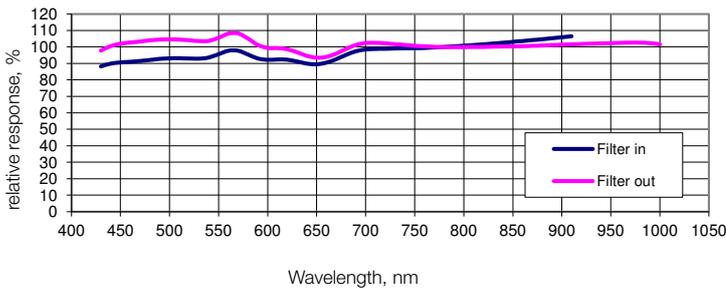


- Note:
1. Graph assumes equal intensity into all angles up to maximum N.A.
 2. Calibration is done with SMF, N.A. 0.13

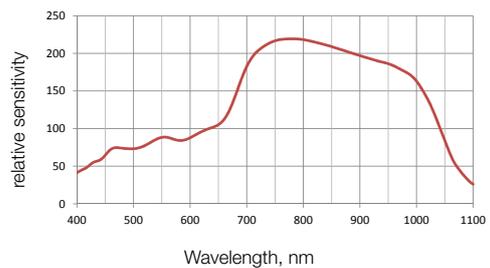
PD300-CIE Spectral Response vs. CIE Curve



Typical Sensitivity Curve of PD300-BB Sensors



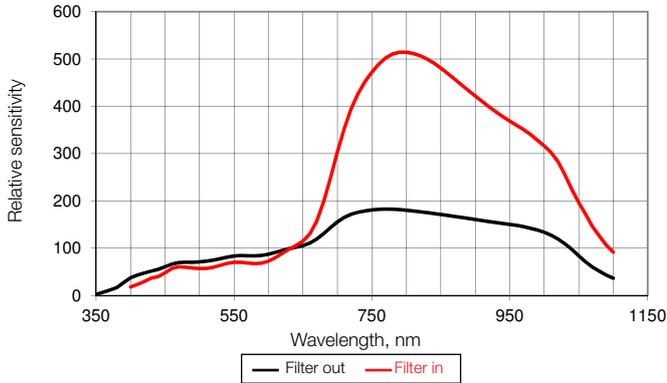
BC20 Relative Spectral Response



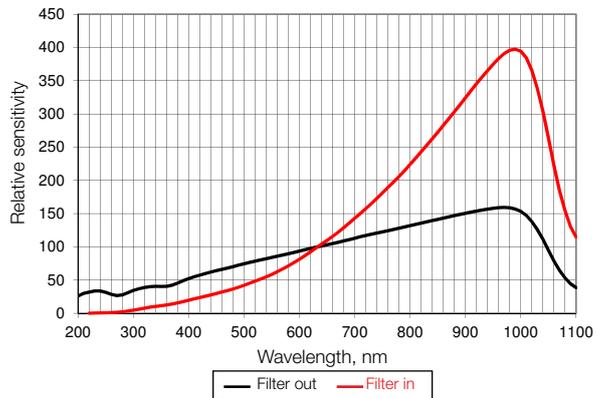
Approximate Spectral Response

Relative to 633nm or 1550nm

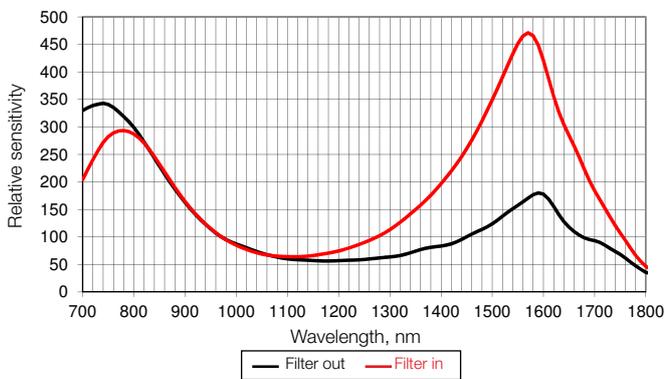
PD300 / PD300R



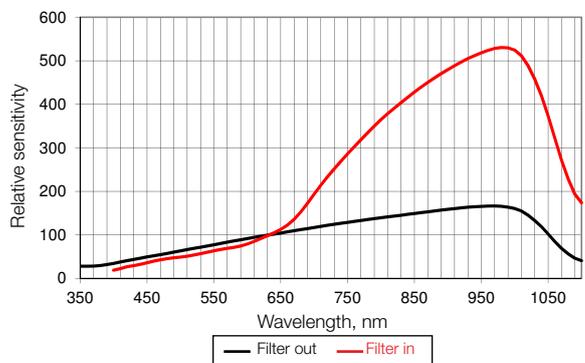
PD300-UV / PD300R-UV



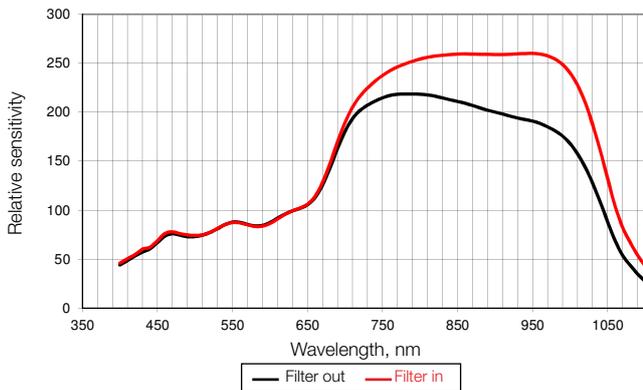
PD300-IR / PD300R-IR



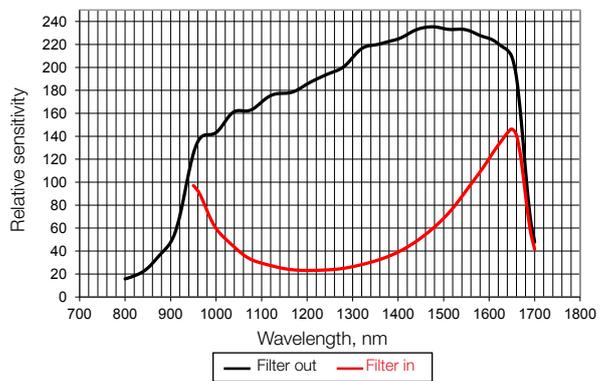
PD300-TP



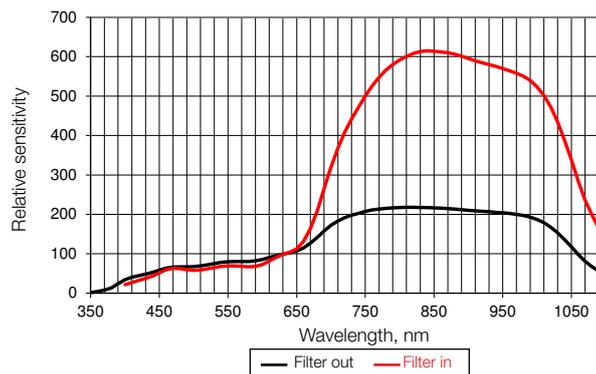
PD300-3W / PD300R-3W



PD300-IRG



PD300-1W



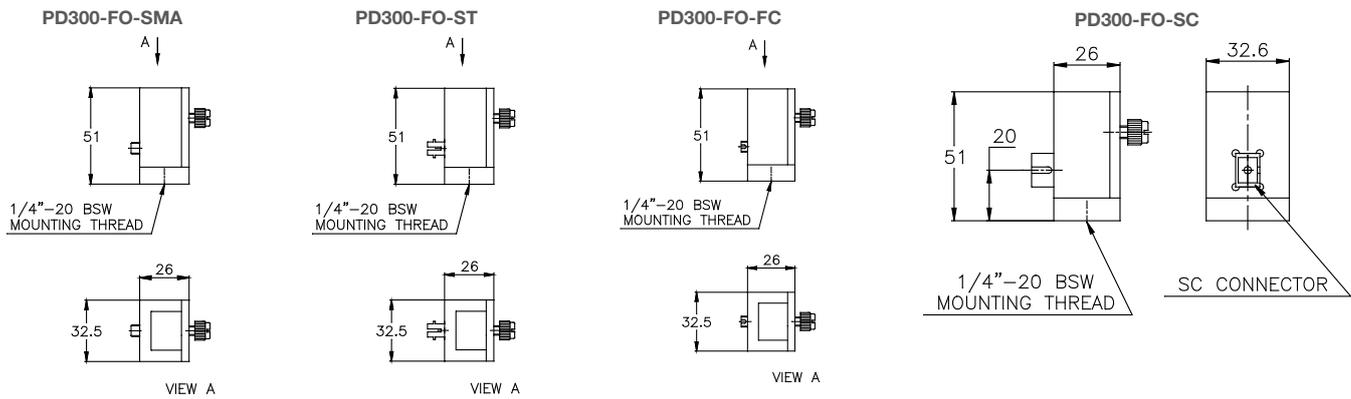
1.1.1.5 Accessories for Photodiode Sensors

Fiberoptic Adapters and Other Accessories

Accessories and Fiberoptic Adapters for PD300 series

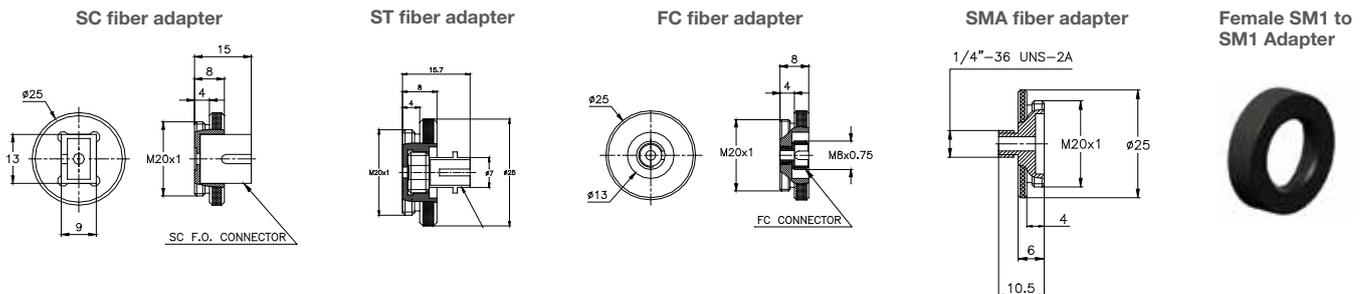
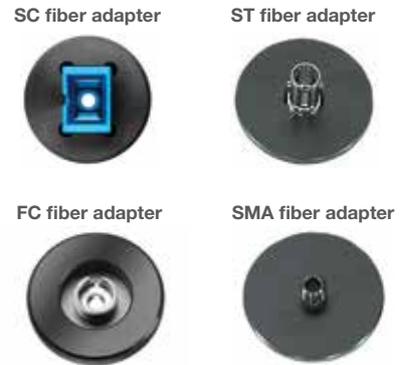
Accessory	Description	Part number			
PD300-CDRH-7mm	Ø7mm aperture adapter for CDRH measurements for PD300	7Z02418			
PD300-CDRH-3.5mm	Ø3.5mm aperture adapter for CDRH measurements for PD300	7Z08336			
Fiber Adapters for Sensor Series	Adapters for mounting fibers to PD300 sensors as shown below	SC type	ST type	FC, FC / APC type	SMA type
PD300 Series		7Z08221	7Z02210	7Z02213	7Z02212

PD300 with F.O. Adapter Mounted



Accessory	Description	Part number			
PD300R-CDRH-7mm	Ø7mm aperture adapter for CDRH measurements for PD300R	7Z08347			
Fiber Adapters for Sensor Series	Fiber adapter mounting bracket (1 bracket fits all fiber adapters)	SC type	ST type	FC, FC / APC type	SMA type
FPS Series	1G02259 - not needed except for FPS-1	7Z08227	7Z08226	7Z08229	1G01236A
PD300R Series	1G02259	7Z08227	7Z08226	7Z08229	1G01236A
3A-IS / 3A-IS-IRG	7Z08213	7Z08227	7Z08226	7Z08229	1G01236A
IS-1-2W	7Z08331	7Z08227	7Z08226	7Z08229	1G01236A
PD300-IRG	not needed			7Z08216	7Z08222
Female SM1 to SM1 Adapter	For mounting PD300R series, PD300RM-UV & PD300RM-8W and FPS-1 sensors to SM1 optical components and systems				1G02260

Accessories and Fiberoptic Adapters for PD300R series, PD300-IRG, 3A-IS, IS-1-2W and FPS series



1.1.1.6 Integrating Spheres

Introduction

Ophir Integrating Sphere sensors are used for measuring divergent light sources such as LEDs, VCSELs and other lasers. Integrating sphere detectors are also used for measuring large beams that do not fit in a PD300 photodiode sensor. The light is introduced to the sphere through the input port, it is reflected many times by the highly reflecting diffuse coating on the inner wall of the sphere until it uniformly illuminates the inner surface of the sphere. A detector samples a small fraction of this light and thus can be used to measure the total power input into the sphere.

Ophir integrating spheres have a highly reflecting diffuse white coating for high efficiency and readings that are independent of beam size, position and divergence.

Diverging and Collimated Beams Measurement Considerations

Ophir Integrating Spheres can be used either with diverging or collimated beams as shown below. In order for an integrating sphere sensor to operate properly, the beam should never directly hit the detector and the detector should only see rays reflected from the wall. The diagram below shows how the sphere can be used with either a collimated or diverging beams. The unused port is closed with a reflective plug.

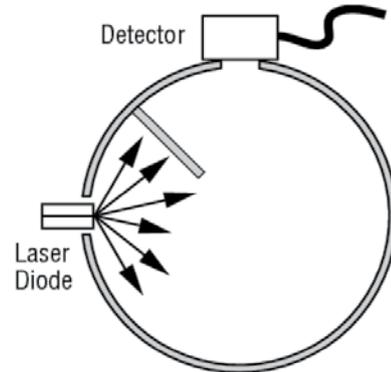
Ophir offers small spheres with 1" to 1.6" diameter and 5.3" spheres. Photodiode detectors provide calibrated power measurement of up to 30W between 200nm and 1800nm. Many accessories are available for Ophir Integrating Spheres such as fiber adapters and fast photodiode detectors for pulse shape monitoring. In order to maintain accuracy and guarantee performance, annual integrating sphere detector calibration is recommended.

Note that the system calibration is no longer valid if any component is changed from the original calibrated configuration.

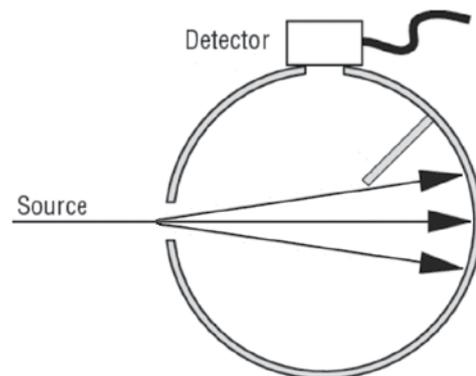
Related Product

Ophir also offers an integrating sphere sensor that has an FPD pulse characterization detector built in.

See our **IS1.5-VIS-FPD-800, 1.5" High Speed Response, Multi-functional Integrating Sphere** on page 36.



This integrating sphere configuration is ideal for a diverging beam



This integrating sphere configuration is ideal for a collimated beam

IS1.5-VIS-FPD-800 (see p. 36)



1.1.1.6 Integrating Spheres

1.1.1.6.1 Small Dimensions 1"-1.6"

500nW to 3W

Features

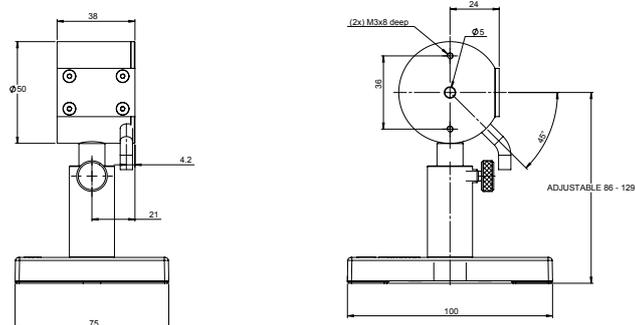
- Integrating sphere for divergent beams (LEDs, VCSELs, etc.)
- Up to Ø12mm aperture
- Fiber or free space input



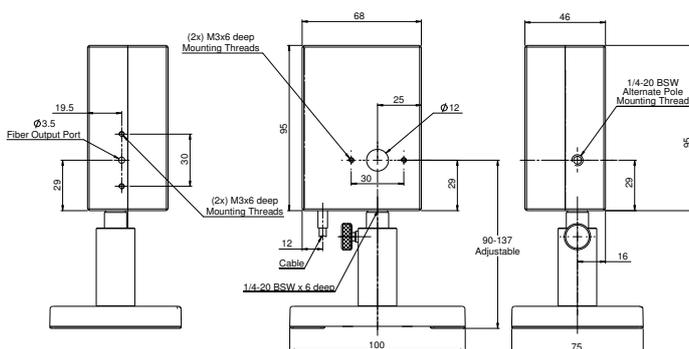
Model	IS-1-2W	3A-IS	3A-IS-IRG
Use	Divergent beams to 2W for UV to NIR	Divergent beams to 3W for visible and NIR	Divergent beams to 3W for IR
Detector Type	Si	Si	InGaAs
Input Port Aperture mm	Ø5mm	Ø12mm	Ø12mm
Spectral Range µm	0.22 - 1.1	0.35 - 1.1	0.8 - 1.7
Power Range	500nW – 2W	1µW – 3W	1µW – 3W
Power Scales	2W to 20µW and dBm	3W to 3µW and dBm	3W to 3µW and dBm
Calibration Uncertainty ±%	1.1 430-1000nm ^(b)	1.1 430-1000nm ^(b)	2.4 800-1430nm ^(b)
% Error vs Wavelength nm	±7 220-250 ±5 250-420 ±4 420-950 ±7 950-1100	±5 350-1000 ±10 1000-1100	±5
Linearity with Power ±%	1	1	1
Damage Threshold kW/cm ²	1 on integrating sphere surface	0.2 on integrating sphere surface	0.2 on integrating sphere surface
Maximum Pulse Energy µJ	600	100	500
Power Noise Level nW	20	20	20
Response Time with Meter s	0.2	0.2	0.2
Maximum Beam Divergence	±40 degrees for fan shaped beam, ±50 degrees for circular beam	±40 degrees	±40 degrees
Sensitivity to Beam Size and Angle	±2%	±2%	±2%
Cooling	convection	convection	convection
Fiber Adapters Available (see page 33)	ST, FC, SMA, SC	ST, FC, SMA ^(a) , SC	ST, FC, SMA ^(a) , SC
Weight kg	0.25	0.6	0.6
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		V1	
Part Number	7Z02484	7Z02404	7Z02403

Notes: (a) One fiber output port available with output = 2E-4 of input power/mm² of fiber area
(b) For calibration uncertainty of wavelengths outside of this range see table on page 24

IS-1-2W



3A-IS / 3A-IS-IRG



1.1.1.6 Integrating Spheres

1.1.1.6.2 VIS 1.5" High Speed Response, Multi-functional Integrating Sphere

400nW – 4W

Features

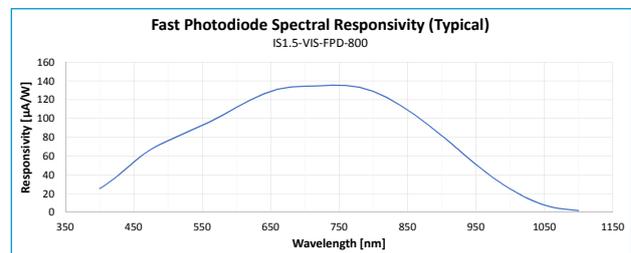
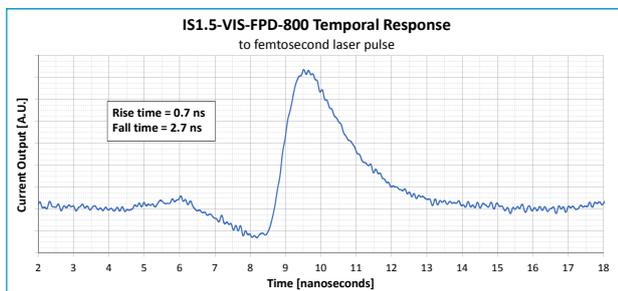
- Fast photodiode for pulse shape characterization of VCSELs
- Built in SMA fiber adapter for connection to a spectrometer
- Large, 20mm input port enabling long working distance
- Accepts beams with divergence angles up to $\pm 60^\circ$
- Small integrating sphere with short time constant

IS1.5-VIS-FPD-800

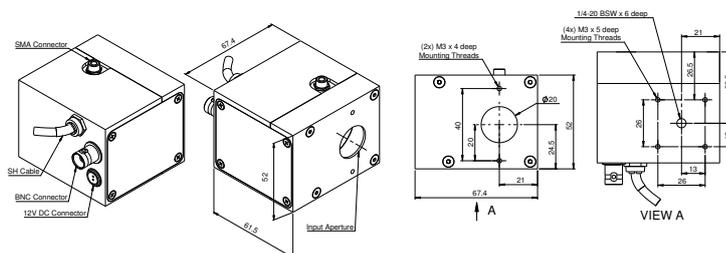


Model	IS1.5-VIS-FPD-800		
Use	Multi-functional Integrating Sphere		
Specifications			
Input Port Aperture mm	Ø20	Cooling	Convection
Maximum Beam Divergence Degrees	$\pm 60^{(a)}$	Operating Temperature Range °C	+15 to +40
Sensitivity to Beam Size and Angle	$\pm 2\%^{(b), (c)}$	Storage Temperature Range °C	-20 to +60
Damage Threshold on Integrating Sphere Surface W/cm ²	200 (average power)	Humidity Range	20% ~ 70% RH non-condensing. The product must not be exposed to high humidity
Integrating Sphere Time Constant nsec	0.7 typ.	Weight g	530
Fiber Optic Port	SMA connector, maximum NA 0.44	Compliance	CE, UKCA, China RoHS
Outputs	Smart Head for power measurement, BNC (50Ω) for temporal pulse shape detection, SMA for optical fiber	Power Supply	Push-pull 2 pin power supply 12 VDC (P/N 7E05047A)
Detector 1		Detector 2	
Type	Si photodiode, calibrated	Type	Fast Si photodiode
Function	Average power	Function	Temporal pulse shape detection
Spectral Range μm	0.4 – 1.1	Spectral Range μm	0.4 – 1.1
Power Range	400nW – 4W	Rise Time (10% to 90%) nsec	0.8
Pulse Width	Not limited	Fall Time (90% to 10%) nsec	2.8
Pulse Repetition Rate ^(d)	Not limited	Bias Voltage Input V	12
Power Scales	4W to 40μW	Peak CW Responsivity @ 740nm μA/W ^(f)	135 typ.
Power Accuracy	$\pm 3\%$ 430nm – 1000nm, $\pm 4\%$ < 430nm, $\pm 7\%$ > 1000nm	Dark Current nA	0.3 typ., 1 max
Linearity with Power $\pm\%$	2	Noise Current fA/√Hz	18 typ.
Power Noise Level nW	20 typ.	Output	Analog current
Saturation Pulse Energy mJ	2 typ.		
Calibration Uncertainty $\pm\%$	1.1 430-1000nm ^(e)		
Output	Smart Head, D15		
Part number	7Z02491		

Notes: (a) For central 2 mm diameter of entrance aperture
 (b) Power Accuracy and Sensitivity to Beam Size and Angle specifications apply to beam divergence up to $\pm 45^\circ$ and central 5.6 mm diameter of entrance aperture, for larger divergence and/or area of entrance aperture, these specifications increase by 2%
 (c) For scanned beams with divergence angle $< \pm 40^\circ$, the maximum acceptance angle of the sphere is $\pm 50^\circ$
 (d) Below 200Hz use low frequency mode in meter
 (e) For calibration uncertainty of wavelengths outside of this range see table on page 24
 (f) Responsivity data provided with sensor



IS1.5-VIS-FPD-800

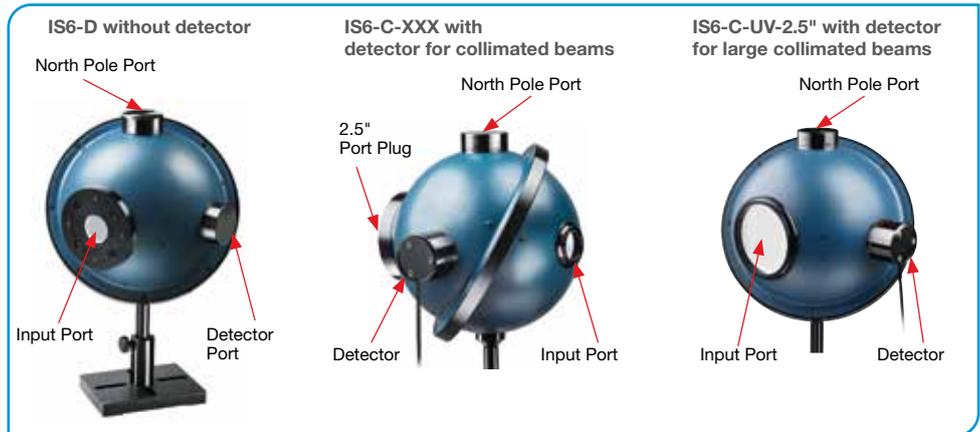


1.1.1.6 Integrating Spheres

1.1.1.6.4 Large Dimensions 5.3"

Features

- 4 port Integrating spheres for collimated and divergent beams (LEDs, VCSELs, etc.)
- Up to 170° acceptance angle
- Ø63.5mm (2.5") aperture
- Fiber or free space input
- Can be ordered with or without detectors



Model	IS6		
Use	For use with customer detector or as light source		
Detector	None – see below for detector versions		
Spectral Range μm	0.2 – 2.2		
Source Geometry ^(a) (see introduction)	Divergent	Collimated	
Input Port Aperture mm	Ø63.5 ^(b)	Ø25	
Maximum Beam Divergence deg°	± 60 ^(d)	± 15	
Sensitivity to Beam Divergence $\pm\%$	3 ^(c)	1	
Power Range	Depends on detector – see below		
Damage Threshold kW/cm^2	1 on integrating sphere surface		
Cooling	Convection		
Weight kg	1.4		
Type	P/N	Version	Compliance
IS6-D For divergent beams (input from 2.5" side)	7Z02487	V1	RoHS, China RoHS
IS6-C For collimated beams (input from 1" side)	7Z02474		RoHS, China RoHS
Supplied Port Accessories (see page 40)	IS6-D: 2.5" to 1" reducer w/cover + 1" port plug + 2 ea. 1" port covers IS6-C: 2.5" port plug + 3 ea. 1" port covers		

Notes: (a) In each configuration, the opposing port is closed with a port plug. See diagram in introduction page 34.
 (b) The sphere is supplied with the 2.5" to 1" reducer.
 (c) For beams up to 30deg divergence, variation with beam size is $\pm 1\%$.
 (d) For central 5mm of aperture, for 10mm aperture maximum beam divergence is $\pm 66^\circ$.

IS6 with Detectors for Collimated Beams - calibrated - VIS, UV & IR types

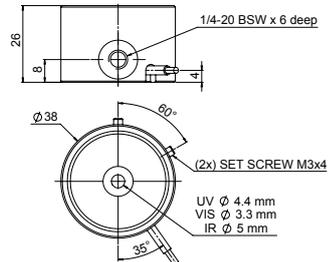
-Recommended for beam divergence $< 15^\circ$

-Comes with calibrated wavelength curve

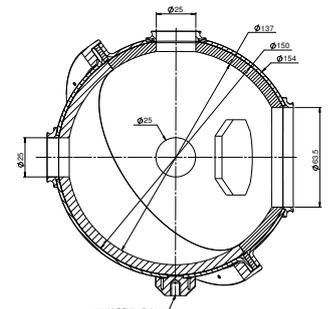
Model	IS6-C-VIS		IS6-C-UV		IS6-C-IR		IS6-C-UV-2.5"	
Detector type	VIS		UV		IR		UV	
Use	High powers		Low powers		Low powers		Large beams	
Type	Si with filter		Si		Germanium		Si	
Spectral Range μm	0.4 – 1.1		0.2 – 1.1		0.7 – 1.8		0.2 – 1.1	
Power Range (approx.)	20 μW to 30W		300nW to 1W		100 μW to 30W		300nW to 2W	
Power Scales	30W to 300 μW		1W to 3 μW		30W to 300 μW		2W to 3 μW	
Linearity with Power $\pm\%$	1							
Power Noise Level	1 μW		15nW		5 μW		15nW	
Calibration Uncertainty $\pm\%$	1.1 430-1000nm ^(b)		1.1 430-1000nm ^(b)		2.4 700-1430nm ^(b)		1.1 430-1000nm ^(b)	
Maximum Pulse Energy mJ	5		0.1		0.3		0.3	
Input Port Aperture mm	Ø25						Ø63.5	
Sensitivity to Beam Size %	± 1						± 1 ^(a)	
Maximum Power vs. Wavelength	nm	W	nm	W	nm	W	nm	W
	<670	30	<600	0.7	<1400	30	<600	1.5
	790	20	800-1000	0.3	1400-1650	15	800-1000	1
	904	15	1064	0.5	>1650	30	1064	2
	1064	25						
Accuracy vs Wavelength	nm	%	nm	%	nm	%	nm	%
	360 - 410	± 10	200 - 270	± 10	700-1650	± 5	200 - 270	± 10
	410 - 950	± 5	270 - 950	± 5	1650-1800	± 7	270 - 950	± 5
	950 - 1100	± 7	950 - 1100	± 7			950 - 1100	± 7
Compliance	CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS	
Part Number	7Z02470		7Z02472		7Z02476		7Z02485	
Supplied Port Accessories (see page 40)	IS6-C-XXX: 2.5" port plug + 2 ea. 1" port covers IS6-C-UV-2.5": 2.5" port cover + 1" port plug + 1" port cover							

Notes: (a) Over central 40mm, $\pm 2\%$ over central 50mm
 (b) For calibration uncertainty of wavelengths outside of this range see table on page 24

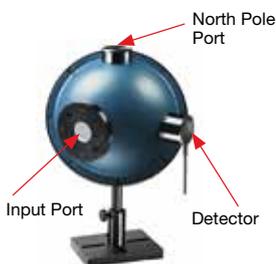
Incorporated Detectors: IS6-C-VIS / IS6-C-UV IS6-C-IR / IS6-C-UV-2.5"



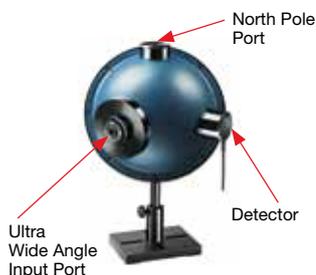
IS6



IS6-D-XXX with detector for divergent beams



IS6-D-IR-170 with detector for highly divergent beams up to 170°



FPD Detector Mounted on IS6-D-IR-170

Ophir FPD fast photodiode detectors (see page 143) interface with all IS6 integrating spheres, facilitating temporal characterization of laser pulses in parallel with other measurements.



IS1.5-VIS-FPD-800

Related Product
For an integrating sphere sensor that has an FPD pulse characterization detector built in, see our **IS1.5-VIS-FPD-800, 1.5" High Speed Response, Multi-functional Integrating Sphere** on page 36.



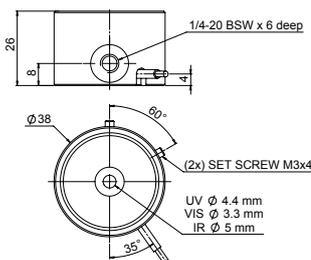
IS6 with Detectors for Divergent Beams– calibrated – VIS, UV & IR types

- Recommended for beam divergence 15° to 120°
- High divergence model for large angles up to 170°
- Comes with calibrated wavelength curve

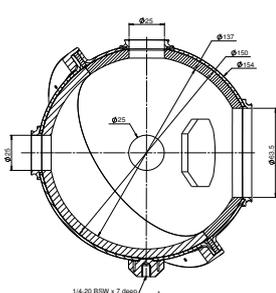
Model	IS6-D-VIS		IS6-D-UV		IS6-D-IR		IS6-D-IR-170	
Detector type	VIS		UV		IR		IR	
Use	High powers for divergent beams		Low powers for divergent beams		Low powers for divergent beams		Low powers for highly divergent beams (up to 170°)	
Type	Si with filter		Si		Germanium		Germanium	
Spectral Range μm	0.4 – 1.1		0.2 – 1.1		0.7 – 1.8		0.7 – 1.8	
Power Range (approx.)	20 μW to 30W		300nW to 1W		100 μW to 30W		20 μW to 30W	
Power Scales	30W to 300 μW		1W to 3 μW		30W to 300 μW		30W to 300 μW	
Linearity with Power $\pm\%$	1		1		1		1	
Power Noise Level	1 μW		15nW		5 μW		1 μW	
Calibration Uncertainty $\pm\%$	1.1 430-1000nm ^(c)		1.1 430-1000nm ^(c)		2.4 700-1430nm ^(c)		2.4 700-1430nm ^(c)	
Maximum Pulse Energy mJ	5		0.15		0.3		0.7	
Maximum Beam Divergence deg°			± 60 ^(b)				$> \pm 85$	
Input Port Aperture mm			$\varnothing 26$				$\varnothing 8$	
Sensitivity to Beam Divergence $\pm\%$			3 ^(a)				1.5	
Maximum Power vs. Wavelength	nm	W	nm	W	nm	W	nm	W
	<670	30	<600	1	<1400	30	700-1800	30
	790	30	800-1000	0.5	1400-1650	15		
	904	20	1064	1	>1650	30		
	1064	30						
Accuracy vs Wavelength	nm	%	nm	%	nm	%	nm	%
	360 - 410	± 10	200 - 270	± 10	700-1650	± 5	700-1650	± 5
	410 - 950	± 5	270 - 950	± 5	1650-1800	± 7	1650-1800	± 7
	950 - 1100	± 7	950 - 1100	± 7				
Compliance	CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS	
Version	V1		V1		V1			
Part Number	7Z02488		7Z02489		7Z02490		7Z02486	
Supplied Port Accessories (see page 40)	IS6-D (with detector): 2.5" to 1" reducer w/cover + 1" port plug + 1" port cover IS6-D-IR-170: 2.5" to 1" reducer with 170° attachment and cover + 1" port plug + 1" port cover							

Notes: (a) For beams up to 30° divergence, variation is $\pm 1\%$
 (b) For central 6mm of aperture, for 12mm aperture maximum beam divergence is $\pm 50^\circ$
 (c) For calibration uncertainty of wavelengths outside of this range see table on page 24

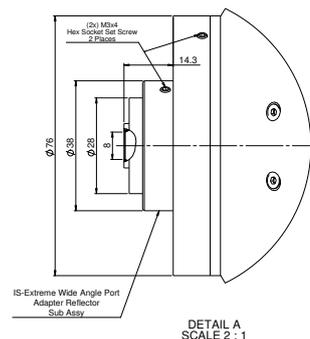
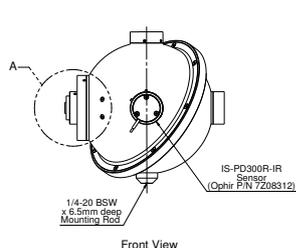
Incorporated Detectors:
IS6-D-VIS / IS6-D-UV / IS6-D-IR



IS6



IS6-D-IR-170



1.1.1.6.5 Accessories for IS6

All accessories can be attached to 1" ports unless otherwise noted.

Accessory	Description	Part number
Port plugs		
IS-1" Port plug	Port plugs close ports with white sphere material, eliminating the port from the sphere geometry	
IS-1" Port plug	White reflectance material, PTFE, Ø25.4mm plug	7Z08280A
IS-2.5" Port plug	White reflectance material, PTFE, Ø63.5mm plug, for 2.5" port	7Z08283A
Port Covers		
Port Covers close ports with a black matte surface. They prevent extraneous light from entering the sphere without changing the sphere configuration. These covers can also be used as blanks for making specialized port adapters		
IS-1" Port cover	Matte black coated Ø25.4mm cover	7Z08282A
IS-2.5" Port cover	Matte black coated Ø63.5mm cover, for 2.5" port	7Z08281A
Adapters and Reducers		
The adapters are black coated and the reducers white coated		
1" SMA fiber adapter	SMA fiber input/output	7Z08285
1" FC fiber adapter	FC fiber input/output	7Z08286
FPD (except FPS-1) to IS6 adapter	For mounting FPD sensor series to North Pole port of IS6 series	7Z08350
1" to SM1 adapter	Female SM1 thread, used for attaching FPS-1 detector to IS6	7Z08289
2.5" to 1" port reducer	Convert the 2.5" port into a 1" port PTFE	7Z08305A
Set of aperture masks	Ø5, Ø7, Ø10mm apertures, for use with 2.5" to 1" port reducer P/N 7Z08305A ^(a) ^(c)	7Z08307
Flange attachment	Dovetail flange for use with 2.5" to 1" port reducer P/N 7Z08305A ^(b) ^(c)	7Z08306

Notes: (a) This accessory is held on to port reducer 7Z08305A magnetically.
 (b) This accessory is mounted to port reducer 7Z08305A with the included screws.
 (c) IS6 P/N's 7Z02471, 7Z02473, 7Z02475, 7Z02477 incorporate an earlier version of the 2.5" to 1" port reducer that is not compatible with this accessory. That port reducer can be replaced with the current version, P/N 7Z08305A, in order to use the new accessories.



1.1.1.7 LED measurement – UV, VIS, NIR

Introduction

UV, VIS and IR LEDs are replacing traditional light sources and thus enabling new applications. Ophir offers a number of choices for LED measurement. There are a number of sources for measuring the power of divergent LED beams

as presented in section 1.1.1.6. There are also radiometer sensors for measuring the irradiance of large area illumination in units of Watts/cm² as presented in section 1.1.1.7.2

1.1.1.7.1 LED Power Sensors

20pW to 3W

Features

- 20pW to 3W
- 200nm to 1100nm
- Photodiode detectors – spectrally calibrated for LEDs and lasers
- Thermal sensors – power measurement is insensitive to wavelength
- Fiber or free space input
- Compatible with all Ophir meters, acquisition devices and StarLab PC software

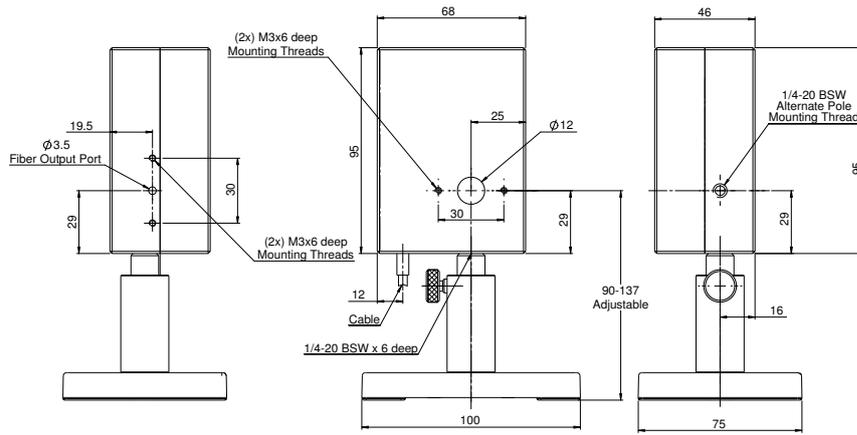


Model	3A-IS	PD300-UV		PD300R-UV		3A
Use	Compact integrating sphere	Standard photodiode sensor for UV-NIR		Round photodiode sensor for UV-NIR		Thermal sensor. Flat spectrum response. For fiber coupled source
Detector Type	Silicon	Silicon		Silicon		Thermal
Input Port Aperture mm	Ø12	10x10		Ø10		Ø9.5
Filter Mode		Filter out	Filter in	Filter out	Filter in	
Spectral Range µm	0.35 – 1.1	0.2-1.1	0.22-1.1	0.2-1.1	0.22-1.1	0.19-20
Power Range	1µW – 3W	20pW-3mW	2µW-300mW	20pW-3mW	2µW-300mW	10µW-3W
Power Scales	3W to 3µW and dBm	3mW to 3nW and dBm	300mW to 300µW and dBm	3mW to 3nW and dBm	300mW to 300µW and dBm	3W-300µW
Resolution nW	1	0.001	100	0.001	100	100
Maximum Power	3W	3mW	300mW	3mW	300mW	3W
Accuracy (including error due to temp variations)						
% Error vs Wavelength nm	±5 350 – 1000 ±10 1000 – 1100	±10 200-230 ±7 230-300 ±3 300-420 ±2 420-980 ±7 980-1100	±10 220-300 ±4 300-420 ±3 420-980 ±7 980-1100	±10 200-230 ±7 230-300 ±3 300-420 ±2 420-980 ±7 980-1100	±10 220-300 ±4 300-420 ±3 420-980 ±7 980-1100	±3%
Damage Threshold W/cm ²	200	10	50	10	50	1000
Max Pulse Energy	5mJ	0.4 µJ	15 µJ	0.4 µJ	15 µJ	2J
Noise Level for Filter Out	20nW	1pW		1pW		2µW
Response Time with Meter s	0.2	0.2		0.2		1.8
Beam Position Dependence	N.A.	±2%		±2%		±2%
Calibration Uncertainty ±%	1.1 430-1000nm ^(b)	1.1 430-1000nm ^(b)		1.1 430-1000nm ^(b)		1.9
Linearity with Power ±%	1	0.5		0.5		1.5
Fiber Adapters Available (see page 33 & 120)	ST, FC, SMA ^(a) , SC	ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC
Weight kg	0.6	0.07		0.11		0.2
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS		CE, UKCA, China RoHS		CE, UKCA, China RoHS
Version	V1					
Part Number	7Z02404	7Z02413		7Z02438		7Z02621

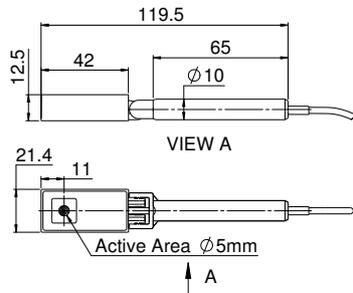
Notes: (a) One fiber output port available with output = 2E-4 of input power/mm² of fiber area.
(b) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For sensors drawings please see page 42

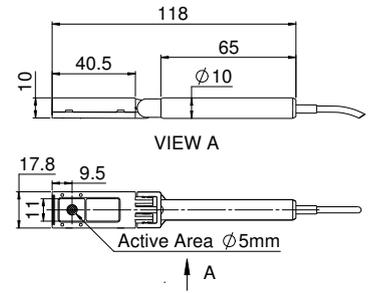
3A-IS



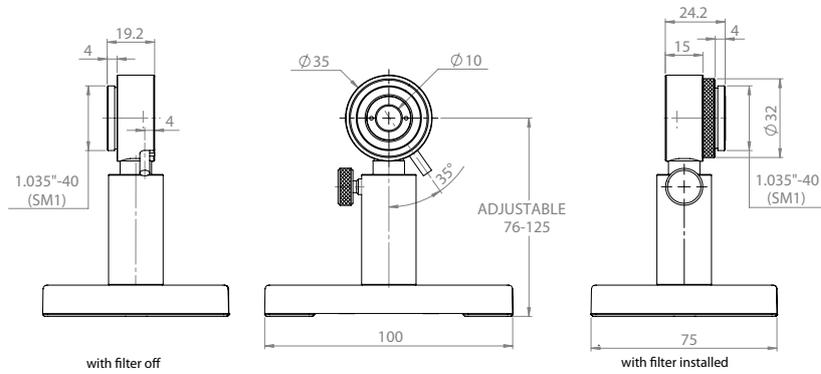
PD300-UV / PD300-IR Filter installed
(Ø5mm for PD300-IR only)



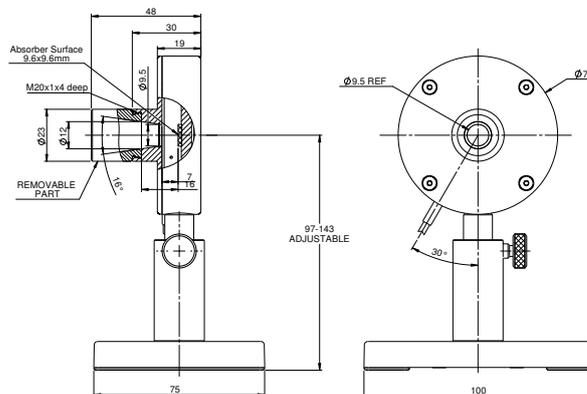
PD300-UV / PD300-IR Filter off
(Ø5mm for PD300-IR only)



PD300R-UV



3A



1.1.1.7.2 LED Irradiance and Dosage Sensors

100nW/cm² to 15W/cm²

Features

- Measure irradiance in W/cm² and dosage in J/cm²
- Cosine corrected
- 200nm to 850nm
- Ø2.75mm and Ø8mm aperture
- For lasers and LEDs

PD300RM-UV / PD300RM-8W

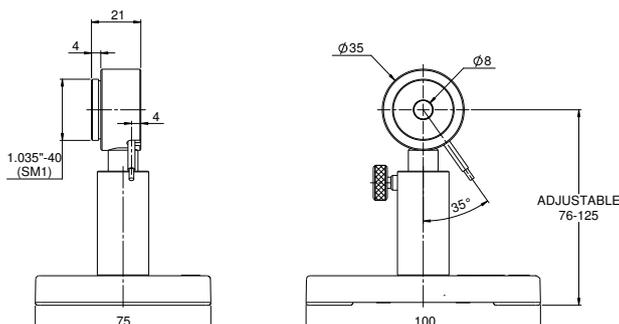
PD300RM-UVA



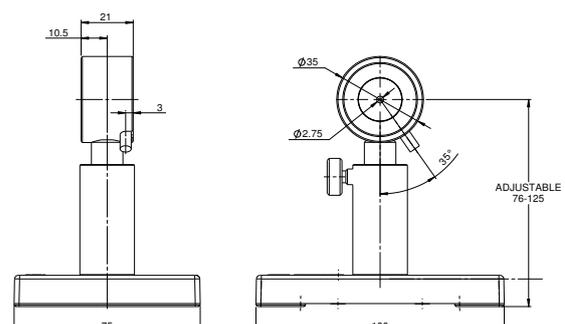
Model	PD300RM-UV	PD300RM-8W	PD300RM-UVA
Detector Type	Silicon	Silicon	Silicon
Input Port Aperture mm	Ø8	Ø8	Ø 2.75
Spectral Range nm	200-850	350-850	350-450
Functions	Irradiance [W/cm ²] Dosage [J/cm ²]	Irradiance [W/cm ²] Dosage [J/cm ²]	Irradiance [W/cm ²] Dosage [J/cm ²]
Irradiance Range	100nW/cm ² – 250mW/cm ²	1µW/cm ² – 8W/cm ² (d)	1.5µW/cm ² – 15W/cm ² (d)
Irradiance Scales	300mW/cm ² to 300nW/cm ² (7 scales), Auto ranging	30W/cm ² to 30µW/cm ² (7 scales), Auto ranging	30W/cm ² to 30µW/cm ² (7 scales), Auto ranging
Resolution nW/cm ²	0.1	10	10
Maximum Irradiance	200nm-400nm, 250mW/cm ² 400nm-550nm, 100mW/cm ² 550nm-850nm, 40mW/cm ²	350nm-650nm, 8W/cm ² 650nm-850nm, 4W/cm ²	350nm-450nm, 15W/cm ²
Dosage Sample Rate	500 samples per second	500 samples per second	500 samples per second
Calibration Uncertainty ±% (e)	3.4 400-850nm	3.4 400-850nm	3.6 350-400nm 3.4 400-450nm
Deviation from Flatness Accuracy	N.A.	N.A.	±3%, 350-400nm, 400-450nm
% error vs Wavelength nm (c)	±10% 200-250nm ±7.5% 250-300nm ±5% 300-400nm ±4% 400-850nm (a)	±5% 350-400nm ±4% 400-850nm (a)	±6% 350-400nm ±5% 400-450nm (b)
Thermal Coefficient %/°C	-0.03	-0.03	-0.03
Damage Threshold W/cm ²	10	50 (d)	50 (d)
Max Pulse Energy (for laser ns pulse) µJ	0.4	20	20
Noise Level nW/cm ²	5	45	65
Response Time with Meter s	0.2	0.2	0.2
Linearity %	±0.5	±0.5	±0.5
f ² Cosine Correction Factor Accuracy	5%	5%	6.5% (f)
Size	Ø35 x 21mm see drawing	Ø35 x 21mm see drawing	Ø35 x 21mm see drawing
Weight	110g	110g	110g
Compatible Meter (g)	Centauri, StarBright and StarLite with or without StarLab, Juno+, Juno-RS	Centauri, StarBright and StarLite with or without StarLab, Juno+, Juno-RS	Centauri, StarBright and StarLite with or without StarLab, Juno+, Juno-RS
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			
Part number	7Z02479	7Z02480	7Z02492

Notes: (a) Accuracy given for lasers. Accuracy for LEDs depends on peak wavelength and bandwidth. Contact Ophir for more details.
 (b) Applicable to lasers and LEDs, includes deviation from flatness.
 (c) Accuracy includes uncertainty of NIST calibrated reference.
 (d) Do not exceed 30 seconds of continuous exposure at > 5W/cm².
 (e) For calibration uncertainty of wavelengths outside of this range see table on page 24.
 (f) Up to 70 degrees.
 (g) Support of Centauri for irradiance sensors is from firmware version 5.02 and up.

PD300RM-UV / PD300RM-8W



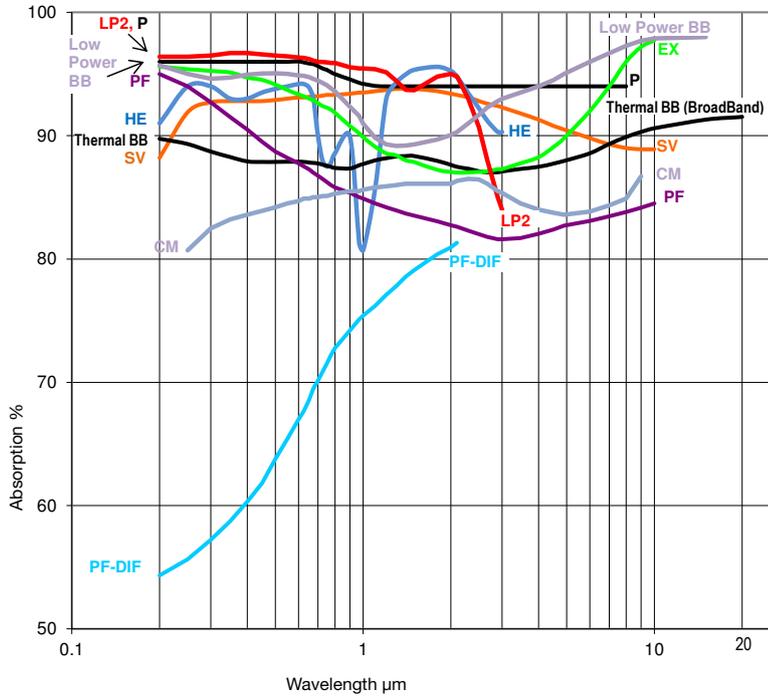
PD300RM-UVA



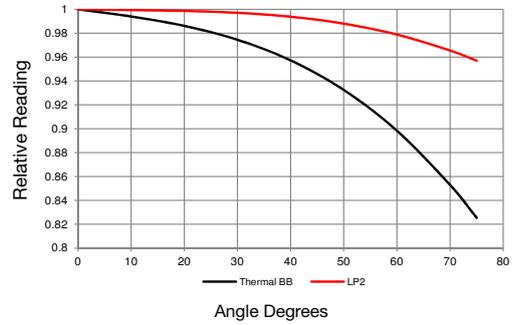
1.1.2 Thermal Power Sensors

Absorption, Angle Dependence and Damage Graphs for Thermal Sensors

Absorption vs. Wavelength

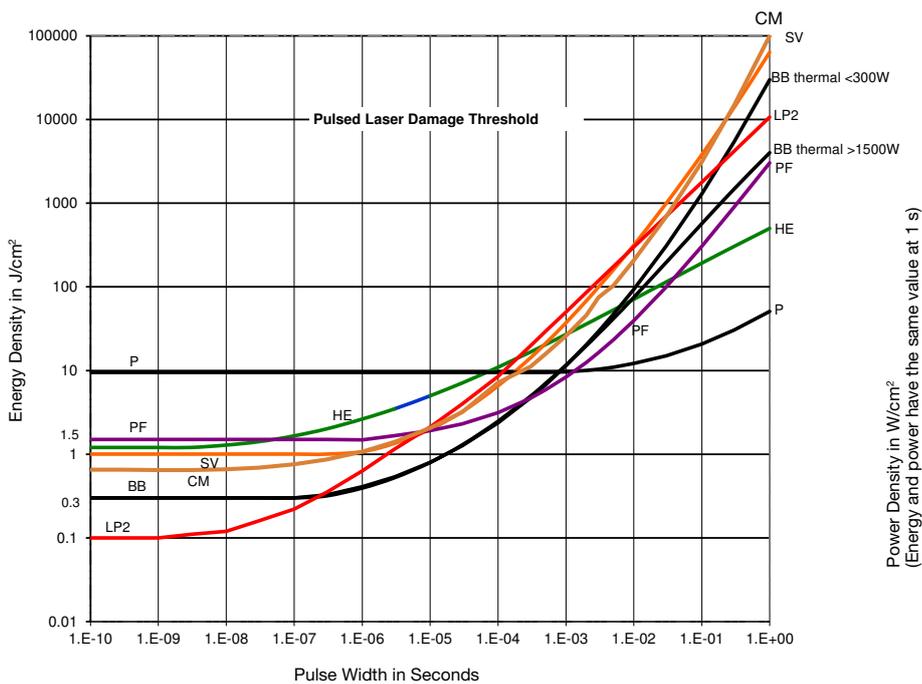


Response vs. Incidence Angle



Damage Threshold vs. Pulse Width

Note: The CW power damage threshold in W/cm^2 is found on the right hand side of the table at the 1 s pulse width value



1.1.2.1 Low Noise Lock In Power Sensors

300fW to 100mW

Features

- Chopper and lock in amplifier for lowest noise and drift
- Wavelength range from UV to deep IR
- RM9 pyro is not sensitive to background radiation



The RM9 series Radiometers use a pyroelectric or photodiode sensor in conjunction with chopped CW or quasi CW radiation, using a digitally synthesized lock-in amplifier to reduce external noise to a minimum. The signal is passed through the 18Hz chopper and the chopped signal is detected by the sensor. All signals not at this 18Hz frequency

are suppressed. The output of the sensor is displayed on a standard Ophir meter or PC interface. The chopper may be placed at any convenient location but preferably close to the signal source so as to eliminate interference from all unchopped radiation. The chopper is to be oriented with the indicated side toward the sensor.

Specifications

Model	RM9	RM9-PD
Use	Low level signals	Very low level signals
Detector Type	Pyroelectric	Si Photodiode
Spectral Range	0.15 - 12 μ m ^(a)	0.2 - 1.1 μ m ^(b)
Aperture mm	Ø8mm	Ø10mm
Surface Reflectivity % approx.	50	50
Power Range ^(c)	100nW – 100mW	300fW – 300nW
Power Scales	100mW to 3 μ W	300nW to 3pW
Power Noise Level ^(d)	~30nW	30fW
Minimum Frequency for Pulsed Sources	200Hz	200Hz
Thermal Drift (20min) ^(e)	~30nW	N.A.
Power Accuracy	±5% ^(a)	±5% ^(b)
Damage Threshold W/cm ²	5	5
Response Time with Meter (0-95%) s	3.5s	3.6s
Linearity with Power	±2%	±2.5%

Connections:

1. 1.5 meter cable hard wired to interface module.
2. BNC connector on module for connection to chopper (2 meter BNC to BNC cable included). Perform zeroing with BNC cable removed.
3. 0.5 meter cable from module terminated in DB15 connector.

Cooling	convection	convection
Weight kg	0.37	0.37
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		
Part Number for RM9 Series with RMC1 Chopper ^(f)	7Y70669	7Y70672
Part Number for RM9 Series Sensors	7Z02952	7Z02953

Note: (a) At calibrated wavelengths 500 – 1100nm. At other wavelengths, there is an additional error as follows: <500nm add ±8%, 1100 – 3000nm add ±5%, 10.6 μ m add ±15%

Note: (b) At calibrated wavelengths 200 – 1100nm. For <700nm add ±2% additional error

Note: (c) For LaserStar, Pulsar, USBI, Quasar and Nova, upper limit is 1mW for RM9 and 90nW for RM9-PD. For these models, accuracy may also be less than values given above

Note: (d) Averaged over 10s

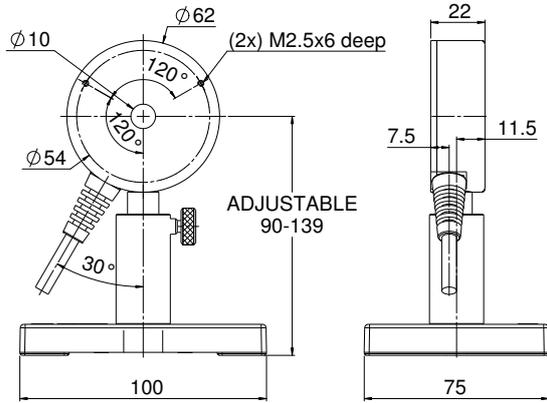
Note: (e) In a typical laboratory environment

Note: (f) The RMC1 or another chopper unit that can be set to 18Hz is required for operation of the RM9 series sensors

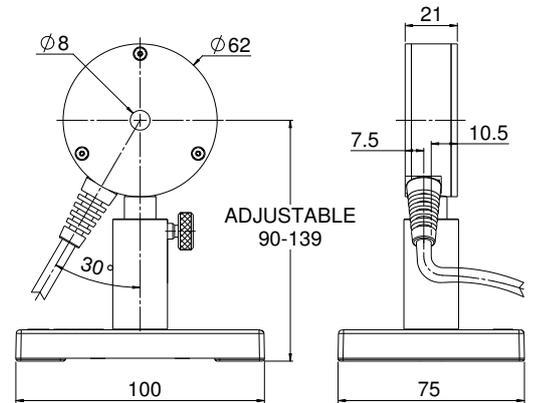
* For drawings please see page 46

Model	RMC1 Chopper
Use	Chopper for RM9 series
Aperture	Ø22mm
Chopping Frequency ^(a)	18Hz
Power Consumption	85mA
Connections:	
1. BNC to interface module	
2. 12V wall cube power supply (included)	
3. Mini USB connector (factory use only)	
Note: (a) not adjustable by user.	

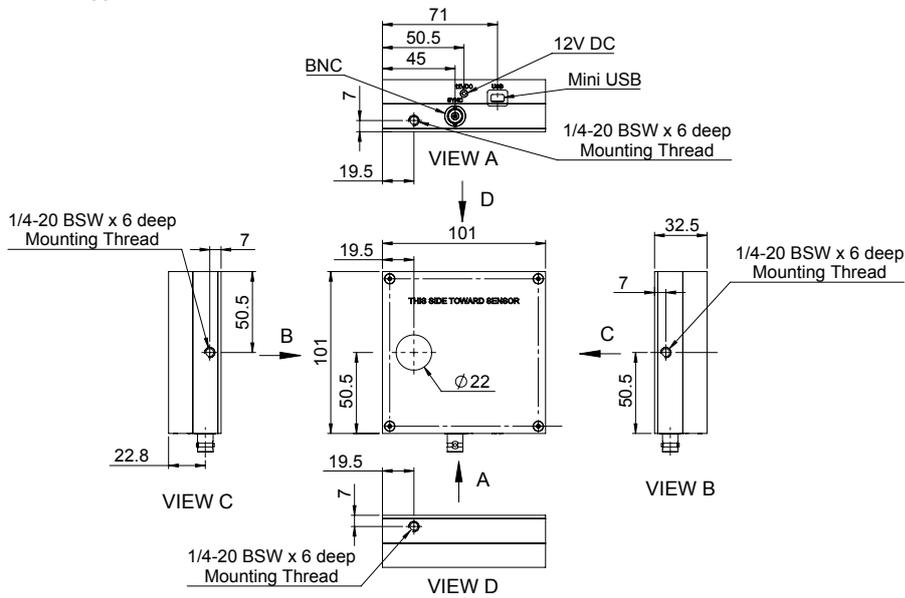
RM9-PD Sensor



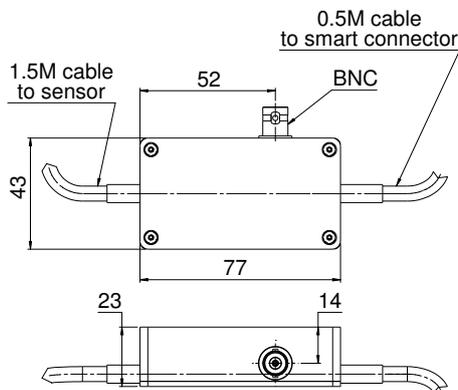
RM9 Sensor



Radiometer-Chopper



Interface Module



1.1.2.2 High Sensitivity Thermal Sensors

10μW to 3W

Features

- Very low noise and drift for measurement of very low powers and energies
- PF absorber has high damage threshold for CW and pulses
- Up to 3W



Model	2A-BB-9	3A	3A-P	3A-PF-12
Use	General purpose	General purpose	Short pulses	Short Pulses UV
Absorber Type	Low power broadband	Low power broadband	P type	PF type
Spectral Range μm	0.19 - 20	0.19 - 20	0.15 - 8	0.15 - 20
Aperture mm	Ø9.5mm	Ø9.5mm	Ø12mm	Ø12mm
Maximum Beam Divergence	NA	NA	NA	NA
Power Mode				
Power Range ^(a)	20μW - 2W	10μW - 3W	15μW - 3W	15μW - 3W
Power Scales	2W to 200μW	3W to 300μW	3W to 300μW	3W to 300μW
Power Noise Level	1μW	1μW	3μW	3μW
Thermal Drift (30min) ^(a)	5 - 20μW	5 - 20μW	5 - 30μW	5 - 30μW
Maximum Average Power Density kW/cm ²	1	1	0.05	3
Response Time with Meter (0-95%) typ. s	1.8	1.8	2.5	2.5
Calibration Uncertainty ±%	1.9	1.9	1.9	1.9
Power Accuracy ±% ^(d)	3	3	3	3 ^(c)
Linearity with Power ±%	1	1	1	1
Energy Mode				
Energy Range	20μJ - 2J	20μJ - 2J	20μJ - 2J	20μJ - 2J
Energy Scales	2J to 200μJ	2J to 200μJ	2J to 200μJ	2J to 200μJ
Minimum Energy	20μJ	20μJ	20μJ	20μJ
Maximum Energy Density J/cm ² ^(b)				
<100ns	0.3	0.3	1	1.5
0.5ms	1	1	1	7
2ms	2	2	1	15
10ms	4	4	1	40
Cooling	Convection	Convection	Convection	Convection
Weight kg	0.2	0.2	0.2	0.2
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			V1	
Part number: Standard Sensor	7Z02767	7Z02621 (1.5m cable)	7Z02622	7Z02720
BeamTrack Sensor: Beam Position & Size (p. 55)		7Z07934	7Z07935	
Sensor with different cable length		7Z02621C (10m cable)		

Note: (a)

Depending on room airflow and temperature variations. Lowest measurable powers are achieved by thermally quiet room conditions, using removable snout (for 3A, 3A-P, 3A-PF-12 sensors), averaging and offset subtraction.

Note: (b) For P and PF types and shorter wavelengths derate maximum energy density as follows:

Wavelength	P type	PF type
1064nm	Derate to value	Derate to value
532nm	Not derated	Not derated
355nm	40% of stated value	70% of stated value
266nm	5% of stated value	15% of stated value
193nm	10% of stated value	5% of stated value

Note: (c)

Calibrated from 193nm to 2.2μm and at 10.6μm. There is an additional error of ±1% from 450nm to 650nm.

Note: (d)

The 3A and 2A-BB-9 sensors have a relatively large spectral variation in absorption and has a calibrated spectral curve at all wavelengths in its spectral range to the above specified accuracy. Nova and LaserStar meters do not support this feature and when used with those meters, the accuracy will be ±3% as above for 532nm, 905nm, 1064nm and 10.6μm but there will be an additional error of up to 3% at other wavelengths in the spectral range 190 – 3000nm.

* For drawings please see page 48

1.1.2.2 High Sensitivity Thermal Sensors

8μW to 3W

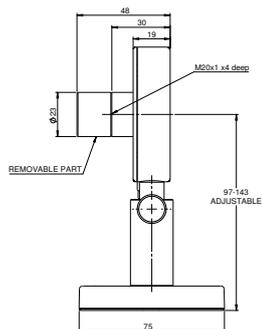
Features

- Very low noise and drift to measure very low powers and energies
- Broadband and P absorbers for CW and short pulses
- Up to 3W
- Version for Terahertz

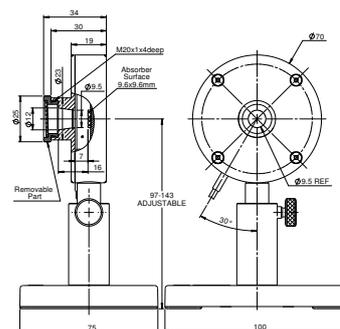


Model	3A-P-THz	3A-FS	3A-P-FS-12
Use	Calibrated for Terahertz radiation	With removable window	For divergent beams, window blocks infrared
Absorber Type	P type	Broadband + F.S. window	P type + F.S. window
Spectral Range μm	0.1THz - 30THz ^(c)	0.19 - 20 ^(b)	0.22 - 2.1
Aperture mm	Ø12mm	Ø9.5mm	Ø12mm
Maximum Beam Divergence	NA	NA	±40 degrees
Power Mode			
Power Range ^(f)	15μW - 3W	8μW - 3W	15μW - 3W
Power Scales	3W to 300μW	3W to 300μW	3W to 300μW
Power Noise Level	4μW ^(d)	2μW	6μW
Thermal Drift (30min) ^(a)	5 - 30μW	2 - 10μW	20 - 40μW
Maximum Average Power Density kW/cm ²	0.05	1	0.05
Response Time with Meter (0-95%) typ. s	2.5	1.8	2.5
Calibration Uncertainty ±%	1.9	1.9	1.9
Power Accuracy ±%	8 ^(c)	3	3
Linearity with Power ±%	1	1	1
Energy Mode			
Energy Range	20μJ - 2J	15μJ - 2J	20μJ - 2J
Energy Scales	2J to 200μJ	2J to 200μJ	2J to 200μJ
Minimum Energy	20μJ	15μJ	20μJ
Maximum Energy Density J/cm ² ^(e)			
<100ns	1	0.3	1
0.5ms	1	1	1
2ms	1	2	1
10ms	1	4	1
Cooling	Convection	Convection	Convection
Weight kg	0.2	0.2	0.15
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	NA
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			
Part number	7Z02742	7Z02628	7Z02687
Note: (a)	Depending on room airflow and temperature variations		
Note: (b)	Remove window for measurement beyond 2.2μm		
Note: (c)	2 sigma standard lab traceable calibration for 0.6THz - 10THz. For 0.3 - 0.5THz add 4% to error. Outside this region the sensor will measure but is not calibrated.		
Note: (d)	Back reflections from meter can sometimes cause interference effects with source. Unit should be tilted ~10° in this case		
Note: (e) For P type and shorter wavelengths derate maximum energy density as follows:	Wavelength 1064nm 532nm 355nm 266nm 193nm	Derate to value Not derated Not derated 40% of stated value 5% of stated value 10% of stated value	
Note: (f)	Lowest measurable powers are achieved by thermally quiet room conditions, using removable snout, averaging and offset subtraction		

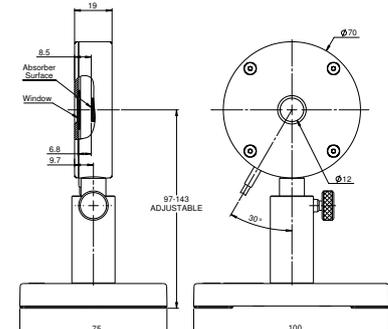
3A-P-THz



3A-FS



3A-P-FS-12



1.1.2.2 High Sensitivity Thermal Sensors

2mW to 12W

Features

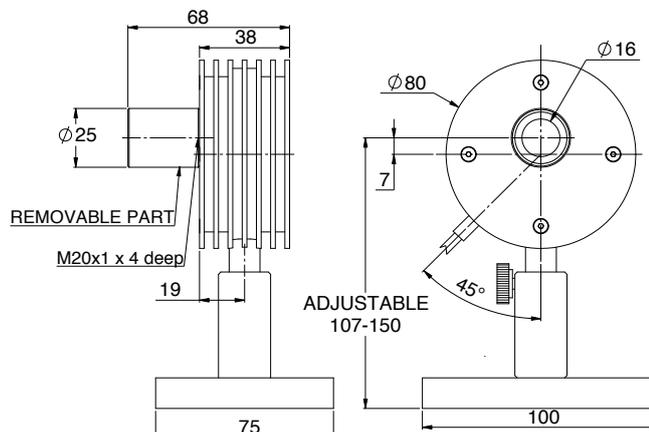
- Very low noise and drift to measure very low powers and energies
- Broadband and P absorbers for CW and short pulses
- Up to 12W
- Spectrally flat

12A / 12A-P



Model	12A	12A-P
Use	General purpose	Short pulses
Absorber Type	Broadband	P type
Spectral Range μm	0.19 - 20	0.15 - 8
Aperture mm	$\varnothing 16\text{mm}$	$\varnothing 16\text{mm}$
Power Mode		
Power Range	2mW - 12W	2mW - 12W
Power Scales	12W to 20mW	12W to 20mW
Power Noise Level	50 μW	50 μW
Thermal Drift (30min) ^(a)	40 - 150 μW	40 - 150 μW
Maximum Average Power Density kW/cm ²	25	0.05
Response Time with Meter (0-95%) typ. s	3	3.5
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3	3
Linearity with Power $\pm\%$	1.5	1.5
Energy Mode		
Energy Range	1mJ - 30J	1mJ - 30J
Energy Scales ^(b)	30J to 30mJ	30J to 30mJ
Minimum Energy mJ	1	1
Maximum Energy Density J/cm ² ^(c)		
Pulse rate:		Single
<100ns	0.3	10
0.5ms	5	10
2ms	10	10
10ms	30	10
Cooling	convection	convection
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight kg	0.35	0.35
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1	
Part number	7Z02638	7Z02624
Note: (a)	Depending on room airflow and temperature variations	
Note: (b)	For the 30mJ energy scale measurements it is recommended to use the screw on barrel supplied with the sensor to protect from direct air flow	
Note: (c) For P type and shorter wavelengths derate maximum energy density as follows:	Wavelength	Derate to value
	1064nm	Not derated
	532nm	Not derated
	355nm	40% of stated value
	266nm	10% of stated value
	193nm	10% of stated value

12A / 12A-P



1.1.2.3 Low Power Thermal Sensors

10mW to 50W

Features

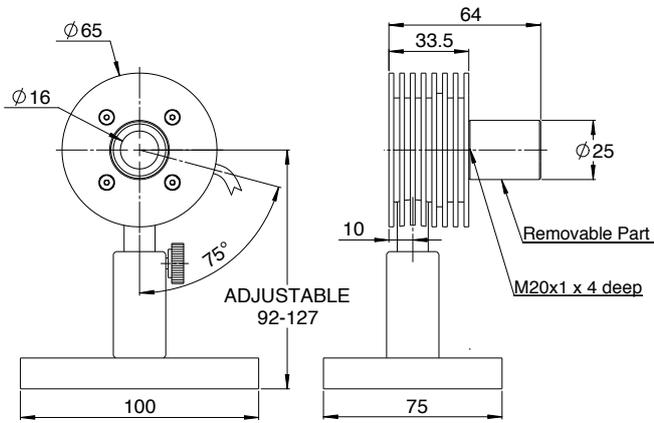
- Convection air cooled
- Broadband or Excimer absorbers
- Ø16mm to Ø26mm apertures
- Fast response time



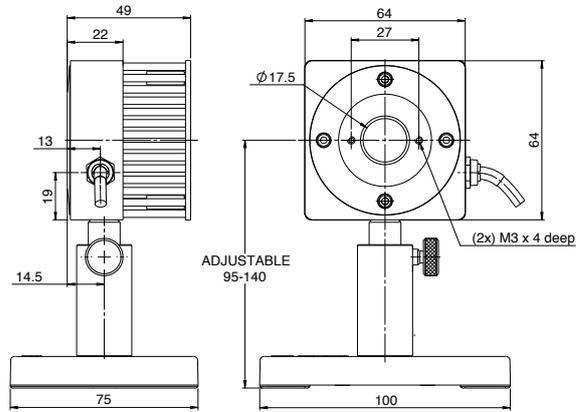
Model	10A-BB-16	30A-BB-18	L30A-BB-26-10MM / L30A-EX-10MM	L30A-EX-10MM	50(150)A-BB-26
Use	Low power	General purpose	Thin profile	Thin profile Excimer	General purpose
Absorber Type	Broadband	Broadband	Broadband	EX	Broadband
Spectral Range μm	0.19 - 11	0.19 - 11	0.19 - 11	0.15 - 0.7, 10.6	0.19 - 11
Aperture mm	Ø16mm	Ø17.5mm	Ø26mm	Ø26mm	Ø26mm
Power Mode					
Power Range	10mW - 10W	10mW - 30W	80mW - 30W	80mW - 30W	40mW - 150W
Maximum Power Intermittent	N.A.	N.A.	8W free standing, 30W heat sunked	8W free standing, 30W heat sunked	150W for 1.5min, 100W for 2.2min, 50W continuous
Power Scales	10W / 5W / 0.5W	30W / 5W / 0.5W	30W / 3W	30W / 5W	150W / 50W / 5W
Power Noise Level	0.2mW	0.5mW	4mW	4mW	2mW
Maximum Average Power Density kW/cm ²	28	20 at 30W 28 at 10W	20 at 30W 28 at 10W	1.5	12 at 150W 17 at 50W
Response Time with Meter (0-95%) typ. s	0.8	0.8	1.5	1.5	1.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(a)	3 ^(a)	3 ^(a)	3	3 ^(a)
Linearity with Power $\pm\%$	1	1	1	1	1.5
Energy Mode					
Energy Range	6mJ - 2J	6mJ - 30J	20mJ - 60J	20mJ - 30J	20mJ - 100J
Energy Scales	2J / 200mJ	30J / 3J / 300mJ	60J / 20J / 2J / 200mJ	30J / 3J / 300mJ	100J / 30J / 3J / 300mJ
Minimum Energy mJ	6	6	20	20	20
Maximum Energy Density J/cm ²					
<100ns	0.3	0.3	0.3	0.5	0.3
0.5ms	2	2	5	6	5
2ms	2	2	10	12	10
10ms	2	2	30	25	30
Cooling	convection	convection	convection / conduction	convection / conduction	convection
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	NA	NA	ST, FC, SMA, SC
Weight kg	0.2	0.3	0.1	0.1	0.3
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V2	V1	V1		V1
Part number: Standard Sensor	7Z07128	7Z07124	7Z07130	7Z02686	7Z07123
BeamTrack Sensor: Beam Position & Size (p. 55/62)	7Z07905				7Z07907
Notes: (a) $\pm 4\%$. For wavelengths <240nm					

* For drawings please see page 52

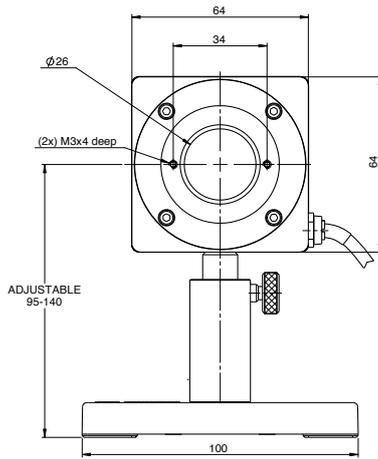
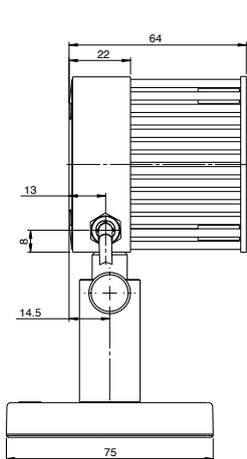
10A-BB-16



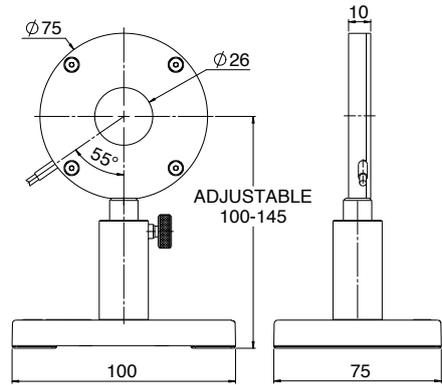
30A-BB-18



50(150)A-BB-26



L30A-BB-26-10MM / L30A-EX-10MM



1.1.2.3 Low Power Thermal Sensors

40mW to 50W

Features

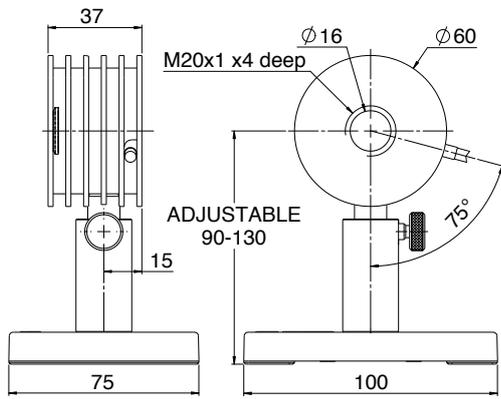
- Convection air cooled
- P, PF and N type absorbers for short pulses
- Ø16mm to 17.5mm apertures



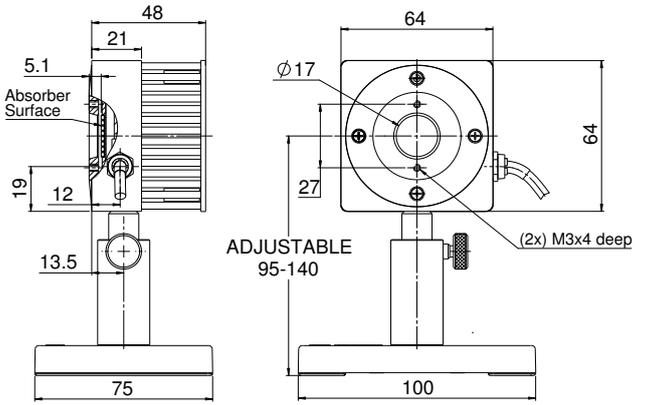
Model	10A-P	30A-P-17	15(50)A-PF-DIF-18/ 50A-PF-DIF-18	30A-N-18
Use	Short pulse to 10W	Short pulse to 30W	High energy density pulsed beams	High power density pulsed YAG
Absorber Type	P type	P type	PF type + diffuser	N type
Spectral Range μm	0.15 - 8	0.15 - 8	0.24 - 2.2	0.532, 1.064
Aperture mm	Ø16mm	Ø17mm	Ø17.5mm	Ø17.5mm
Power Mode				
Power Range	40mW - 10W	60mW - 30W	140mW - 50W	60mW - 30W
Maximum Intermittent Power W	N.A.	N.A.	(for 15(50)A-PF-DIF-18 only) 50W for 5min, 15W continuous	N.A.
Power Scales	10W / 2W / 200mW and dBm	30W / 3W	50W / 5W	30W / 3W
Power Noise Level	2mW	3mW	7mW	3mW
Maximum Average Power Density kW/cm ²	0.05	0.05	>10	5
Response Time with Meter (0-95%) typ. s	3.5	2.5	2	2
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3	3	5	3
Linearity with Power $\pm\%$	1.5	1.5	1.5	1
Energy Mode				
Energy Range	10mJ - 10J	40mJ - 30J	60mJ - 200J	30mJ - 200J
Energy Scales	10J / 2J / 200mJ	30J / 3J	200J / 30J / 3J	200J / 30J / 3J
Minimum Energy mJ	10	40	60	30
Maximum Energy Density J/cm ² (a)				
Pulse rate:	Single 10 - 30Hz	Single 10 - 30Hz	10 - 50Hz	10 - 50Hz
<1 μs	10 1	10 1	4	1
0.5ms	10 1	10 1	15	20
5ms	10 1	10 1	50	>100
Cooling	convection	convection	convection	convection
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	NA	ST, FC, SMA, SC
Weight kg	0.2	0.3	0.35	0.3
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V3			
Part number	7Z02649	7Z02693	7Z02740/ 7Z02738	7Z02695
Note: (a) For shorter wavelengths derate maximum energy density as follows:	Wavelength 1064nm 532nm 355nm 266nm 193nm	Derate to value Not derated Not derated 40% of stated value 10% of stated value 10% of stated value	Wavelength 1064nm 532nm 355nm 266nm 193nm	Derate to value Not derated 80% of stated value 60% of stated value 40% of stated value N.A.

* For drawings please see page 54

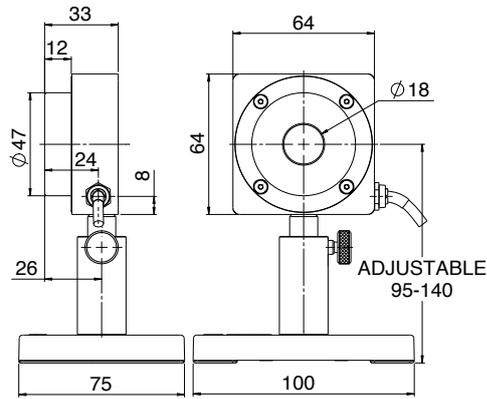
10A-P



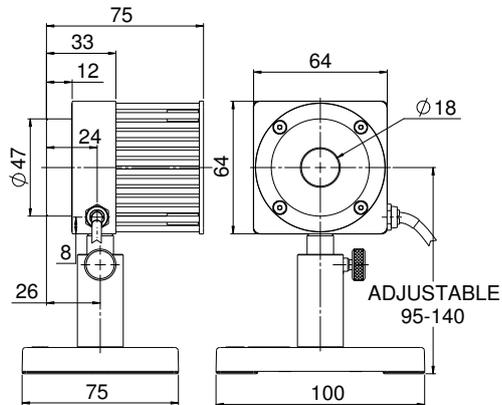
30A-P-17



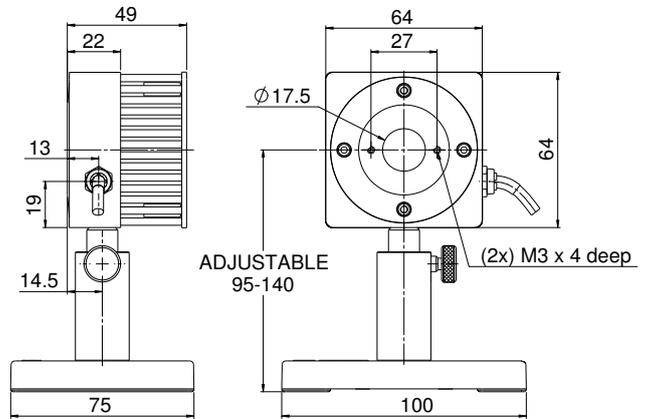
15(50)A-PF-DIF-18



50A-PF-DIF-18



30A-N-18



1.1.2.3 Low Power Thermal Sensors

1.1.2.3.1 Low Power BeamTrack-Power / Position / Size Sensors

100μW to 10W

Features (see introduction in pages 111-113)

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

3A-QUAD / 3A-P-QUAD



10A-BB-16-PPS



Model	3A-QUAD ^(a)	3A-P-QUAD ^(a)	10A-BB-16-PPS ^(a)
Use	General purpose	Short pulses	Low power
Functions	Power / Energy / Position	Power / Energy / Position	Power / Energy / Position / Size
Absorber Type	Low power broadband	P type	Broadband
Spectral Range μm	0.19 - 20	0.15 - 8	0.19 - 11
Aperture mm	Ø9.5mm	Ø12mm	Ø16mm
Power Mode			
Power Range	100μW - 3W	160μW - 3W	20mW - 10W
Power Scales	3W to 300μW	3W to 300μW	10W / 5W / 0.5W
Power Noise Level	5μW	10μW	1mW
Thermal Drift (30min)%	10 - 40μW ^(b)	10 - 40 μW ^(b)	NA
Maximum Average Power Density kW/cm ²	1	0.05	28
Response Time with Meter (0-95%) typ. s	1.8	2.5	0.8
Calibration Uncertainty ±%	1.9	1.9	1.9
Power Accuracy ±% ^(g)	3	3	3 ^(h)
Linearity with Power ±%	1	1	1
Energy Mode			
Energy Range	20μJ - 2J	30μJ - 2J	6mJ - 2J
Energy Scales	2J to 200μJ	2J to 200μJ	2J / 200mJ
Minimum Energy	20μJ	30μJ	6mJ
Maximum Energy Density J/cm ²			
<100ns	0.3	1 ^(f)	0.3
0.5ms	1	1 ^(f)	2
2ms	2	1 ^(f)	2
10ms	4	1 ^(f)	2
Beam Tracking Mode			
Position			
Beam Position Accuracy mm ^(c)	0.15	0.15	0.15
Beam Position Resolution mm	0.02	0.02	0.02
Min Power for Position Measurement	300μW	400μW	50mW
Size ^(d)			
Size Accuracy ^(e)	NA	NA	±(5%+50μm) for centered beam
Size Range mm (4σ beam diameter)	NA	NA	1.5 - 10
Min Power for Size Measurement	NA	NA	50mW
Cooling	Convection	Convection	Convection
Weight kg	0.3	0.3	0.3
Fiber Adapter Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			V1
Part number	7Z07934	7Z07935	7Z07905

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) Depending on room airflow and temperature variations.

Note: (c) For position within inner 30% of aperture. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

Note: (d) Assumes laser beam with circular Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams ≥1.8 mm not deviating from center by more than 15% of beam diameter.

Note: (f) For P type and shorter wavelengths derate maximum energy density as follows:

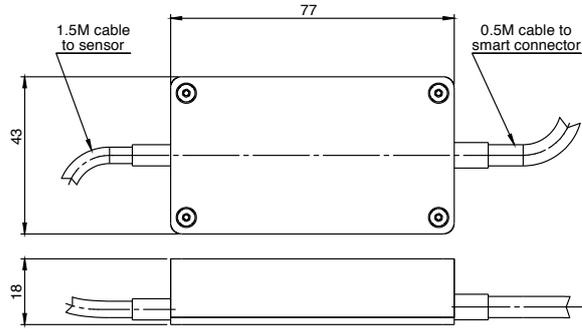
Wavelength	Derate to value
1064nm	not derated
532nm	not derated
355nm	40% of stated value
266nm	10% of stated value
193nm	10% of stated value

Note: (g) The 3A-QUAD has a relatively large spectral variation in absorption and has a calibrated spectral curve at all wavelengths in its spectral range to the above specified accuracy. Nova and LaserStar meters do not support this feature and when used with those meters, the accuracy will be ±3% as above for 532nm, 905nm, 1064nm and 10.6μm but there will be an additional error of up to 3% at other wavelengths in the spectral range 190 - 3000nm.

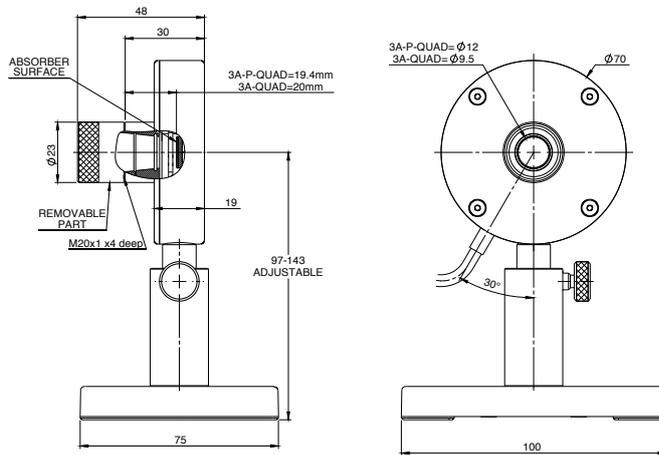
Note: (h) ±4%. For wavelengths <240nm

* For drawings please see page 56

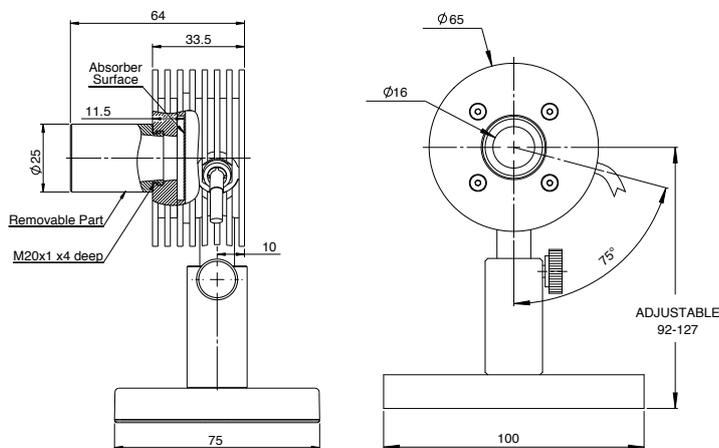
Interface Module on cable



3A-QUAD / 3A-P-QUAD



10A-BB-16-PPS



1.1.2.3 Low Power Thermal Sensors

1.1.2.3.2 Beam Trap

Up to 50W

Features

- Does not measure power, traps beam only
- Power capacity up to 50W
- Backscattered power 0.05%
- Pulsed damage threshold 4J/cm²
- Average power density up to 16kW/cm²
- Ø15mm aperture

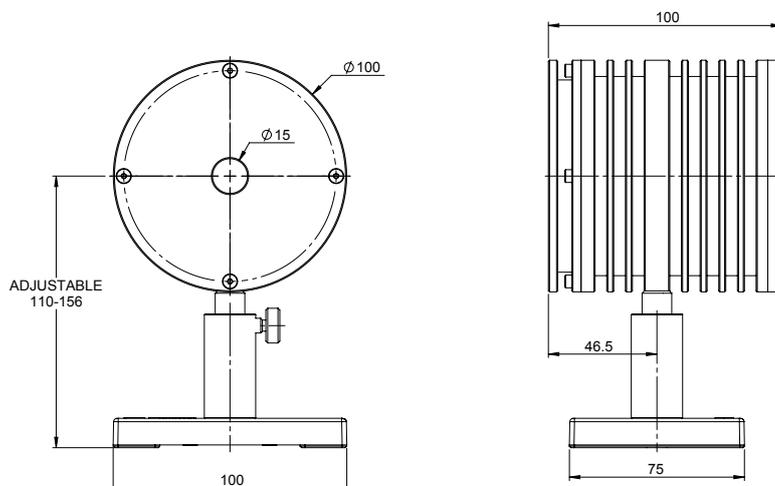


The BT50A-15 absorbs a laser beam that is inserted into the entrance aperture parallel to the unit's optic axis. The beam trap is designed that only a very small fraction of the light is backscattered. The BT50A-15 does not measure power. It is a beam trap only.

When operated at full power, the BT50A-15 can heat up to over 100degC. Note that the absorbing element of the beam trap is graphite which may not be suitable for some environments.

Model	BT50A-15	
Use	Beam trap for CW and pulsed lasers up to 50W average power	
Absorber Type	Broadband graphite absorber	
Spectral Range μm	0.19 - 20	
Backscatter	0.05% or less, typical	
Aperture mm	Ø15mm	
Maximum Acceptance Angle	± 10 degrees	
Maximum Incident Power	50W	
Maximum Average Power Density	16kW/cm ²	
Maximum Energy Density	<100ns pulses	4J/cm ²
	2ms pulses	100J/cm ²
Cooling	convection	
Dimensions	See drawing below	
Weight kg	0.9	
Compliance	RoHS, China RoHS	
Version		
Part number	7Z17204	

BT50A-15



1.1.2.4 Low - Medium Power Thermal Sensors - Apertures to 35mm

30mW to 150W

Features

- Convection air cooled
- CW to 30W or 50W, intermittent to 150W
- Ø17.5mm and Ø35mm apertures
- Measure powers up to 4000W by short exposures to laser

30(150)A-BB-18



30(150)A-LP2-18

L50(150)A-BB-35
L50(150)A-PF-35

L50(150)A-LP2-35



Model	30(150)A-BB-18	30(150)A-LP2-18	L50(150)A-BB-35	L50(150)A-LP2-35	L50(150)A-PF-35
Use	General purpose	High power density and long pulse lasers	General purpose	High power density and long pulse lasers ^(b,c)	Short pulse lasers
Absorber Type	Broadband	LP2	Broadband	LP2	PF
Spectral Range μm	0.19 - 11	0.25 - 2.2	0.19 - 11	0.25 - 2.2	0.15-20
Absorption	>85%	>94% from 0.25 to 1.1 μm	>85%	>94% from 0.25 to 1.1 μm	>85%
Aperture mm	Ø17.5mm	Ø17.5mm	Ø35mm	Ø35mm	Ø35mm
Power Mode					
Power Range	30mW - 150W	30mW - 150W	100mW - 150W	100mW - 150W ^(b,c)	100mW - 150W
Maximum Intermittent Power W	150W for 1.5min, 100W for 2.2min, 30W continuous		150W for 1.5min, 100W for 2.5min, 50W continuous	For L50(150)A-LP2-35: 4000W for 0.4s exposure ^(b,c)	
Power Scales	150W / 30W / 3W	150W / 30W / 3W	150W / 50W / 5W	150W / 50W / 5W	150W / 50W / 5W
Power Noise Level	2mW	2mW	4mW	4mW	4mW
Maximum Average Power Density kW/cm ²	12 at 150W 20 at 30W	33 at 150W 50 at 30W	12 at 150W 17 at 50W	33 at 150W 50 at 50W	3
Response Time with Meter (0-95%) typ. s	1.2	1.2	2	2	2
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(g)	3 ^(a)	3 ^(g)	3 ^(a)	4 ^(d)
Linearity with Power $\pm\%$	1	1	1	1	1
Energy Mode					
Energy Range	20mJ - 100J	20mJ - 300J	40mJ - 300J	40mJ - 3000J	50mJ - 300J
Energy Scales	100J / 30J / 3J	300J / 30J / 3J	300J / 30J / 3J	3000J / 300J / 30J / 3J	300J / 30J / 3J
Minimum Energy mJ	20	20	40	40	50
Maximum Energy Density J/cm ²					Single ^(e) 10-50Hz ^(e)
<100ns	0.3	0.1	0.3	0.1	3 ^(f) 1.5
0.5ms	5	50	5	50	7 7
2ms	10	130	10	130	15 15
10ms	30	400	30	400	40 40
>300 ms	NA	NA	NA	See below ^(b,c)	NA NA
Cooling	convection	convection	convection	convection	convection
Fiber Adapters Available (p. 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight kg	0.3	0.3	0.35	0.35	0.35
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1		V1		
Part number: Standard Sensor	7Z07122	7Z02786	7Z07118 (1.5m cable)	7Z02785	7Z02737
Sensor with different cable length			7Z07118D (12m cable)		

Notes: (a) Above 1.1 μm there is an additional calibration uncertainty of up to 2%.

Notes: (b) Long pulses (0.5 – 4s) can be used to measure power of high power lasers by measuring the energy of a short exposure. The StarBright, Juno, Juno+, Juno-RS and Centauri meters have a Pulsed Power mode where the user may specify the pulse width and get a reading directly in units of power for this short exposure energy measurement. See also page 108

Notes: (c) Powers up to 4000W can be measured.

Recommended exposure times and 1/e² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 15kJ. Recommended time between shots 12s.

Laser Power W	Recommended Exposure s	Number of shots before cooling down	Min 1/e ² beam dia mm
100	4	20	9
500	1	20	9
1000	1	10	13
2000	1	7	17
4000	0.4	7	20

Notes: (g) $\pm 4\%$. For wavelengths <240nm

Notes: (d) Calibrated for 0.25 – 2 μm , 10.6 μm

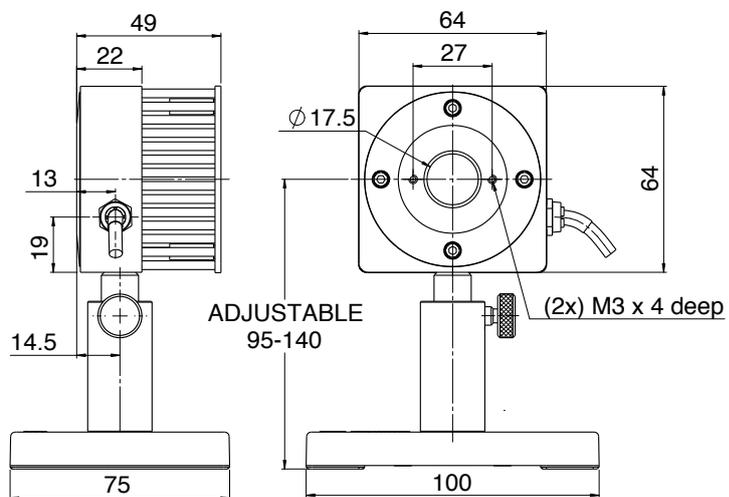
Notes: (e) For 10-50Hz, derate as follows:

Wavelength	Derate to value
1064nm	Not derated
532nm	Not derated
355nm	70% of stated value
266nm	15% of stated value
193nm	10% of stated value

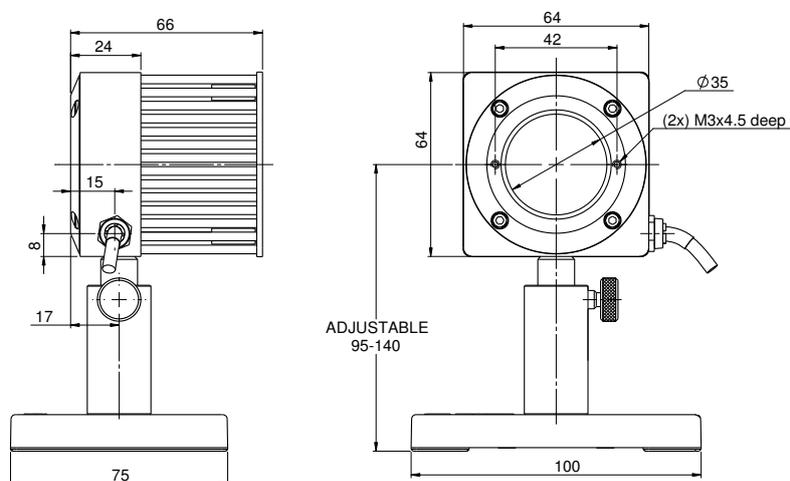
Notes: (f) Damage threshold 1.5J/cm² for wavelengths <500nm

* For drawings please see page 59

30(150)A-BB-18 / 30(150)A-LP2-18



L50(150)A-BB-35 / L50(150)A-LP2-35 / L50(150)A-PF-35



1.1.2.4 Low - Medium Power Thermal Sensors - Apertures to 17.5mm

100mW to 200W

Features

- High repetition rate pulsed lasers for material processing
- Air and fan cooled
- CW to 80W, intermittent to 200W

F80(120)A-CM-17 /
F150(200)A-CM-16



30(150)A-SV-17

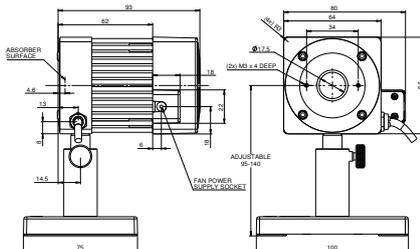


Model	F80(120)A-CM-17	F150(200)A-CM-16	30(150)A-SV-17
Use	High repetition rate pulsed lasers for material processing	High repetition rate pulsed lasers for material processing	High repetition rate pulsed lasers for material processing
Absorber Type	CM	CM	SV
Spectral Range μm	0.248 – 9.4 ^(b)	0.248 – 9.4 ^(b)	0.19 - 11
Aperture mm	\varnothing 17.5mm	\varnothing 16mm	\varnothing 17mm
Power Mode			
Power Range	100mW - 120W	300mW - 200W	100mW - 150W
Maximum Intermittent Power W	120W for 1min, 80W continuous	200W for 1 min, 150W continuous	150W for 1.5min, 100W for 2.2min, 30W continuous
Power Scales	120W / 80W / 8W	200W / 80W / 8W	150W / 30W / 3W
Power Noise Level	5mW	15mW	5mW
CW Maximum Power Density kW/cm ²	7 at 80W (& at 120W for 1 min), 100 at 10W ^(c)	2 at 200W, 3 at 150W, 7 at 80W, 100 at 10W ^(c)	60 at 150W
Pulsed Maximum Average Power Density kW/cm ² ^(d)	35 at 25W for ns pulses 7 at 20W for ps pulses	35 at 25W for ns pulses 7 at 20W for ps pulses	100 at 25W for ns pulses 20 at 20W for ps pulses
Response Time with Meter (0-95%) typ. s	2	3	1.7
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3	3	3
Linearity with Power $\pm\%$	1.5	1.5 ^(e)	1
Energy Mode			
Energy Range	50mJ – 200J	50mJ – 200J	50mJ - 300J
Energy Scales	200J / 30J / 3J	200J / 30J / 3J	300J / 30J / 3J
Minimum Energy mJ	50	50	50
Maximum Energy Density J/cm ²	Pulse width ^(a)	Pulse width ^(a)	Pulse width ^(a)
	<100ns	<100ns	<100ns
	0.5ms	0.5ms	0.5ms
	2ms	2ms	2ms
	0.7	0.7	1
	16	16	20
	45	45	50
Cooling	Fan	Fan	Convection
Fiber Adapters Available (see page 120)	NA	NA	ST, FC, SMA, SC
Weight kg	0.54	0.54	0.3
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			
Part number	7Z07103	7Z07107	7Z02724

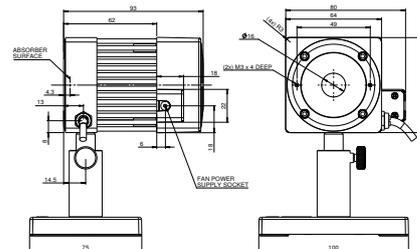
Notes:

- (a) At 1064nm. For shorter wavelengths derate maximum energy density to:
 355nm 50% of above values
 266nm 50% of above values (for CM type 30% of above values)
 193nm 10% of above values
- (b) The sensor is only calibrated in the spectral range 0.25-2.2 μm
- (c) At 1064nm
- (d) For repetition rates \geq 100kHz
- (e) At 200W add additional linearity error of \pm 0.5%

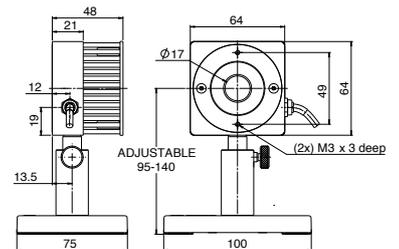
F80(120)A-CM-17



F150(200)A-CM-16



30(150)A-SV-17



1.1.2.4 Low - Medium Power Thermal Sensors - Apertures to 17mm

50mW to 150W

Features

- Special purpose SV and HE absorbers
- For concentrated beams and pulses
- Convection air cooled
- CW to 30 or 50W, intermittent to 150W
- Ø17mm aperture



Model	30(150)A-HE-17		30(150)A-HE-DIF-17	
Use	High energy pulsed lasers		Concentrated beam high energy pulsed lasers - has removable diffuser	
Absorber Type	HE		HE	
Spectral Range μm	0.19 - 0.625, 1.064, 2.1, 2.94		0.19 - 3 except for 0.625 - 0.9 ^(b)	
Aperture mm	Ø17mm		Ø17mm	
Power Mode				
Power Range	50mW - 150W		50mW - 150W	
Maximum Intermittent Power W	150W for 1.5min, 100W for 2.2min, 30W continuous		150W for 1.5min, 100W for 2.2min, 30W continuous	
Power Scales	150W / 30W / 3W		150W / 30W / 3W	
Power Noise Level	3mW		3mW	
CW Maximum Power Density kW/cm ²	0.5		0.5	
Pulsed Maximum Average Power Density kW/cm ² ^(c)	NA		NA	
Response Time with Meter (0-95%) typ. s	3.8		3.8	
Calibration Uncertainty $\pm\%$	1.9		1.9	
Power Accuracy $\pm\%$	3		5 ^(b)	
Linearity with Power $\pm\%$	1.5		1.5	
Energy Mode				
Energy Range	60mJ - 200J		60mJ - 200J	
Energy Scales	200J / 30J / 3J		200J / 30J / 3J	
Minimum Energy mJ	60		60	
Maximum Energy Density J/cm ²	Pulse width ^(a)	Single	10-50Hz	
	<100ns	5	2	
	0.5ms	100	25	
	2ms	150	40	
				Wavelength
				DIF IN
				DIF OUT
				1064nm
				532nm
				355nm
Cooling	Convection		Convection	
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC		NA	
Weight kg	0.3		0.4	
Compliance	CE, UKCA, China RoHS		CE, UKCA, China RoHS	
Version				
Part number	7Z02722		7Z02729	

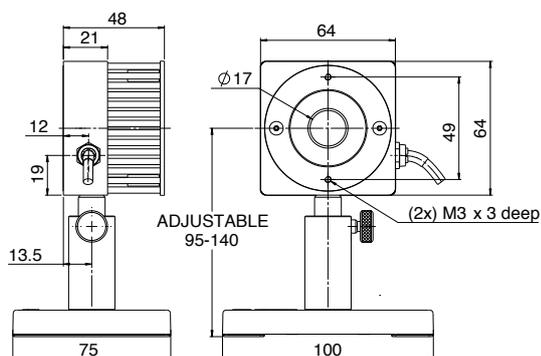
Notes: (a) At 1064nm. For shorter wavelengths derate maximum energy density to:

355nm 50% of above values
266nm 50% of above values
193nm 10% of above values

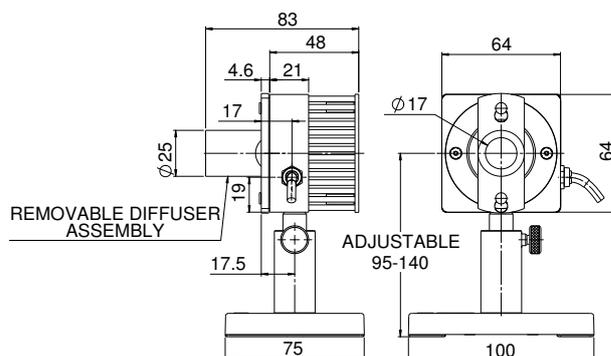
(b) With diffuser in, sensor is only calibrated for 1064nm, 532nm and 355nm wavelengths

(c) For repetition rates $\geq 100\text{kHz}$

30(150)A-HE-17



30(150)A-HE-DIF-17



1.1.2.4 Low - Medium Power Thermal Sensors - Apertures to 26mm

1.1.2.4.1 Medium Power BeamTrack-Power / Position / Size Sensors

40mW to 150W

Features (see introduction in pages 111-113)

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

50(150)A-BB-26-QUAD
/ 50(150)A-BB-26-PPS



F150A-BB-26-PPS



Model	50(150)A-BB-26-QUAD ^(a)	50(150)A-BB-26-PPS ^(a)	F150A-BB-26-PPS ^(a)
Use	General purpose	General purpose	General purpose
Functions	Power / Energy / Position	Power / Energy / Position / Size	Power / Energy / Position / Size
Absorber Type	Broadband	Broadband	Broadband
Spectral Range μm	0.19 - 11	0.19 - 11	0.19 - 11
Aperture mm	\varnothing 26mm	\varnothing 26mm	\varnothing 26mm
Power Mode			
Power Range	40mW - 150W	40mW - 150W	50mW - 150W ^(b)
Maximum Intermittent Power	150W for 1.5min, 100W for 2.2min, 50W continuous	150W for 1.5min, 100W for 2.2min, 50W continuous	N.A.
Power Scales	150W / 50W / 5W	150W / 50W / 5W	150W / 30W / 3W
Power Noise Level	2mW	2mW	8mW ^(b)
Maximum Average Power Density kW/cm ²	12 at 150W, 17 at 50W	12 at 150W, 17 at 50W	12 at 150W, 17 at 50W
Response Time with Meter (0-95%) typ. s	1.5	1.5	1.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(f)	3 ^(f)	3 ^(f)
Linearity with Power $\pm\%$	1.5	1.5	1
Energy Mode			
Energy Range	20mJ - 100J	20mJ - 100J	20mJ - 100J
Energy Scales	100J / 30J / 3J / 300mJ	100J / 30J / 3J / 300mJ	100J / 30J / 3J / 300mJ
Minimum Energy mJ	20	20	20 ^(b)
Maximum Energy Density J/cm ²			
<100ns	0.3	0.3	0.3
0.5ms	5	5	5
2ms	10	10	10
10ms	30	30	30
Beam Tracking Mode			
Position			
Beam Position Accuracy mm ^(c)	0.1 + 5% of distance from center	0.1 + 5% of distance from center	0.1 + 5% of distance from center
Beam Position Resolution mm	0.1	0.1	0.1
Min Power for Position Measurement	1W	1W	1W
Size ^(d)			
Size Accuracy mm ^(e)	N.A.	\pm 5% for centered beam	\pm 5% for centered beam
Size Range mm (4 σ beam diameter)	N.A.	\varnothing 3 - 20	\varnothing 3 - 20
Min Power Density for Size Measurement	N.A.	1 W/cm ²	1 W/cm ²
Cooling	Convection	Convection	Fan
Fiber Adapter Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight Kg	0.4	0.4	0.45
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1	V1	V1
Part number	7Z07938	7Z07907	7Z07906

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) For powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Note: (c) Position accuracy for the central 10mm of the aperture as limited by beam position resolution. Position can be tracked with \pm 1mm accuracy over the entire aperture. Accuracy is reduced by a factor of 3 at minimum power. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

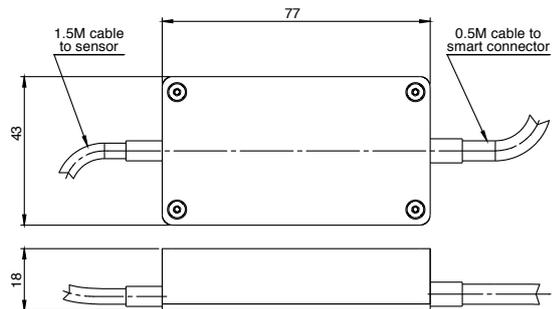
Note: (d) Assumes laser beam with Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams from 3.5 to 17mm not deviating from center more than 15% of beam diameter. For beams below 8mm in size and powers above 75W error in size can reach \pm 10%.

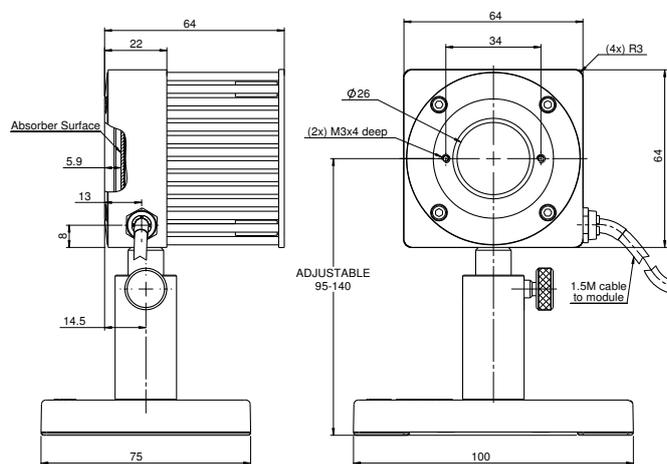
Note: (f) \pm 4%. For wavelengths <240nm

* For drawings please see page 63

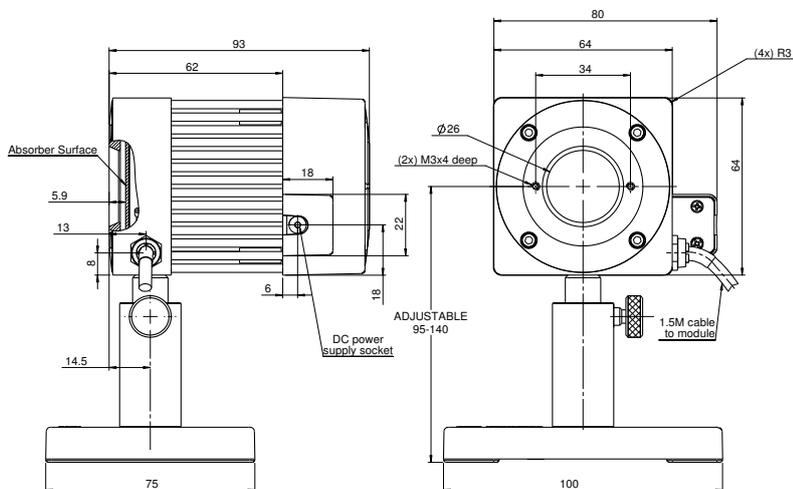
Interface Module on cable



50(150)A-BB-26-QUAD / 50(150)A-BB-26-PPS



F150A-BB-26-PPS



1.1.2.4 Low - Medium Power Thermal Sensors - Apertures to 26mm

1.1.2.4.2 Standard OEM Smart Sensors

10mW to 150W

Features

- Sensors come with threaded holes for mounting to host system
- Compact
- Up to 150W
- Ø12 to Ø26mm apertures



Model	20C-BB-12-SH	L30C-SH	L30C-LP2-26-SH	100C-BB-18-SH	150C-SH / 150W-SH
Use	Compact	Larger aperture	High pulse energy and intermittent power	Slim profile	Compact higher power
Absorber Type	Broadband	Broadband	LP2	Broadband	Broadband
Spectral Range μm	0.19 - 11	0.19 - 20	0.25 - 2.2	0.19 - 11	0.19 - 20
Absorption	~88%	~88%	>94% from 0.25 to 1.1 μm	~88%	~88%
Aperture mm	Ø12	Ø26	Ø26	Ø18	Ø18
Power Mode					
Minimum power	10mW	300mW	300mW	60mW	60mW / 100mW
Maximum power free standing	4W continuous, 20W for 1.8min	10W continuous, 100W for 2min	10W continuous, 100W for 2min	4W	5W continuous, 150W for 1min
Maximum power heat sinked	20W	100W	100W	100W	60W cond. / 150W water
Power Scales	20W / 3W	100W / 10W	100W / 10W	100W / 30W / 3W	150W / 30W
Power Noise Level	0.2mW	15mW	15mW	3mW	3mW / 5mW
Maximum Average Power Density kW/cm ²	23 at 20W, 35 at 4W	14 at 100W, 28 at 10W	42 at 100W	30 at 4W, 14 at 100W	30 at 5W, 20 at 60W / 12 at 150W
Response Time with Meter (0-95%), typ. s	0.8	1.5	1.5	1.2	1.2
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3	3	3 ^(b)	3	3
Linearity with Power $\pm\%$	1	1.5	1.5	1	1
Energy Mode					
Energy Range	6mJ-10J	30mJ-100J	30mJ-2000J	NA	20mJ-100J / 50mJ-100J
Energy Scales	10J / 1J	100J / 30J / 3J / 300mJ	2kJ / 300J / 30J / 3J / 300mJ	NA	100J / 30J / 3J
Minimum Energy mJ	6	30	30	NA	20
Maximum Energy Density J/cm ²					
<100ns	0.3	0.3	0.1	0.3	0.3
0.5ms	2	5	50	5	5
2ms	2	10	130	10	10
10ms	2	30	400	30	30
>300ms	NA	NA	See below ^(c, d)	NA	NA
Cooling	Conduction	Conduction	Conduction	Conduction	Conduction / Water
Weight kg	0.2	0.3	0.3	0.2	0.3
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1			V1	
Part number	7Z07129	773434	7Z02775	7Z07126	7N77023^(a) / 771001

Note: (a) P/N 7N77023 replaces P/N 77023

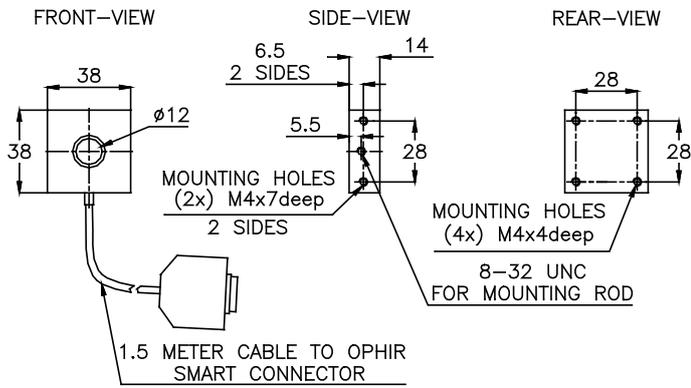
Note: (b) Above 1.1 μm there is an additional calibration uncertainty of up to 2%

Note: (c) Long pulses (0.5 – 4s) can be used to measure power of high power lasers by measuring the energy of a short exposure. The StarBright, Juno, Juno+, Juno-RS and Centauri meters have a Pulsed Power mode where the user may specify the pulse width and get a reading directly in units of power for this short exposure energy measurement. See also page 108

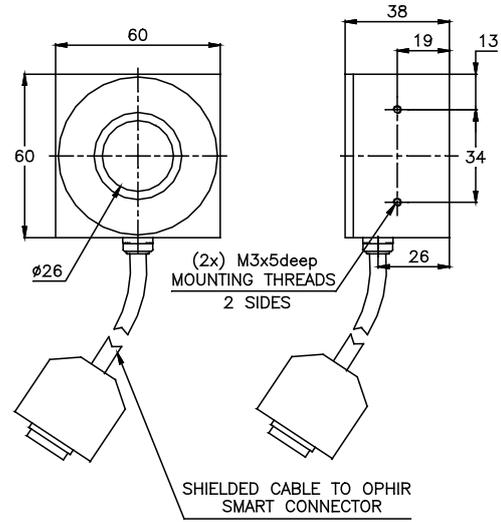
Note: (d) Recommended exposure times and 1/e ² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 2kJ. Recommended time between shots 12s.	Laser Power W	Recommended Exposure s	Number of shots before cooling down	Min 1/e ² beam dia. mm
	100	4	20	9
	500	1	20	9
	1000	1	10	13
	2000	1	5	17
	4000	0.5	5	22

* For drawings please see page 65

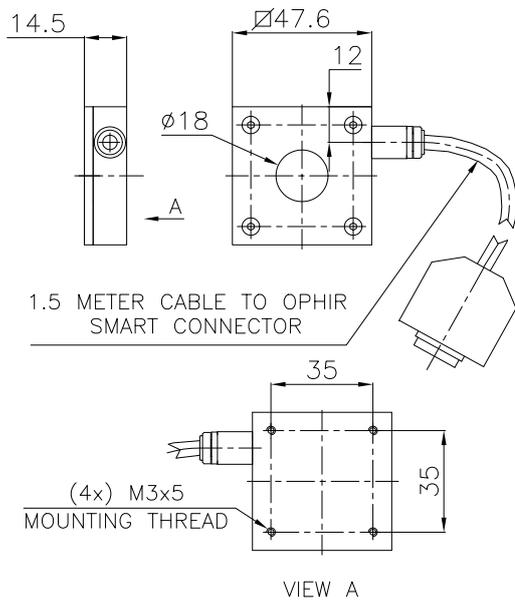
20C-BB-12-SH



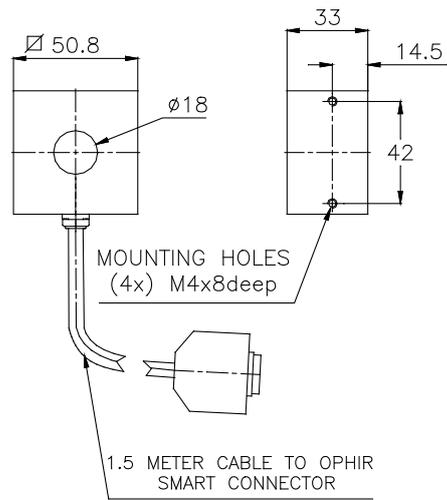
L30C-SH / L30C-LP2-26-SH



100C-BB-18-SH



150C-SH



1.1.2.5 Medium Power Large Aperture Thermal Sensors - Apertures 50mm

300mW to 500W and up to 10kJ

Features

- Thin profile
- CW to 40W, intermittent to 500W
- Pulse energies up to 10,000 Joules
- For continuous, long pulse and Excimer lasers
- Measure high power lasers by 0.5-4s exposures



Model	L40(250)A-BB-50	L40(250)A-LP2-50	L40(200)A-EX-50	L40(500)A-LP2-DIF-35
Use	General purpose	CW and Long Pulse Lasers	Excimer lasers	Concentrated Beams
Absorber Type	Broadband	LP2	EX	LP2 + Diffuser
Spectral Range μm	0.19 - 11	0.25 - 2.2, 2.94	0.15 - 0.7, 10.6	0.44 - 2.2 ^(c)
Absorption	~88%	>94% from 0.25 to 1.1 μm	~95%	~14% backscatter from diffuser
Aperture mm	\varnothing 50mm	\varnothing 50mm	\varnothing 50 mm	\varnothing 35mm
Power Mode				
Power Range	300mW - 250W ^(b)	300mW - 250W ^(b)	300mW - 200W	300mW - 500W ^(b)
Maximum Intermittent Power	250W for 1.5min, 150W for 3min, 80W for 6min, 35W continuous ^(b)	250W for 1.5min, 150W for 3min, 80W for 6min, 40W continuous ^(b)	200W for 1.5min, 150W for 3min, 80W for 6min, 35W continuous	500W for 45s, 250W for 1.5min, 150W for 3min, 80W for 6min, 40 continuous ^(b)
Power Scales	250W / 30W	250W / 30W	200W / 20W	500W / 50W
Power Noise Level	15mW	15mW	15mW	20mW
Maximum Average Power Density kW/cm ²	10 at 250W 20 at 35W	20 at 250W 50 at 40W	1.5	>150 at 500W
Response Time with Meter (0-95%) typ. s	2.5	2.5	2.5	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(f)	3 ^(a)	3	3
Linearity with Power $\pm\%$	1	1	1	1
Beam Size Dependence	<1% for beams up to 35mm diameter			
Max Beam Diameter for Gaussian beam	\varnothing 35mm	\varnothing 35mm for up to 30deg incidence	\varnothing 35mm	\varnothing 25mm for normal incidence \varnothing 15mm for 20deg incidence ^(d) \varnothing 10mm for 30deg incidence ^(d)
Energy Mode				
Energy Range	100mJ - 4000J	100mJ - 10,000J	100mJ - 200J	100mJ - 2000J
Energy Scales	4kJ / 400J / 40J / 4J	10kJ / 1kJ / 100J / 10J	200J / 30J / 3J	2kJ / 200J / 20J / 2J
Energy Accuracy	\pm 5%	\pm 5% 700 - 1100nm ^(a, b)	\pm 5%	\pm 5% 900 - 1100nm ^(b)
Maximum Exposure Before Cooling Down is Necessary	NA	See page 108	NA	See page 108
Minimum Energy mJ	100	100	100	100
Maximum Energy Density J/cm ²				
<100ns	0.3	0.1	0.5	3
1 μ s	0.4	0.9	0.6	3
0.5ms	5	50	6	10
2ms	10	130	12	20
10ms	30	400	25	30
>300ms	See below ^(b, e)	See below ^(b, e)	NA	See below ^(b, e)
Cooling	Convection	Convection	Convection	Convection
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	NA	NA
Weight kg	0.6	0.8	0.6	0.6
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1			
Part number: Standard Sensor	7Z07110 (1.5m cable)	7Z02794	7Z02795	7Z02797
Sensor with different cable length	7Z07110D (12m cable)			

Notes: (a) Above 1.1 μm there is an additional calibration uncertainty of up to 2% except at the additional calibration point of 2.94 μm where the additional uncertainty is 1%.

Notes: (b) Long pulses (0.5 - 4s) can be used to measure power of high power lasers by measuring the energy of a short exposure. The StarBright, Juno, Juno+, Juno-RS and Centauri meters have a Pulsed Power mode where the user may specify the pulse width and get a reading directly in units of power for this short exposure energy measurement. See also page 108

Notes: (c) Calibrated for 900 - 1100nm

Notes: (d) At large angles of incidence, the position the beam hits the absorber should be offset into the direction of incidence by 5-10mm for correct reading and at 20deg incidence the reading will be 5% lower and at 30deg incidence 10% lower

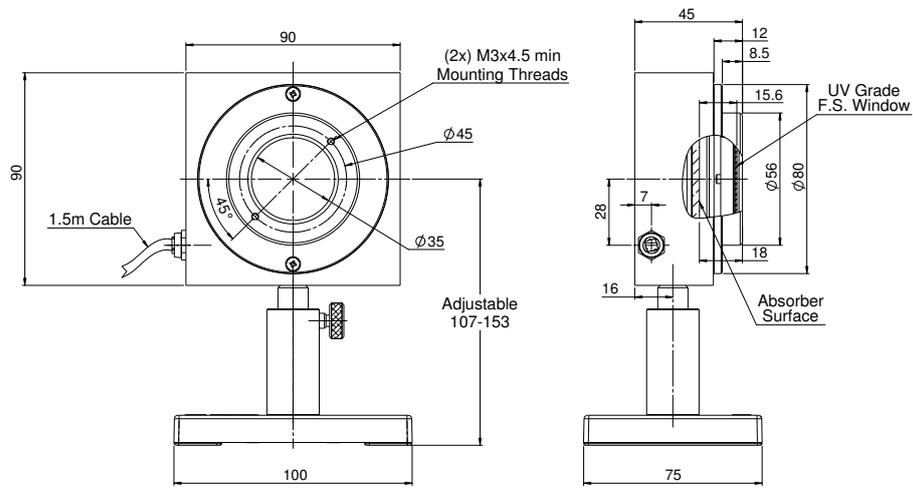
Notes: (e) Recommended exposure times and 1/e ² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 20kJ (*8kJ). Cooling down time before another 20kJ (*8kJ) series, 10min. Recommended time between shots 12s.	Laser Power W	Recommended Exposure s		Number of shots before cooling down	Min 1/e ² beam dia. mm		
		Non- Diffuser	Diffuser		L40(250)A-BB-50	L40(250)A-LP2-50	L40(500)A-LP2-DIF-35
	100	4	4	20	14	9	1
	500	2	1	20	14	9	1
	1000	1	1	20	14	9	1
	2000	1	1	10	21	12	1.5
	4000	1	0.4	5	32	16	3.5
	5000	1	NA	4	NA	18	NA
	10000	0.3	NA	4	NA	22	NA

* for L40(500)A-LP2-DIF-35

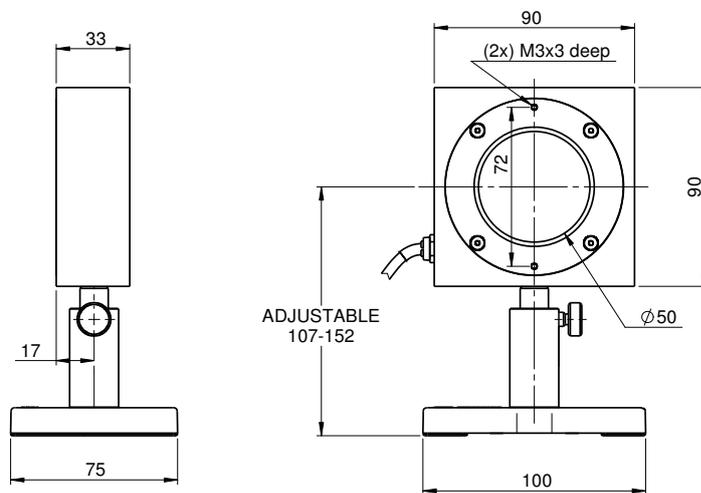
Notes: (f) \pm 4%. For wavelengths <240nm

* For drawings please see page 67

L40(500)A-LP2-DIF-35



L40(250)A-BB-50 / L40(250)A-LP2-50 / L40(200)A-EX-50



1.1.2.5 Medium Power Large Aperture Thermal Sensors - Apertures to 65mm

300mW to 300W

Features

- Thin profile, very large aperture
- CW to 50W, intermittent to 300W
- Ø50mm to Ø65mm apertures

For L50(250)A-BB-50:

- Pulse energies up to 4,000 Joules
- Measure high power lasers by 0.5-4s exposures

L50(250)A-BB-50



L50(300)A-LP2-65

L50(300)A-BB-65 /
L50(300)A-PF-65

Model	L50(250)A-BB-50	L50(300)A-BB-65	L50(300)A-LP2-65	L50(300)A-PF-65
Use	General purpose	General purpose	Long pulse lasers	Large beam short pulsed lasers
Absorber Type	Broadband	Broadband	LP2	PF type
Spectral Range μm	0.19 - 11	0.19 - 11	0.25 - 2.2	0.15 - 20
Absorption	~88%	~88%	>94% from 0.25 to 1.1 μm	~85%
Aperture mm	Ø50mm	Ø65mm	Ø65mm	Ø65mm
Power Mode				
Power Range	300mW - 250W ^(a)	400mW - 300W	400mW - 300W	400mW - 300W
Maximum Intermittent Power	250W for 1.5min, 150W for 3min, 80W for 6min, 50W continuous ^(a)	300W for 2min, 150W for 4.5min, 50W continuous		
Power Scales	250W / 30W	300W / 30W	300W / 30W	300W / 30W
Power Noise Level	15mW	20mW	20mW	20mW
Maximum Average Power Density kW/cm ²	10 at 250W 17 at 50W	9.5 at 300W 17 at 50W	17 at 300W 50 at 50W	3
Response Time with Meter (0-95%) typ. s	2.5	3	3	3
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(g)	3 ^(g)	3 ^(g)	4 ^(c)
Linearity with Power $\pm\%$	1	1	1	1
Beam Size Dependence	<1% for beams up to 35mm diameter	NA	NA	NA
Energy Mode				
Energy Range	100mJ - 4000J	200mJ - 300J	200mJ - 1000J	200mJ - 300J
Energy Scales	4kJ / 400J / 40J / 4J	300J / 60J / 6J	1000J / 600J / 60J / 6J	300J / 60J / 6J
Minimum Energy mJ	100	200	200	200
Maximum Energy Density J/cm ²				Single ^(d) 10-50Hz ^(d)
<100ns	0.3	0.3	0.1	3 ^(e) 1.5
1 μs	0.4	0.4	0.9	3 ^(e) 1.5
0.5ms	5	5	50	7 7
2ms	10	10	130	15 15
10ms	30	30	400	40 40
>300ms	See below ^{(a), (f)}	NA	NA	NA
Cooling	convection	convection	convection	convection
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	NA	NA	NA
Weight kg	0.6	0.9	0.9	0.9
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1	V1		
Part number	7Z07109	7Z07127	7Z02782	7Z02743

Note: (a) Long pulses (0.5 – 4s) can be used to measure power of high power lasers by measuring the energy of a short exposure. The StarBright, Juno, Juno+, Juno-RS and Centauri meters have a Pulsed Power mode where the user may specify the pulse width and get a reading directly in units of power for this short exposure energy measurement. See also page 108

Note: (b) Above 1.1 μm there is an additional calibration uncertainty of up to 2%

Note: (c) Calibrated for 0.25 – 2 μm , 10.6 μm

Note: (d) For 10-50Hz, derate as follows:

Wavelength	Derate to value
1064nm	Not derated
532nm	Not derated
355nm	70% of stated value
266nm	15% of stated value
193nm	10% of stated value

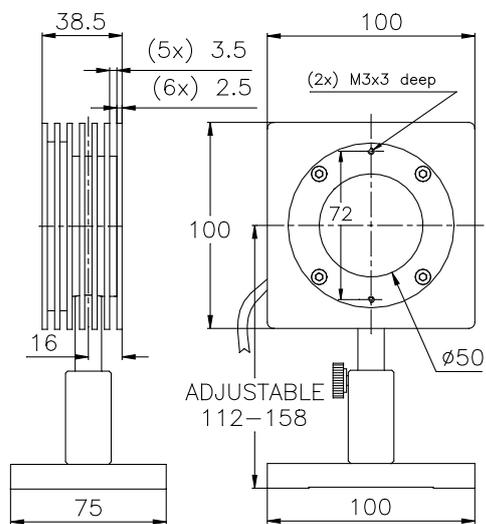
Note: (e) Damage threshold 1.5J/cm² for wavelengths <500nm

Note: (f) Recommended exposure times and 1/e ² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 20kJ. Cooling down time before another 20kJ series, 10min. Recommended time between shots 12s.	Laser Power W	Recommended Exposure s	Number of shots before cooling down	Min 1/e ² beam dia. mm
	500	2	20	14
	1000	1	20	14
	2000	1	10	21
	4000	1	5	32
	5000	1	4	NA
	10000	0.3	4	NA

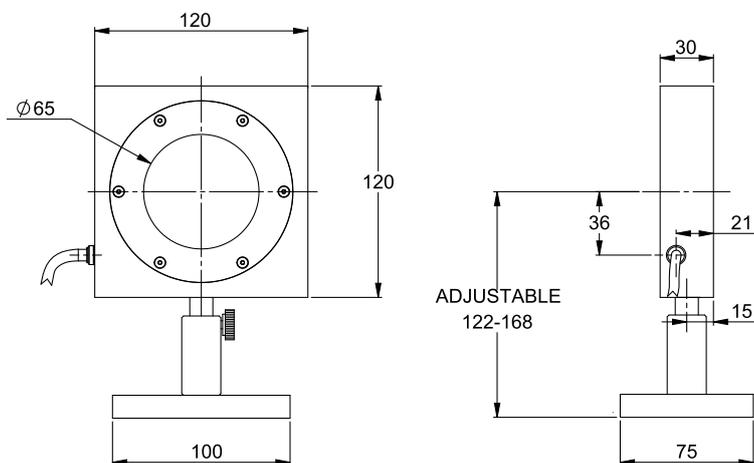
Note: (g) $\pm 4\%$. For wavelengths <240nm

* For drawings please see page 69

L50(250)A-BB-50



L50(300)A-BB-65 / L50(300)A-LP2-65 / L50(300)A-PF-65



1.1.2.5 Medium Power Large Aperture Thermal Sensors – Apertures to 120mm

1W to 500W

Features

- Very large aperture
- Pulsed absorber
- Up to 500W
- Ø120mm aperture

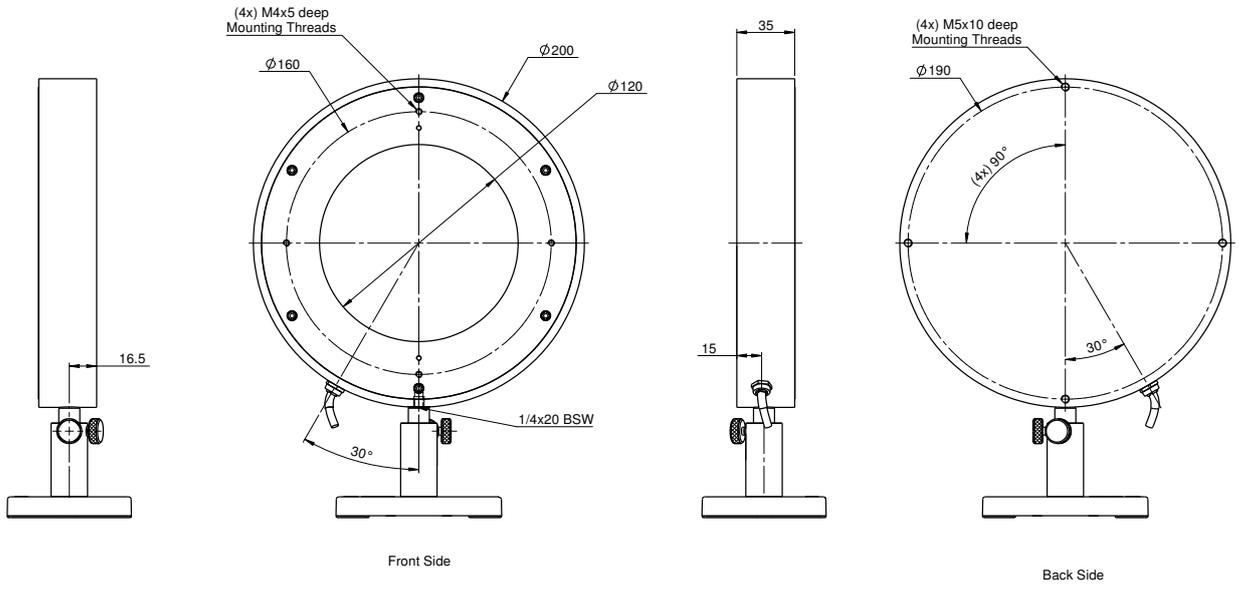
L100(500)A-PF-120



Model	L100(500)A-PF-120	
Use	High peak power, high energy measurements	
Absorber Type	PF volume absorber	
Spectral Range μm	0.15 – 20	
Aperture mm	Ø120mm	
Power Mode		
Power Range	1W – 500W	
Maximum Intermittent Power	500W for 2min, 100W continuous, 500W continuous if heat sinked on rear	
Power Scales	500W / 50W	
Power Noise Level	50mW	
Maximum Average Power Density W/cm^2	2000	
Response Time with Meter (0-95%) typ. s	7	
Calibration Uncertainty $\pm\%$	1.9	
Power Accuracy $\pm\%$	4 ^(a)	
Linearity with Power $\pm\%$	2	
Energy Mode		
Energy Range	6J – 6000J	
Energy Scales	6kJ / 600J / 60J	
Minimum Energy	6J	
Maximum Energy Density J/cm^2	Single	10-50Hz ^(b)
<100ns	3 ^(c)	1.5
1 μs	3 ^(c)	1.5
0.5ms	7	7
2ms	15	15
10ms	40	40
1s	3000	NA
Cooling	Convection or conduction	
Fiber Adapters	Consult Ophir representative	
Accessories for High Power Sensors	See pages 99-102	
Weight kg	4.4	
Compliance	CE, UKCA, China RoHS	
Version		
Part number	7Z02765	
Notes: (a)	Calibrated for 0.25 – 2 μm	
Notes: (b)	For 10-50Hz derate as follows: 1064nm not derated 532nm not derated 355nm 70% of stated value 266nm 15% of stated value 193nm 10% of stated value	
Notes: (c)	Damage threshold 1.5J/cm ² for wavelengths <500nm	

* For drawings please see page 69B

L100(500)A-PF-120



1.1.2.5 Medium Power Large Aperture Thermal Sensors - Apertures 65mm

1.1.2.5.1 Sensors for Intense Pulsed Light IPL

100mJ to 2000J

Features

- L50(300)A-IPL: Large aperture with glass for gel coupling
- L40(150)A-IPL: Designed for gel coupled sources
- L50(300)A-LP2-65: Large aperture and low angle dependence

L50(300)A-IPL



L40(150)A-IPL



L50(300)A-LP2-65



Model	L50(300)A-IPL	L40(150)A-IPL	L50(300)A-LP2-65
Use	Gel and Air coupled IPL and laser sources	Gel coupled IPL sources and laser sources	Air coupled IPL and laser sources
Absorber Type	LP2 + coated window ^(a)	LP2 + pyramid coupling to capture large output light angles	LP2
Spectral Range μm	0.5 - 1.3	0.5 - 1.3	0.25 – 2.2
Absorption	86%	92%	>94% from 0.25 to 1.1 μm
Aperture mm	\varnothing 65mm	22x22mm ^(b)	\varnothing 65mm
Power Mode			
Power Range	400mW - 300W	NA	400mW - 300W
Maximum Intermittent Power	300W for 2 min, 150W for 4.5min, 50W continuous	NA	300W for 2min, 150W for 4.5min, 50W continuous
Power Scales	300W / 30W	NA	300W / 30W
Power Noise Level	20mW	NA	20mW
Maximum Average Power Density kW/cm ²	17 at 300W 50 at 50W	NA	17 at 300W 50 at 50W
Response Time with Meter (0-95%) typ. s	3	NA	3
Calibration Uncertainty $\pm\%$	1.9	NA	1.9
Power Accuracy $\pm\%$	6 for most gel or air coupled IPL sources	NA	3 ^(e)
Linearity with Power $\pm\%$	1	NA	1
Energy Mode			
Energy Range	120mJ - 1000J	100mJ - 2000J	200mJ – 1000J
Energy Scales	1000J / 600J / 60J / 6J	2000J / 600J / 60J / 6J	1000J / 600J / 60J / 6J
Minimum Energy mJ	120	100	200
Damage Threshold	Maximum Energy Density J/cm ²	Maximum Energy J	Maximum Energy Density J/cm ²
<100ns	0.1	1	0.1
1 μs	0.9	9	0.9
0.5ms	50	500	50
2ms	130	1300	130
10ms	400	2000	400
Energy Accuracy $\pm\%$	8 for gel coupled source ^(c) 5 for air coupled source	8 for gel coupled source ^(c)	5 for air coupled source ^(d)
Cooling	convection / ballistic	convection / ballistic	convection / ballistic
Weight kg	1.0	1.0	0.9
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1		
Part number	7Z02780	7Z02771	7Z02782

Note: (a) Sensor has a window for gel coupled IPL sources where IPL source is coupled to window with gel or water for measurement. Can also measure air coupled IPLs.

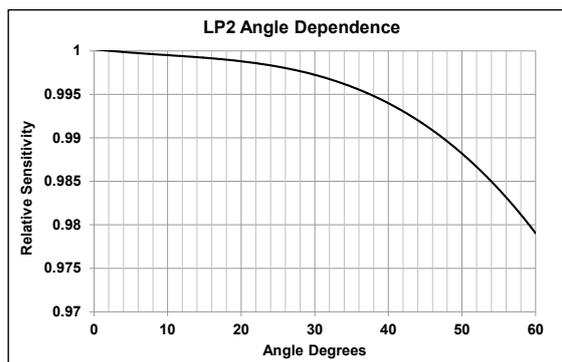
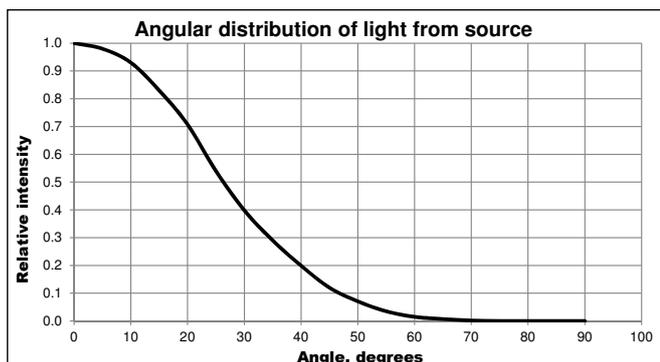
Note: (b) If the source is longer than the aperture, it can overfill and the output can be calculated proportionately.

Note: (d) Accurate measurement of air coupled sources due to low angular dependence of LP2 coating. See graph on page 71.

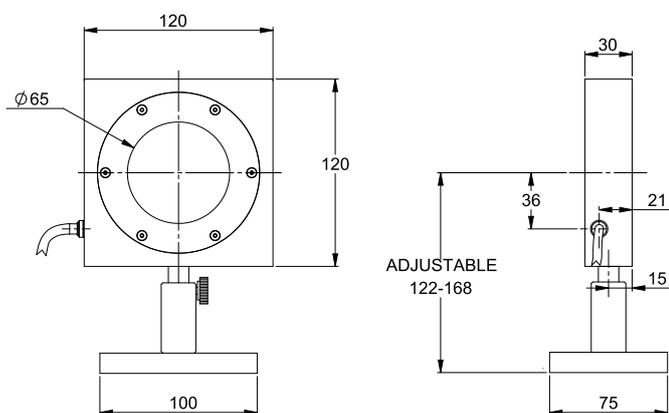
Note: (e) Above 1.1 μm there is an additional calibration uncertainty of up to 2%.

Note: (c) The assumed angular distribution of the IPL light is given below. The angle dependence of the LP2 coating is shown on page 71.

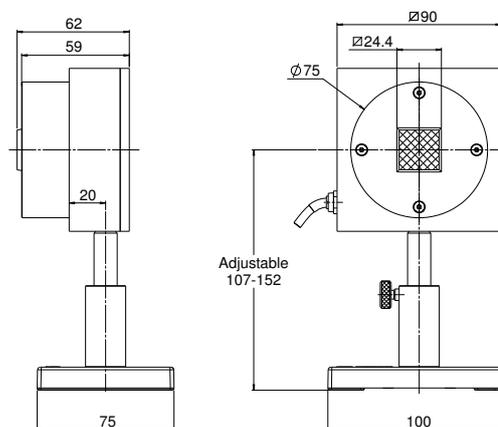
* For drawings and graphs please see page 71



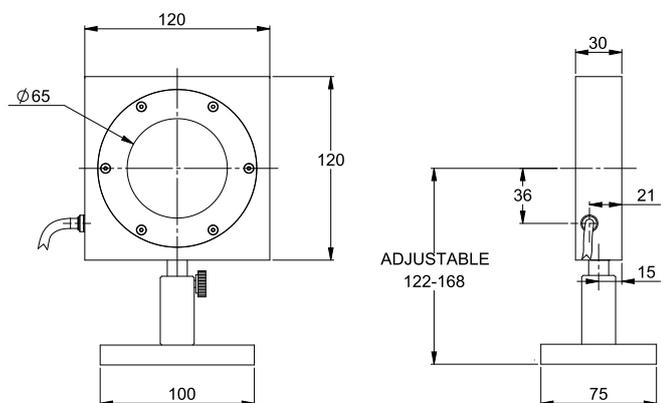
L50(300)A-IPL



L40(150)A-IPL



L50(300)A-LP2-65



1.1.2.6 Medium - High Power Fan Cooled Thermal Sensors

10mW to 150W

Features

- General purpose and high damage threshold
- Fan cooled
- Powers to 150W
- Ø17.5mm to Ø35mm apertures
- F50A-BB-18 very stable reading and wide dynamic range

F50A-BB-18



F100A-PF-DIF-33



F150A-BB-26



Model	F50A-BB-18	F100A-PF-DIF-33	F150A-BB-26
Use	Monitoring stability of power	Short pulse lasers	General purpose
Absorber Type	Broadband	PF type + diffuser	Broadband
Spectral Range μm	0.19 - 11	0.24 - 2.2	0.19 - 11
Aperture mm	Ø17.5mm	Ø33mm	Ø26mm
Power Mode			
Power Range	10mW - 50W ^(a)	50mW - 100W ^(d)	50mW - 150W ^(d)
Power Scales	50W / 5W / 500mW	100W / 30W / 3W	150W / 30W / 3W
Power Noise Level	0.5mW	6mW ^(c)	3mW ^(c)
Maximum Average Power Density kW/cm ²	17 at 50W 28 at 10W	>6	12 at 150W 17 at 50W
Response Time with Meter (0-95%) typ. s	0.8	2.5	1.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(e)	5 ^(c)	3 ^(e)
Linearity with Power $\pm\%$	1	1.5	1
Energy Mode			
Energy Range	6mJ - 50J ^(a)	60mJ - 200J	20mJ - 100J
Energy Scales	50J / 5J / 500mJ	200J / 30J / 3J	100J / 30J / 3J / 300mJ
Minimum Energy mJ	6	60 ^(d)	20 ^(d)
Maximum Energy Density J/cm ²			
<100ns	0.3	4 ^(b)	0.3
0.5ms	2	15 ^(b)	5
2ms	2	35 ^(b)	10
10ms	2	50 ^(b)	30
Cooling	fan	fan	fan
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	NA	ST, FC, SMA, SC
Weight kg	0.35	0.8	0.35
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1		V1
Part number: Standard Sensor	7Z07121	7Z02744	7Z07120
BeamTrack Sensor: Beam Position & Size (p. 62)			7Z07906

Notes: (a) Fan should be on for power above 3W. Fan should be off for measuring very low power and for energy measurement.

Notes: (b) For shorter wavelengths derate maximum energy density as follows: Wavelength Derate to value:

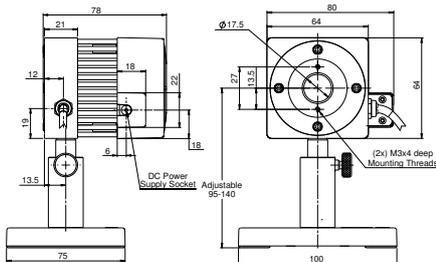
1064nm	not derated	355nm	60% of stated value
532nm	80% of stated value	266nm	40% of stated value
		193nm	NA

Notes: (c) Calibrated at specified wavelengths only: 266nm, 355nm, 532nm, 1064nm and 2100nm only

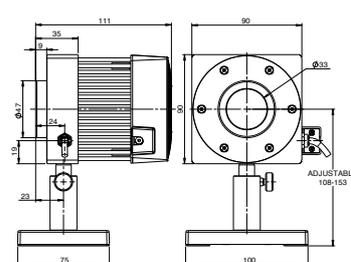
Notes: (d) For lower powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Notes: (e) $\pm 4\%$. For wavelengths <240nm

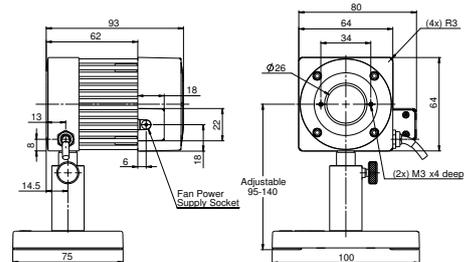
F50A-BB-18



F100A-PF-DIF-33



F150A-BB-26



1.1.2.6 Medium - High Power Fan Cooled Thermal Sensors

100mW to 250W

Features

- General purpose and high damage threshold
- Fan cooled
- Up to 250W
- Up to Ø35mm apertures



Model	FL250A-BB-35	FL250A-LP2-35	FL250A-LP2-DIF-33
Use	General purpose	High power density and long pulse lasers	Diffuser for highest energy densities
Absorber Type	Broadband	LP2	LP2 + diffuser
Spectral Range μm	0.19 - 20	0.25 - 2.2	0.4 - 3
Absorption	~88%	>94% from 0.25 to 1.1 μm	20%
Aperture mm	Ø35mm	Ø35mm	Ø33mm
Power Mode			
Power Range ^(c)	150mW - 250W	100mW - 250W	400mW - 250W
Power Scales	250W / 30W	250W / 30W	250W / 30W
Power Noise Level ^(c)	15mW	10mW	20mW ^(d)
Maximum Average Power Density kW/cm ²	10 at 250W 12 at 150W	20 at 250W 33 at 150W	2
Response Time with Meter (0-95%) typ. s	2	2	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3	3 ^(b)	3 ^(b)
Linearity with Power $\pm\%$	1	1	1.5
Energy Mode			
Energy Range	50mJ - 300J	50mJ - 300J	400mJ - 600J
Energy Scales	300J / 30J / 3J	300J / 30J / 3J	600J / 60J
Minimum Energy mJ ^(d)	50	50	400
Maximum Energy Density J/cm ²			
<100ns	0.3	0.1	0.5
0.5ms	5	50	200
2ms	10	130	400
10ms	30	400	1000
Cooling	fan	fan	fan
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	NA
Weight kg	0.4	0.4	0.45
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			
Part number	7Z02728	7Z02777	7Z02787

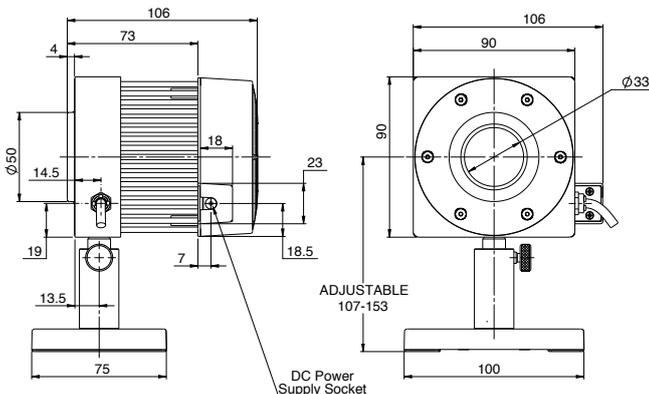
Notes: (a) Calibrated at specified wavelengths only: 532nm, 755nm, 1064nm and 2940nm

Notes: (b) Above 1.1 μm there is an additional calibration uncertainty of up to 2%

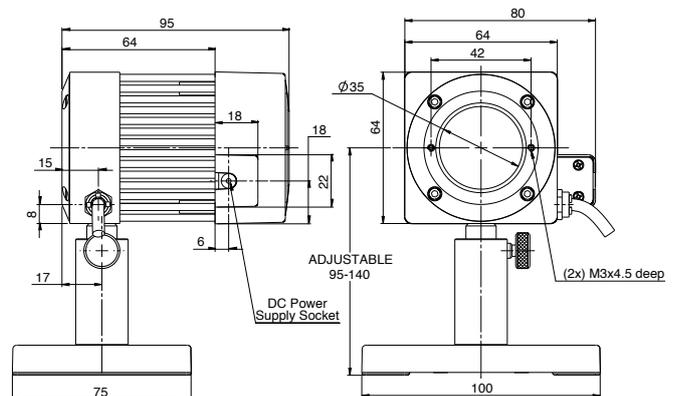
Notes: (c) For lower powers up to 30W it is recommended to work with the fan off and then the noise level is ~5 times lower. It is also recommended to measure energy with the fan off

Notes: (d) When sensor is hot, there can be large zero offset up to 300mW

FL250A-LP2-DIF-33



FL250A-BB-35 / FL250A-LP2-35



1.1.2.6 Medium - High Power Fan Cooled Thermal Sensors

100mW to 500W

Features

- High powers and energies, large apertures
- Fan cooled
- Up to 500W
- Ø50mm aperture

FL250A-BB-50 /
FL400A-BB-50



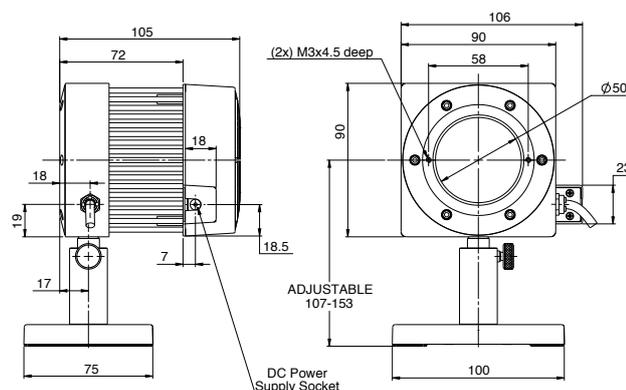
FL400A-LP2-50



Model	FL250A-BB-50	FL400A-BB-50	FL400A-LP2-50
Use	General purpose	General purpose	High power densities and long pulses
Absorber Type	Broadband	Broadband	LP2
Spectral Range μm	0.19 - 11	0.19 - 20	0.35 - 2.2, 10.6 ^(b)
Absorption	~88%	~88%	>96% from 0.35 to 1.1 μm , 75% for 10.6 μm
Aperture mm	Ø50mm	Ø50mm	Ø50mm
Power Mode			
Power Range ^(a)	150mW - 250W	300mW - 500W	100mW - 500W
Maximum Intermittent Power	NA	500W for 1 min, 400W continuous	500W for 1 min, 400W continuous
Power Scales	250W / 30W	500W / 50W	500W / 50W
Power Noise Level ^(a)	10mW	40mW	15mW
Maximum Average Power Density kW/cm ²	10 at 250W 12 at 150W	8.5 at 400W 12 at 150W	10 at 400W 20 at 150W
Response Time with Meter (0-95%) typ. s	2.5	4	4
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(c)	3	3 ^(b)
Linearity with Power $\pm\%$	1	1.5	1.5
Energy Mode			
Energy Range	80mJ - 300J	75mJ - 600J	250mJ - 600J
Energy Scales	300J / 30J / 3J	600J / 60J / 6J	600J / 60J / 6J
Minimum Energy mJ ^(a)	80	75	250
Maximum Energy Density J/cm ²			
<100ns	0.3	0.3	0.07
1 μs	0.4	0.4	0.6
0.5ms	5	5	35
2ms	10	10	90
10ms	30	30	270
Cooling	fan	fan	fan
Fiber Adapters Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight kg	0.8	0.9	0.9
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1		
Part number: Standard Sensor	7Z07116 (1.5m cable)	7Z02734	7Z02778
BeamTrack Sensor: Beam Position & Size (p. 76)	7Z07902		
Sensor with different cable length	7Z07116B (5m cable)		

Notes: (a) For lower powers up to 30W it is recommended to work with the fan off and then the noise level is ~5 times lower. It is also recommended to measure energy with the fan off.
Notes: (b) This LP2 sensor is calibrated for 0.35-1.1 μm and 10.6 μm . For other wavelengths in the spectral range 1100 - 2200nm there is an additional calibration uncertainty of up to 1%.
Notes: (c) $\pm 4\%$. For wavelengths <240nm

FL250A-BB-50 / FL400A-BB-50 / FL400A-LP2-50



1.1.2.6 Medium - High Power Fan Cooled Thermal Sensors

5W to 1100W

Features

- High powers and energies, large apertures
- Fan cooled
- Up to 1100W
- Ø65mm aperture

FL600A-BB-65 /
FL1100A-BB-65



FL600A-LP2-65 /
FL1100A-LP2-65



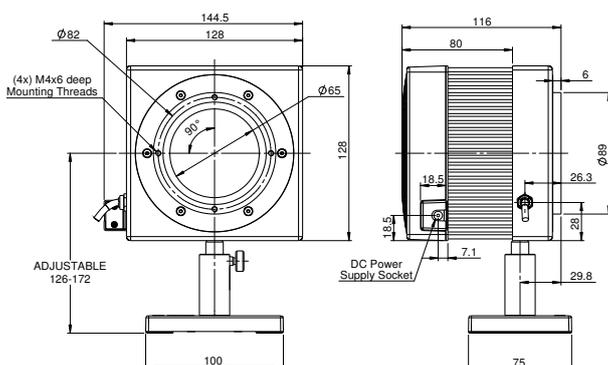
Model	FL600A-BB-65	FL600A-LP2-65	FL1100A-BB-65	FL1100A-LP2-65
Use	General purpose	Long pulses	Highest power fan cooled	Long pulses
Absorber Type	Broadband	LP2	Broadband	LP2
Spectral Range μm	0.19 - 11	0.35 - 2.2	0.19 - 11	0.35 - 2.2
Absorption	~88%	>94% from 0.35 to 1.1 μm	~88%	>94% from 0.35 to 1.1 μm
Aperture mm	Ø65mm	Ø65mm	Ø65mm	Ø65mm
Power Mode				
Power Range	5W - 600W	5W - 600W	5W - 1100W	5W - 1100W
Power Scales	600W / 60W	600W / 60W	1100W / 500W / 50W	1100W / 800W / 80W
Power Noise Level	200mW	200mW	200mW	200mW
Maximum Average Power Density kW/cm ²	12 at 150W 7 at 600W	33 at 150W 11 at 600W	8 at 500W 5.5 at 1100W	33 at 150W 11 at 600W 9 at 1100W
Response Time with Meter (0-95%) typ. s ^(c)	4	4	4	4
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9	1.9
Power Accuracy $\pm\%$	3	3 ^(b)	3	3 ^(b)
Linearity with Power $\pm\%$	1.5	1.5	1.5	1.5
Energy Mode^(a)				
Energy Range	600mJ - 600J	600mJ - 600J	600mJ - 600J	600mJ - 1000J
Energy Scales	600J / 60J / 6J	600J / 60J / 6J	600J / 60J / 6J	1000J / 600J / 60J / 6J
Minimum Energy mJ	600	600	600	600
Maximum Energy Density J/cm ²				
<100ns	0.3	0.1	0.3	0.1
1 μs	0.4	0.9	0.4	0.9
0.5ms	4	50	4	50
2ms	10	130	10	130
10ms	30	400	30	400
Cooling	fan	fan	fan	fan
Fiber Adapters	Consult Ophir representative	Consult Ophir representative	Consult Ophir representative	Consult Ophir representative
Weight kg	2.4	2.4	2.4	2.6
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version				
Part Number: Standard Sensor	7Z02762	7Z02779	7Z02761	7Z02784
Sensor with different cable lengths			7Z02761A (3m cable)	

Notes: (a) It is recommended to measure energy with the fan off.

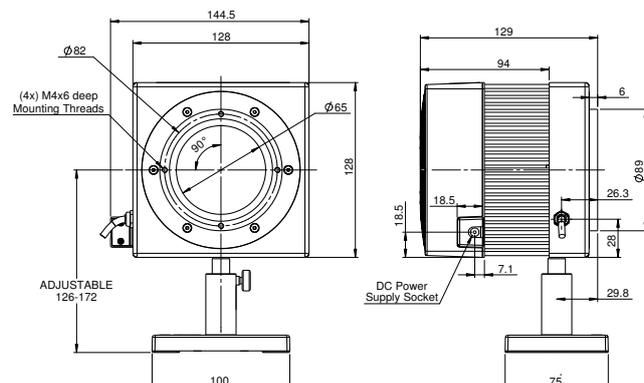
Notes: (b) Above 1.1 μm there is an additional calibration uncertainty of up to 2%.

Notes: (c) Time to reach 98% of final reading is ~30s. 99% within ~2minutes. This time may be longer at low powers less than 20W.

FL600A-BB-65 / FL600A-LP2-65



FL1100A-BB-65 / FL1100A-LP2-65



1.1.2.6 Medium - High Power Thermal Sensors

1.1.2.6.1 Medium - High Power BeamTrack-Power / Position / Size Sensors

150mW to 1000W

Features (see introduction in pages 111-113)

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

FL250A-BB-50-PPS



1000W-BB-34-QUAD



Model	FL250A-BB-50-PPS ^(a)	1000W-BB-34-QUAD ^(a)
Use	General purpose	General purpose
Functions	Power / Energy / Position / Size	Power / Energy / Position
Absorber Type	Broadband	Broadband
Spectral Range μm	0.19 - 20	0.19 - 20
Aperture mm	\varnothing 50mm	\varnothing 34mm
Power Mode		
Power Range	150mW - 250W ^(b)	5W - 1000W
Power Scales	250W / 30W	1000W / 200W
Power Noise Level	15mW	200mW
Maximum Average Power Density kW/cm ²	10 at 250W, 12 at 150W	10 at 500W, 7 at 1000W
Response Time with Meter (0-95%) typ. s	2.8	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3	3 ^(f)
Linearity with Power $\pm\%$	1.5	2
Energy Mode		
Energy Range	80mJ - 300J	500mJ - 300J
Energy Scales	300J / 30J / 3J	300J / 30J
Minimum Energy mJ	80	500mJ
Maximum Energy Density J/cm ²		
<100ns	0.3	0.3
1 μs	0.4	0.4
0.5ms	5	5
2ms	10	10
10ms	30	30
Beam Tracking Mode		
Position		
Beam Position Accuracy	0.3mm + 7% of distance from center ^(c)	0.6mm + 6% of distance from center ^(h)
Beam Position Resolution mm	0.1	0.1
Min Power for Position Measurement	2W	10W
Size ^(d)		
Size Accuracy mm ^(e)	\pm 5% for centered beam	NA
Size Range mm (4 σ beam diameter)	\varnothing 5-35	NA
Min Power Density for Size Measurement	3W/cm ²	NA
Cooling	Fan	Water
Minimum and Recommended Water Flow Rate at Full Power	NA	3 liter/min 6 liter/min ^(g)
Fiber Adapter Available (see page 120)	ST, FC, SMA, SC	Consult Ophir representative
Accessories for High Power Sensors	NA	See pages 99-102
Weight kg	0.9	0.9
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		
Part number	7Z07902	7Z07936

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) For powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Note: (c) Position accuracy for the central 20mm of the aperture as limited by beam position resolution. Position can be tracked with \pm 1mm accuracy over central 32mm of the aperture. Accuracy is reduced by a factor of 3 at minimum power. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

Note: (d) Assumes laser beam with Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams from 6 to 35mm not deviating from center more than 15% of beam diameter.

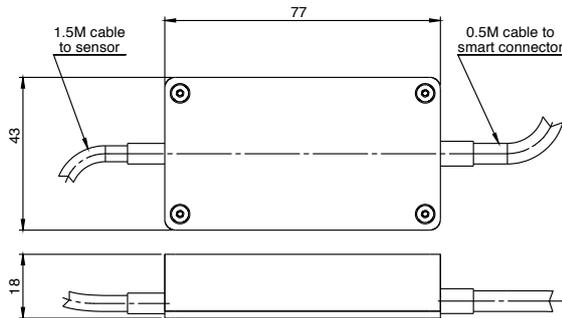
Note: (f) Calibrated for ~0.8 μm , 1.064 μm and 10.6 μm

Note: (g) Water temperature range 18-30°C, Water temperature rate of change <1°C/min. Pressure drop across sensor 0.03MPa.

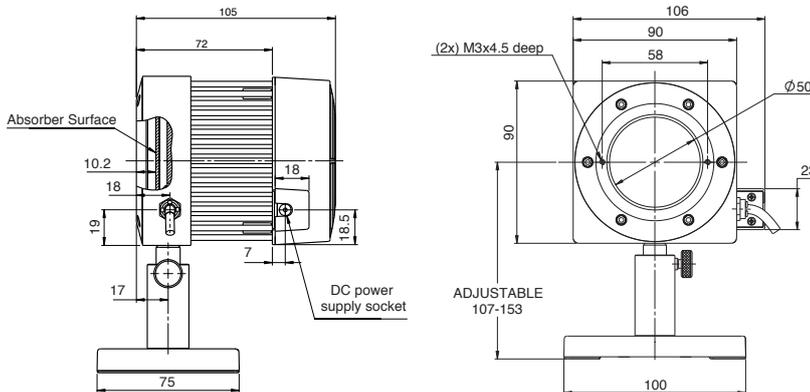
Note: (h) Position accuracy for the central 10 mm of the aperture as limited by beam position resolution. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

* For drawings please see page 77

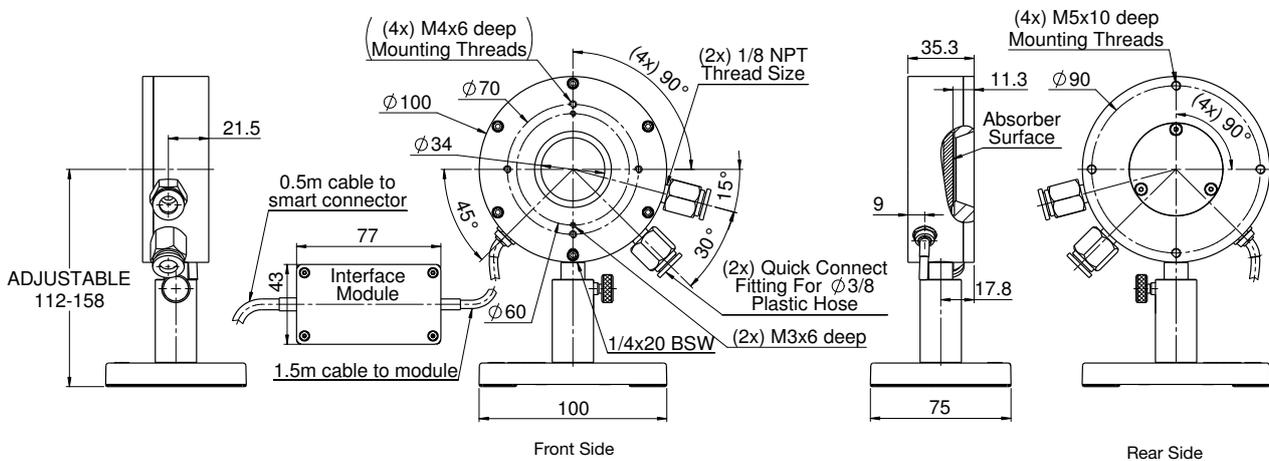
Interface Module on cable



FL250A-BB-50-PPS



1000W-BB-34-QUAD



1.1.2.7 High Power Thermal Sensors

1.1.2.7.1 Introduction

Introduction to High Power Water Cooled Sensors

Ophir has many years of experience in supplying measurement systems for high power industrial lasers and has the highest power measuring equipment available on the market – up to 120 kilowatts. Ophir meters also have the highest damage threshold available – up to $10\text{kW}/\text{cm}^2$ at 10kW. Ophir supplies water cooled sensors from 250W up to 120kW (and air-cooled sensors up to 1100W).

Sensors supplied by Ophir are tested at up to full power and their linearity verified over the entire power range. This is done by measuring the reading over the power range against a higher power sensor that has been previously measured and verified by NIST or PTB. The accuracy, linearity and damage specifications have been carefully verified over many years of development and use by the largest existing user base. In cases of unique and/or extreme user parameters (such as ultra high-power levels, pulse energies, unique beam profiles) Ophir has advanced simulation capabilities both thermal and optical to validate the functionality of its sensors. In addition to power meters for high powers, Ophir also has beam profilers, beam dumps and protective enclosures for industrial lasers.

Calibration Method and Estimated Accuracy for Ophir High Power Sensors

Ophir high-power sensors (models 5000W, 10K-W, IPM-10KW, 15K-W, 20K-W, Comet 10K, 30K-W, 120K-W and 150K-W) are ordinarily calibrated using moderate-power lasers, not exceeding 6000W (though in certain cases, sensors can be calibrated at up to 15,000W). In other words, we calibrate high-power sensors using laser powers that are in many cases much lower than the power rating of the sensors being calibrated. This raises the question of calibration accuracy. The following brief explanation will clarify how we know that these highest power sensors are indeed accurate to $\pm 5\%$ over their entire measurement range as specified.

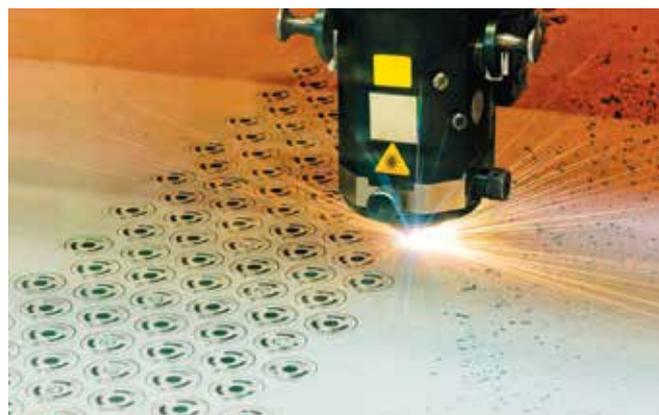
Basing high-power calibration accuracy on lower power calibration measurements is valid, subject to the condition that the sensors are linear all across the full power range.

The calibration measurements themselves (using the moderate-power lasers) are all based on NIST-calibrated master references.

At the lower powers, the reference sensors are based on photodiode detectors; photodiode detectors are well known to be highly linear.

At the higher powers, thermal sensors are used as the reference. A series of detailed tests have confirmed that indeed these sensors are highly linear, all the way up to the highest powers for which they are rated.

Since the thermal sensors have been shown to be linear over the entire range of powers, it follows that if the calibration is correct at low powers, it will remain correct at high powers as well.



Some additional points:

1. An additional issue is zero offset; although the output may be linear at low powers, there may be a zero offset that, due to the relatively low output at low powers, will cause an error in calibration. For example, if calibration is performed at 200W and the output of the sensor is $10\mu\text{V}/\text{W}$ (a typical value) and there is a zero offset of only $1\mu\text{V}$, this will cause a calibration error of 10%. Ophir's calibration method includes measuring the difference between the reading with power applied and without power applied, thus eliminating error due to zero offset. This measurement is taken several times to insure accuracy.
2. The above measurement method assures that the calibration inaccuracy due to measurement errors is less than 1%, comparable to the expected errors in our lower powered sensors. In order to verify this, all of our high power sensors have been measured by comparison to various calibration standards. These measurements have shown Ophir sensors to be well within the claimed limits of linearity.
3. The Comet 10K series measures the heat rise of the absorbing puck when irradiated by the laser for 10s. In order to calibrate the Comet 10K, we simply irradiate with a lower power laser for longer e.g. 150W for 60s. Thus the heating effect is similar to that of a higher power laser. Tests of the Comet calibrated by this method vs. NIST traceable high power sensors have shown that it is accurate and reproducible.

For more information on calibration please read tutorial on our website at www.ophiropt.com

Note regarding water cooling:

Most Ophir high power sensors are water cooled. Customers often have questions about our water cooled sensors such as the correct flow rate and pressure under various conditions and the quality of the water required. For further information on water cooled sensors, please see our tutorial on the subject on our website: <http://www.ophiropt.com>

1.1.2.7 High Power Thermal Sensors

1.1.2.7.2 Medium Power Water Cooled Thermal Sensors

0.5W to 300W

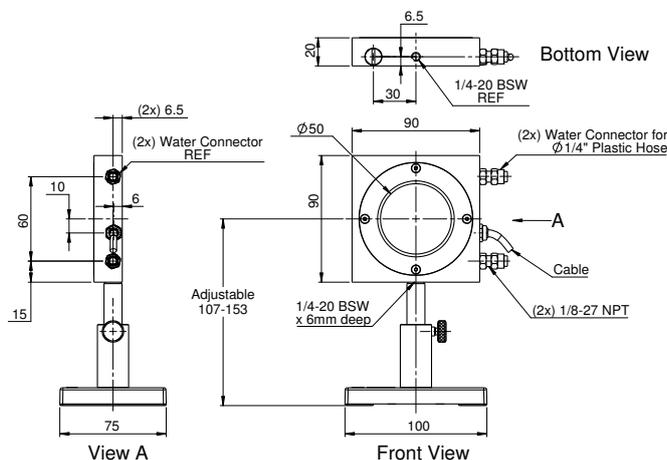
Features

- High powers
- Water cooled
- Up to 300W
- Ø50mm aperture



Model	L250W-BB-50	L300W-LP2-50
Use	General purpose	High power densities and long pulses
Absorber Type	Broadband	LP2
Spectral Range μm	0.19 - 11	0.35-2.2, 10.6 ^(a)
Absorption	~88%	>96% from 0.35 to 1.1 μm , 75% for 10.6 μm
Aperture mm	Ø50mm	Ø50mm
Power Mode		
Power Range	1W - 250W	0.5W - 300W
Power Scales	250W / 30W	300W / 30W
Power Noise Level	50mW	20mW
Maximum Average Power Density kW/cm ²	10 at 250W 14 at 100W	12 at 300W 20 at 150W
Response Time with Meter (0-95%) typ. s	2.5	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3 ^(c)	3 ^(a)
Linearity with Power $\pm\%$	2	1.5
Energy Mode		
Energy Range	120mJ - 200J	200mJ - 300J
Energy Scales	200J / 30J / 3J	300J / 30J / 3J
Minimum Energy mJ	120	200
Maximum Energy Density J/cm ²		
<100ns	0.3	0.07
1 μs	0.4	0.6
0.5ms	5	35
2ms	10	90
10ms	30	270
Cooling	water	water
Recommended water flow at full power ^(b)	3 liter/min	3 liter/min
Accessories for High Power Sensors	See pages 99-102	See pages 99-102
Weight kg	0.6	0.6
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1	
Part number: Standard Sensor	7Z07125 (1.5m cable)	7Z02776
Sensor with different cable length	7Z07125B (5m cable)	
Notes: (a)	This LP2 sensor is calibrated for 0.35 - 1.1 μm and 10.6 μm . For other wavelengths in the spectral range 1100 - 2200nm there is an additional calibration uncertainty of up to 1%.	
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.03MPa.	
Notes: (c)	±4%. For wavelengths <240nm	

L250W-BB-50 / L300W-LP2-50



1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

5W to 1000W

Features

- High powers
- Water cooled
- Up to 1000W
- Ø34mm aperture
- 1000WP for non-contaminating water flow

1000W-BB-34



1000WP-BB-34



1000W-LP2-34



Model	1000W-BB-34 / 1000WP-BB-34	1000W-LP2-34
Use	General purpose and CO ₂ laser / Controlled materials in contact with water flow ^(c)	High power densities and long pulses
Absorber Type	Broadband	LP2
Spectral Range μm	0.19 - 20	0.35 - 2.2
Absorption	~88%	>94% from 0.35 to 1.1 μm
Aperture mm	Ø34mm	Ø34mm
Power Mode		
Power Range	5W - 1000W	5W - 1000W
Power Scales	1000W / 200W	1000W / 200W
Power Noise Level	200mW	200mW
Maximum Average Power Density kW/cm ²	10 at 500W 7 at 1000W	12 at 500W 10 at 1000W
Response Time with Meter (0-95%) typ. s	2.5	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3 ^(a)	3 ^(a)
Linearity with Power $\pm\%$	2	2
Energy Mode		
Energy Range	400mJ - 300J	400mJ - 300J
Energy Scales	300J / 30J	300J / 30J
Minimum Energy mJ	400mJ	400mJ
Maximum Energy Density J/cm ²		
<100ns	0.3	0.1
1 μs	0.4	0.9
0.5ms	5	50
2ms	10	130
10ms	30	400
Cooling	water	water
Minimum and Recommended water flow at full power ^(b)	3 liter/min 6 liter/min	3 liter/min 6 liter/min
Fiber Adapters	Consult Ophir representative	Consult Ophir representative
Accessories for High Power Sensors	See pages 99-102	See pages 99-102
Weight kg	0.8 / 0.9	0.8
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V3 / NA	
Part number: Standard Sensor	7Z02750 / 7Z02753	7Z02774
BeamTrack Sensor: Beam Position & Size (p. 76)	7Z07936	
Notes: (a)	Calibrated for ~0.8 μm , 1.064 μm and 10.6 μm	
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.03MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below the minimum. When used at full power with substantially below the recommended flow rate, the damage threshold may be as much as 20% lower. The response time will be optimum with the recommended flow rate.	
Notes: (c)	The 1000WP-BB-34 has a nylon rear housing and nothing but nylon and copper in contact with the water flow. This prevents contamination of the water flow with aluminum and prevents the possibility of corrosion.	

* For drawings please see page 81

1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

15W to 1500W

Features

- High powers
- Water cooled
- Up to 1500W
- Ø50mm aperture

L1500W-BB-50

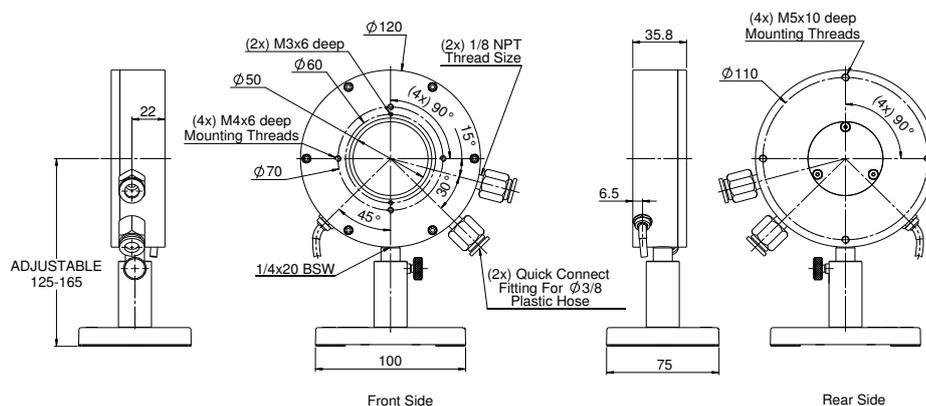


L1500W-LP2-50



Model	L1500W-BB-50	L1500W-LP2-50
Use	General purpose and CO ₂ laser	High power densities and long pulses
Absorber Type	Broadband	LP2
Spectral Range μm	0.19 - 20	0.35 - 2.2
Absorption	~88%	>94% from 0.35 to 1.1 μm
Aperture mm	Ø50mm	Ø50mm
Power Mode		
Power Range	15W - 1500W	15W - 1500W
Power Scales	1500W / 300W	1500W / 300W
Power Noise Level	700mW	700mW
Maximum Average Power Density kW/cm ²	7 at 1000W 4 at 1500W	10 at 1000W 5.5 at 1500W
Response Time with Meter (0-95%) typ. s	2.7	2.7
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	4 ^(a)	4 ^(a)
Linearity with Power $\pm\%$	2	2
Energy Mode		
Energy Range	500mJ - 200J	500mJ - 200J
Energy Scales	200J / 20J	200J / 20J
Minimum Energy mJ	500mJ	500mJ
Maximum Energy Density J/cm ²		
<100ns	0.3	0.1
1 μs	0.4	0.9
0.5ms	5	50
2ms	10	130
10ms	30	400
Cooling	water	water
Minimum and Recommended water flow at full power ^(b)	3.5 liter/min 6 liter/min	3.5 liter/min 6 liter/min
Fiber Adapters	QBH-Fiber Adapter (see page 99)	QBH-Fiber Adapter (see page 99)
Accessories for High Power Sensors	See pages 99-102	See pages 99-102
Weight kg	1.2	1.2
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V2	
Part number	7Z02752	7Z02772
Notes: (a)	Calibrated for ~0.8 μm , 1.064 μm and 10.6 μm	For spectral range 0.35 to 1.1 μm
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.03MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below the minimum. When used at full power with substantially below the recommended flow rate, the damage threshold may be as much as 20% lower. The response time will be optimum with the recommended flow rate.	

L1500W-BB-50 / L1500W-LP2-50



1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

1W to 2000W

Features

- Very large aperture
- Broadband or Pulsed absorber
- Up to 2000W
- Ø120mm aperture

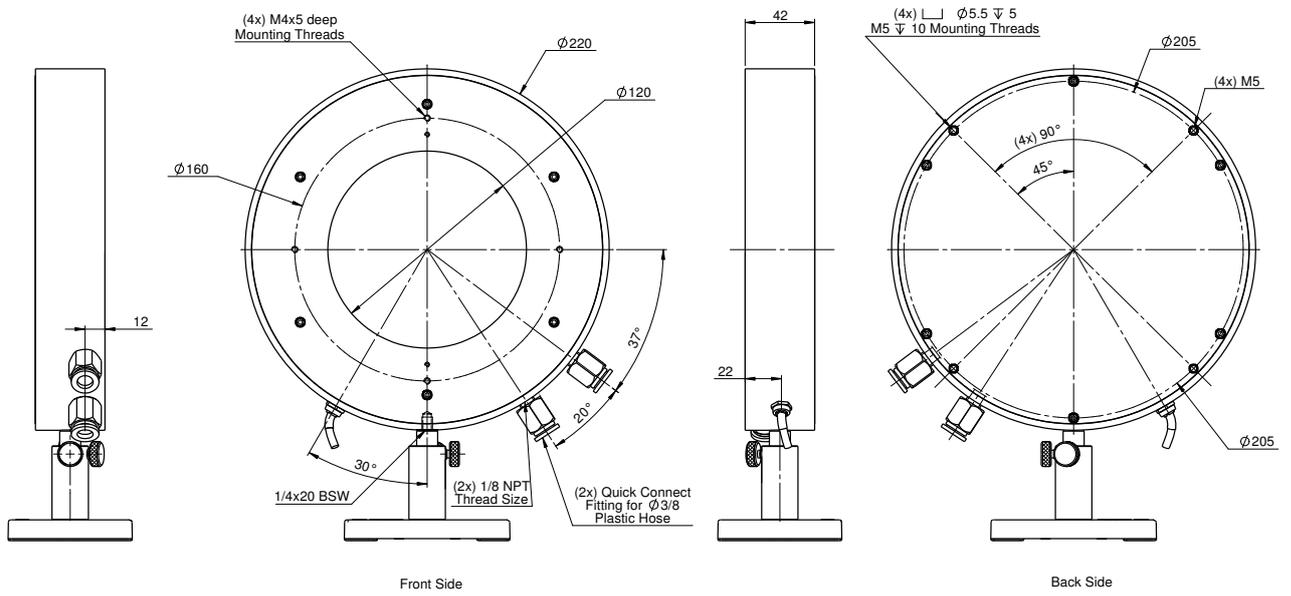
L2000W-BB-120 / L2000W-PF-120



Model	L2000W-BB-120	L2000W-PF-120
Use	Very large beams	Very large beams, short pulses, high average power
Absorber Type	Broadband	PF volume absorber
Spectral Range μm	0.19 – 20	0.3 – 2.2
Aperture mm	Ø120mm	Ø120mm
Power Mode		
Power Range	1W – 2000W	1W – 2000W
Maximum Intermittent Power	NA	NA
Power Scales	2000W / 200W	2000W / 200W
Power Noise Level	50mW	50mW
Maximum Average Power Density W/cm^2	700 at 1000W, 150 at 1500W, 60 at 2000W	600
Response Time with Meter (0-95%) typ. s	7	7
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3 ^(a)	3 ^(a)
Linearity with Power $\pm\%$	2	2
Energy Mode		
Energy Range	6J – 6000J	6J – 6000J
Energy Scales	6kJ / 600J / 60J	6kJ / 600J / 60J
Minimum Energy	6J	6J
Maximum Energy Density J/cm^2		Single 10 – 50Hz ^(c)
<100ns	0.3	3 ^(d) 1.5
1 μs	0.4	3 ^(d) 1.5
0.5ms	5	7 7
2ms	10	15 15
10ms	30	40 40
1s	4000	3000 NA
Cooling	Water	Water
Minimum and Recommended Water Flow Rate at Full Power	3.5 liter/min 6 liter/min ^(b)	3.5 liter/min 6 liter/min ^(b)
Fiber Adapters	Consult Ophir representative	Consult Ophir representative
Accessories for High Power Sensors	See pages 99-102	See pages 99-102
Weight kg	4.5	4.5
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		
Part number	7Z02751	7Z02792
Notes: (a)	Calibrated for $\sim 0.8\mu\text{m}$, $1.064\mu\text{m}$ and $10.6\mu\text{m}$	Calibrated for $1.07\mu\text{m}$. Max additional error at other wavelengths not specified above: $\pm 1\%$
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change $< 1^\circ\text{C}/\text{min}$. Pressure drop across sensor 0.06MPa.	Water temperature range 18-30°C. Water temperature rate of change $< 1^\circ\text{C}/\text{min}$. Pressure drop across sensor 0.06MPa.
Notes: (c)		For 10-50Hz derate as follows: 1064nm not derated 532nm not derated 355nm 70% of stated value 266nm 15% of stated value 193nm 10% of stated value
Notes: (d)		Damage threshold $1.5\text{J}/\text{cm}^2$ for wavelengths $< 500\text{nm}$

* For drawings please see page 84

L2000W-BB-120 / L2000W-PF-120



1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

20W to 5000W

Features

- Powers up to 5000W
- Water cooled
- Ø50mm aperture
- 5000WP for non-contaminating water flow

5000W-BB-50



5000W-LP2-50

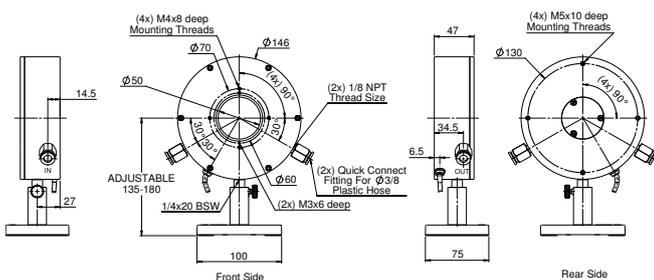


5000WP-LP2-50

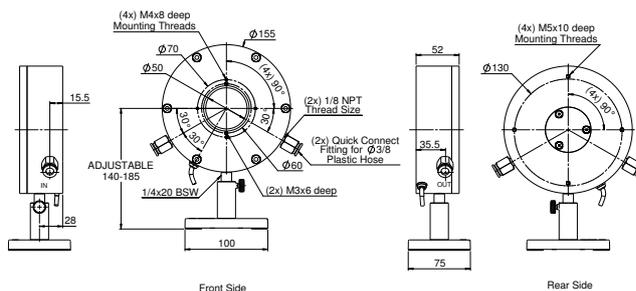


Model	5000W-BB-50	5000W-LP2-50 / 5000WP-LP2-50
Use	General purpose and CO ₂ laser	High power densities and long pulses lasers / Controlled materials in contact with water flow ^(c)
Absorber Type	Broadband	LP2
Spectral Range μm	0.19 - 11	0.35 – 2.2
Absorption	~88%	>94% from 0.35 to 1.1 μm
Aperture mm	Ø50mm	Ø50mm
Power Mode		
Power Range	20W - 5000W	20W - 5000W
Power Scales	5000W / 500W	5000W / 500W
Power Noise Level	1W	1W
Maximum Average Power Density kW/cm ²	3 at 3kW 1.7 at 5kW	5 at 3kW 2.5 at 5kW
Response Time with Meter (0-95%) typ. s	3	3
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	4 ^(a)	4 ^(a)
Linearity with Power $\pm\%$	2	2
Energy Mode		
Energy Range	NA	NA
Energy Scales	NA	NA
Minimum Energy mJ	NA	NA
Maximum Energy Density J/cm ²		
<100ns	0.3	0.1
1 μs	0.4	0.9
0.5ms	5	50
2ms	10	130
10ms	30	400
Cooling	water	water
Fiber Adapters	QBH-Fiber Adapter (see page 99)	For 5000W-LP2-50: QBH-Fiber Adapter (see page 99)
Accessories for High Power Sensors	See pages 99-102	See pages 99-102
Minimum and Recommended water flow at full power ^(b)	5 liter/min 8 liter/min	5 liter/min 8 liter/min
Cable Length	1.5 meters	1.5 meters
Weight kg	2.8	2.8 / 3
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V2	V2 / NA
Part number: Standard Sensor	7Z07111 (1.5m cable)	7Z07135 / 7Z02788
Sensor with different cable length	7Z07111B (5m cable)	
Notes: (a)	Calibrated for ~0.8 μm , 1.064 μm and 10.6 μm	
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.06MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below the minimum. When used at full power with substantially below the recommended flow rate, the damage threshold may be as much as 20% lower. The response time will be optimum with the recommended flow rate.	
Notes: (c)	The 5000WP-LP2-50 has nylon rear housing and nothing but nylon and copper in contact with the water flow. This prevents contamination of the water flow with aluminum and prevents the possibility of corrosion.	

5000W-BB-50 / 5000W-LP2-50



5000WP-LP2-50



1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

100W to 11kW

Features

- High powers
- Water cooled
- Up to 11kW
- Up to Ø45mm apertures

10K-W-BB-45



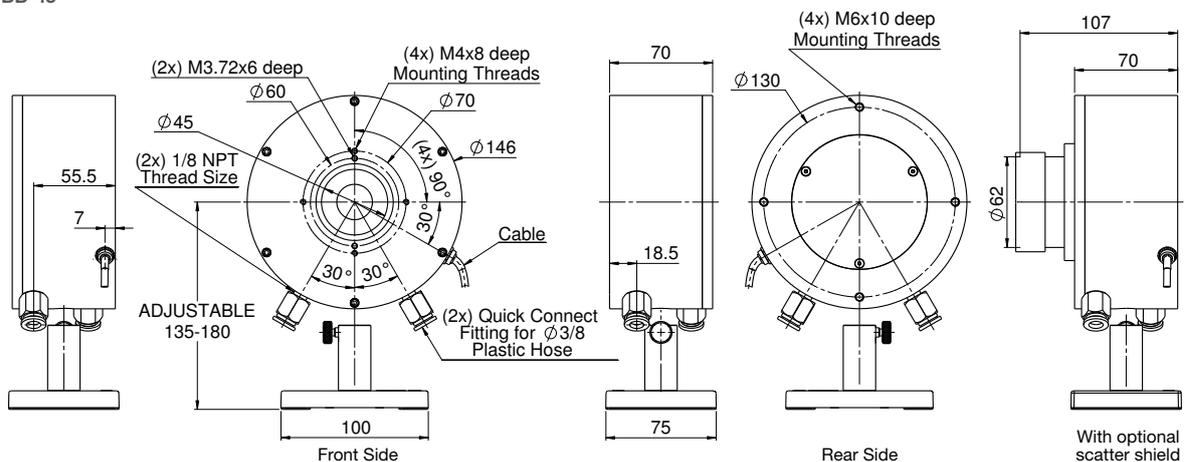
10K-W-BB-45

With optional scatter shield



Model	10K-W-BB-45																												
Use	High power up to 11kW																												
Absorber Type	Beam deflector + broadband absorber																												
Spectral Range μm ^(a)	0.8 - 2, 10.6																												
Aperture mm	Ø45mm																												
Power Range	100W – 11kW																												
Power Scales	11kW / 6kW / 600W																												
Power Noise Level	1W																												
Backscattered Power ^(b, c)	~3.5% without Scatter Shield, ~1% with Scatter Shield																												
Maximum Average Power Density kW/cm ²	See note ^(c) and table ⁽¹⁾ below																												
Response Time with Meter (0-95%) typ. s	2.7																												
Calibration Uncertainty $\pm\%$	1.9																												
Power Accuracy $\pm\%$	5 ^(a)																												
Linearity with Power $\pm\%$	2																												
Cooling	water ^(d)																												
Minimum Water Flow Rate	8 liter/min at full power ^(d)																												
Water Connectors ^(e)	Quick connector for 3/8" OD nylon tubing																												
Cable Length	5 meters																												
Optional Scatter Shield Accessory ^(e)	10K-W / 15K-W Scatter Shield (P/N 7Z08295)																												
Weight kg	4.5																												
Compliance	CE, UKCA, China RoHS																												
Version	V4																												
Part number	7Z07102																												
IPM-10KW Ruggedized Industrial Version	7Z07106 see page 94																												
Note: (a)	Calibrated at 1.07 μm and 10.6 μm . For other wavelengths in the ranges of 0.8 - 0.95 μm & 1.1 - 2 μm add up to $\pm 2\%$ to the calibration error.																												
Note: (b)	When scatter shield is installed, use the NIRS setting to compensate for slightly higher reading. When not installed, use the NIR setting.																												
Note: (c)	For circular beam centered within 1/4 of beam diameter. IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR. Maximum tilt angle ± 5 degrees. For rectangular beam please consult Ophir representative.																												
Note: (d)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.1MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below 3 liter/min. The response time will be optimum with the recommended flow rate. For solutions for prolonged usage with untreated water (tap water, non DI water), please contact Ophir.																												
Note: (e)	Heavy duty stand is available as optional extra. For further information and other options see Accessories for High Power Sensors on pages 99-102.																												
Table: (1)	<table border="1"> <thead> <tr> <th rowspan="2">Beam diameter</th> <th rowspan="2">Max power density</th> <th colspan="3">Max energy density</th> </tr> <tr> <th>1ms pulse width</th> <th>3ms pulse width</th> <th>10ms pulse width</th> </tr> </thead> <tbody> <tr> <td><15mm</td> <td>10kW/cm²</td> <td>30J/cm²</td> <td>60J/cm²</td> <td>150J/cm²</td> </tr> <tr> <td>15 - 20mm</td> <td>7kW/cm²</td> <td>20J/cm²</td> <td>40J/cm²</td> <td>100J/cm²</td> </tr> <tr> <td>20 - 40mm</td> <td>5kW/cm²</td> <td>15J/cm²</td> <td>30J/cm²</td> <td>70J/cm²</td> </tr> <tr> <td>40 - 45mm</td> <td>4kW/cm²</td> <td>12J/cm²</td> <td>25J/cm²</td> <td>60J/cm²</td> </tr> </tbody> </table>	Beam diameter	Max power density	Max energy density			1ms pulse width	3ms pulse width	10ms pulse width	<15mm	10kW/cm ²	30J/cm ²	60J/cm ²	150J/cm ²	15 - 20mm	7kW/cm ²	20J/cm ²	40J/cm ²	100J/cm ²	20 - 40mm	5kW/cm ²	15J/cm ²	30J/cm ²	70J/cm ²	40 - 45mm	4kW/cm ²	12J/cm ²	25J/cm ²	60J/cm ²
Beam diameter	Max power density			Max energy density																									
		1ms pulse width	3ms pulse width	10ms pulse width																									
<15mm	10kW/cm ²	30J/cm ²	60J/cm ²	150J/cm ²																									
15 - 20mm	7kW/cm ²	20J/cm ²	40J/cm ²	100J/cm ²																									
20 - 40mm	5kW/cm ²	15J/cm ²	30J/cm ²	70J/cm ²																									
40 - 45mm	4kW/cm ²	12J/cm ²	25J/cm ²	60J/cm ²																									

10K-W-BB-45



1.1.2.7 High Power Thermal Sensors

1.1.2.7.3 High Power Water Cooled Thermal Sensors

100W to 30kW

Features

- High powers
- Water cooled
- Up to 30kW
- Ø74mm aperture

30K-W-BB-74



Model	30K-W-BB-74
Use	High power up to 30kW
Measurement Type	Beam deflector + broadband absorber
Spectral Range μm	0.8 - 2
Aperture mm	Ø74mm
Power Range for Calibrated Reading	100W – 30kW
Power Noise Level	1W
Backscattered Power	~4.3% without Scatter Shield, ~1.3% with Scatter Shield ^(b, c)
Maximum Average Power Density kW/cm ²	10kW/cm ² anywhere in the beam
Beam Centering Requirements IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR	For circular beam centered within ¼ of beam diameter. Maximum tilt angle ± 5 degrees. For rectangular beam please consult Ophir representative
Response Time 0-95% typ	7s
Calibration Uncertainty $\pm\%$	1.9
Power Accuracy $\pm\%$	5 ^(a)
Linearity with Power $\pm\%$	2
Variation with Beam Size $\pm\%$	1 from 20 to 40 mm 1.5 from 15 to 20 mm and 40 to 45 mm
Cooling Requirements	25 liter/min at full power, proportionally less at lower power. Min flow rate 6 liter/min. Water temperature range 15-30°C. Water temperature rate of change $<1^\circ\text{C}/\text{min}$ ^(d)
Water Pressure Drop across Beam Absorber	Pressure drop across sensor ~0.2MPa. Pressure drop across 8 meters of ½" tubing with 9.5mm ID is ~0.3MPa
Water Connections	Quick connector for ½" OD nylon tubing ^(c)
Outputs	10 meter cable terminated in DB15 smart connector
Optional Accessories ^(c)	30K-W Scatter Shield (P/N 7Z08293) 30K-W Rubber Feet Assembly (P/N 7Z08217)
Dimensions	See drawing on next page
Weight kg	19
Compliance	CE, UKCA, China RoHS
Version	V4
Part number	7Z07136
Note: (a) Calibrated at 1.07 μm . For other wavelengths in the ranges of 0.8 - 0.95 μm & 1.1 – 2 μm add up to $\pm 2\%$ to the calibration error	
Note: (b) When scatter shield is installed, use the 107S laser setting to compensate for the slightly higher reading. When not installed, use the 107 setting	
Note: (c) For further information and options see Accessories for High Power Sensors on pages 99-102	
Note: (d) For solutions for prolonged usage with untreated water (tap water, non DI water), please contact Ophir	

* For drawings please see page 89

1.1.2.8 Calorimetric Power Meters

1.1.2.8.1 High Power Water Cooled Calorimetric Sensor

200W to 6000W

Features

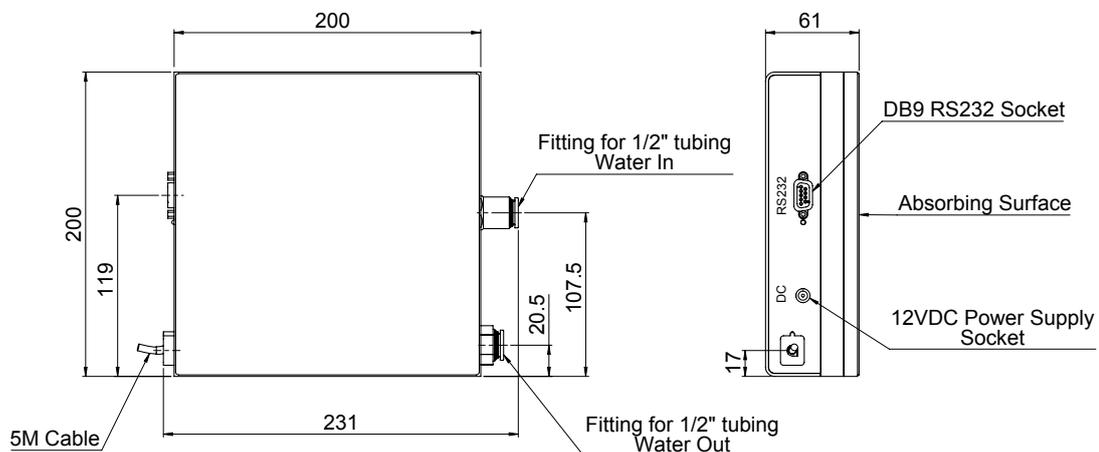
- Very large aperture 200mm x 200mm
- Water cooled
- Up to 6000W
- Smart sensor or RS232 interface

6K-W-BB-200 x 200



Model	6K-W-BB-200x200
Use	Largest size beams to 6kW
Measurement Method	Calorimetric, measure water temperature rise and flow rate
Absorber Type	Broadband
Spectral Range μm ^(a)	0.19 - 20
Aperture mm	198 x 198mm
Power Mode	
Power Range	200W – 6000W
Power Scales	6kW / 1kW
Power Noise Level	5W
Maximum Average Power Density kW/cm ²	1.5 at 1000W 0.4 at 6000W
Response Time with Meter (0-95%) typ. s	50
Calibration Uncertainty $\pm\%$	1.9
Power Accuracy $\pm\%$	4 ^(a) ^(b)
Linearity with Power $\pm\%$	2 ^(b)
Maximum Energy Density J/cm²	
<100ns	0.3
1 μs	0.4
0.5ms	5
2ms	10
10ms	30
1s	4000
Cooling	Water
Recommended Flow Rates	6 liter/min ^(b)
Outputs	1. 5 meter cable terminated in DB15 Smart Connector measuring power only. 2. RS232 with supplied WaterFlowMeter PC Application measuring power, water temp. and water flow rate. In RS232 mode, the sensor is powered by the supplied 12V wall cube.
Fiber Adapters	N.A.
Dimensions	See drawing
Weight kg	3.6
Compliance	CE, UKCA, China RoHS
Version	
Part number	7Z02764
Notes: (a)	Calibrated for $\sim 0.8\mu\text{m}$ and $1.08\mu\text{m}$ at flow rate of 6 liters/min. Calibration for $10.6\mu\text{m}$ available
Notes: (b)	Min flow rate at maximum power 6 liter/min. Flow rate may be proportionately less at lower power. Flow rate dependence of reading is $\pm 2\%$ for flow rates between 4 and 8 liters/min. Water temperature range 15-25°C. Water temperature rate of change $< 1^\circ\text{C}/\text{min}$, at max power, proportionately less at lower power. Pressure drop across sensor 0.05MPa. Water should be filtered with a $< 50\mu\text{m}$ filter.

6K-W-BB-200 x 200



1.1.2.8 Calorimetric Power Meters

1.1.2.8.2 Ultra-High Power Water Cooled Calorimetric Sensors

2kW to 70kW

Features

- Ultra-high powers
- Calorimetric
- Up to 70kW
- Ø130mm aperture

70K-W



Model	70K-W
Use	High power up to 70kW
Interfaces	24v power: M12 male RS232: M12 female Ethernet (48V PoE capable ^(a)): M12 female Interlock: M8 male Analog output: BNC
Measurement Type	Calorimetric
Spectral Range μm	0.8-10.6
Aperture mm	Ø130
Reflector Usable Clear Aperture mm	Ø150
Power Range for Calibrated Reading	2kW – 70kW
Typical Power Noise Level	20W
Backscattered Power	<0.5%
Maximum CW/QCW Power Density at Max Power kW/cm²	2 kW/cm ² for Flat top beam 4 kW/cm ² for Gaussian beam (Equivalent to 65 mm diameter beam at 70 kW)
Beam Divergence and Centering Requirements^(b)	Collimated beams: Max decenter 5mm, max tilt 5° Diverging beams: Up to 0.22NA
Response Time 0-99% (typical)	45s at flow rate of 35 L/min
Power Accuracy $\pm\%$	Calibration uncertainty 1.9 Accuracy 3 ^(c)
Linearity with Power $\pm\%$	2
Photodiode Spectral Range μm	0.8-1.6
Photodiode Monitor Responsivity	70mV at 70kW, 1070nm (typical, uncalibrated)
Cooling Requirements	35 liter/min at max power proportionally lower down to 10 L/min. Absolute minimum flowrate 7.5 LPM with additional measurement error >5%
Cooling Water	Tap water, DI water
Water Pressure Drop Across Sensor Beam Absorber	0.3 MPa (3 Bar) at 35 LPM
Water Connections	16mm, 5/8"
Dimensions	467 x 396 x 427 LxWxD mm
Weight kg	42kg dry
Compliance	CE, China RoHS, UKCA
Version	
Part number	7Z07141

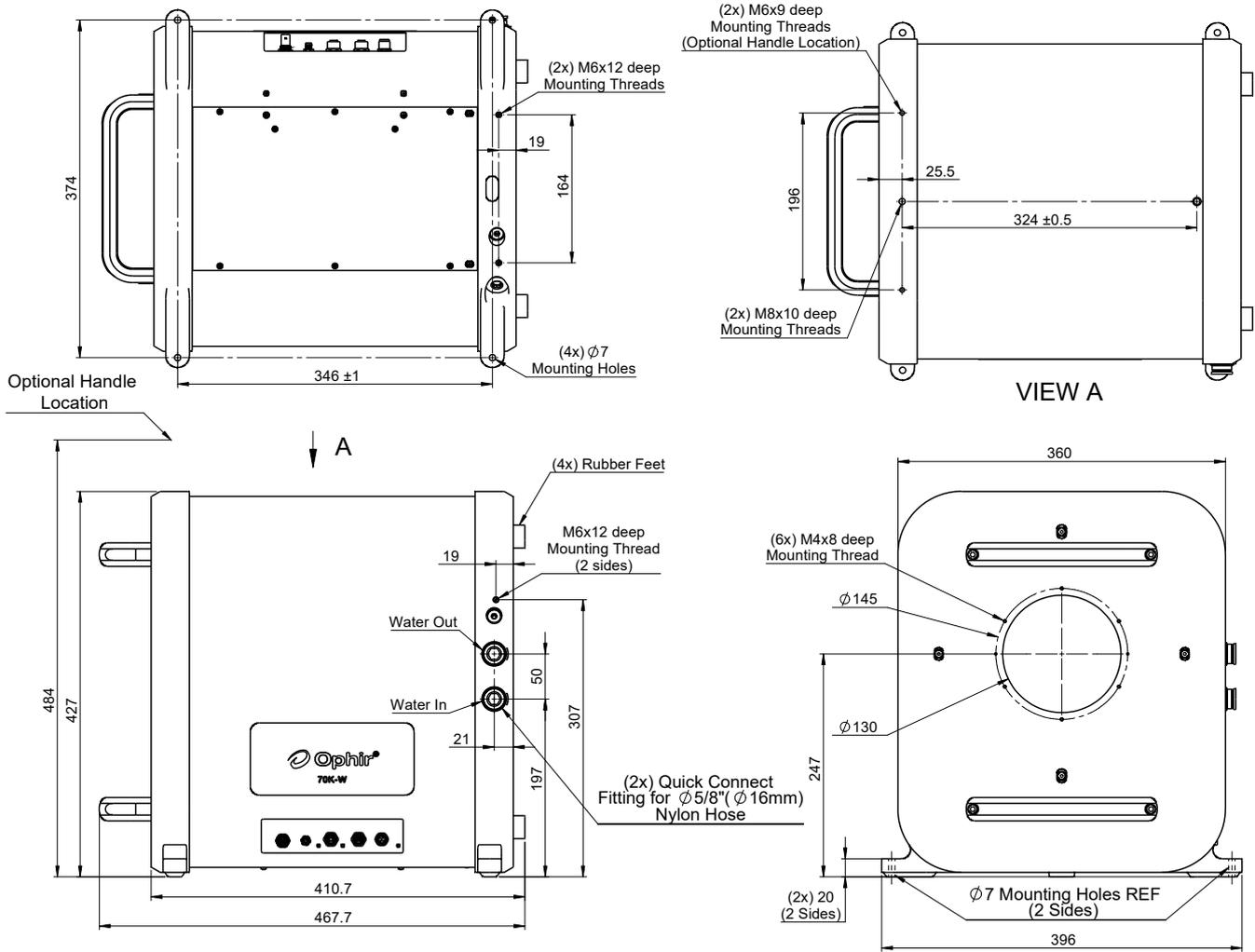
Note: (a) Compliant with IEEE803.2af

Note: (b) Divergent sources (fibers) must be positioned correctly such that the beam does not exceed the usable reflector diameter. Consult Ophir for more information

Note: (c) Calibrated at 1070nm

* For drawings please see page 90B

70K-W



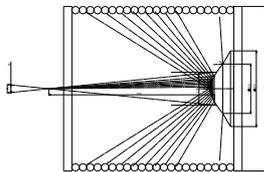
1.1.2.8 Calorimetric Power Meters

1.1.2.8.2 Ultra-High Power Water Cooled Calorimetric Sensors

100W to 150kW

Features

- Highest powers
- Calorimetric
- Up to 150kW
- Ø200mm aperture



Laser Beam Path

120K-W / 150K-W



Model	120K-W	150K-W
Use	Measuring Highest powers to 120kW	Measuring Highest powers to 150kW
Measurement Type	Calorimetric, water cooled beam absorber chamber with deflecting cone. Separate power measuring unit monitoring input and output cooling water flow and temperature	Calorimetric, water cooled beam absorber chamber with deflecting cone. Separate power measuring unit monitoring input and output cooling water flow and temperature
Spectral Range μm	0.9 – 1.1 ^(a)	0.9 – 1.1 ^(a)
Aperture mm	Ø200	Ø200
Power Range for Calibrated Reading	10kW – 120kW	10kW – 150kW
Power Noise Level	±20W with stable water temperature	±20W with stable water temperature
Backscattered Power	Less than 1%	Less than 1%
Maximum Average Power Density kW/cm ²	Designed for near Gaussian beam. The 1/e ² beam diameter should have a divergence of 0 to 6 degrees and should be Ø100mm in diameter at the reflecting cone (see sketch above where the beam may also be collimated and not divergent as long as beam diameter requirement is met).	Designed for near Gaussian beam. The 1/e ² beam diameter should have a divergence of 0 to 6 degrees and should be Ø100mm in diameter at the reflecting cone (see sketch above where the beam may also be collimated and not divergent as long as beam diameter requirement is met).
Beam Centering Requirements IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR	Beam to be centered on deflecting cone ±5mm and parallel ±2degrees	Beam to be centered on deflecting cone ±5mm and parallel ±2degrees
Response Time 0-95% typ	40s at flow rate 60 liter/min and 60s at flow rate 20 liter/min	<40s at flow rate 75 liter/min and 60s at flow rate 20 liter/min
Calibration Uncertainty ±%	1.9	1.9
Power Accuracy ±%	5 ^(a)	5 ^(a)
Linearity with Power ±%	2	2
Variation with Beam Size ±%	NA	NA
Cooling Requirements	Water flow rate, 60 liters/min at max power. Inlet temperature 15-20degC. Inlet water temperature rate of change <0.3degC/min at full power, proportionately less at lower power ^(b, c)	Water flow rate, 75 liters/min at max power. Inlet temperature 15-20degC. Inlet water temperature rate of change <0.5degC/min
Water Pressure Drop across Beam Absorber	0.4MPa at 60 liter/min flow rate	0.45MPa at 75 liter/min flow rate
Water Connections	Up to 4 meters in each direction of 1" OD 13/16" ID flexible nylon tubing	Up to 4 meters in each direction of 1" OD 13/16" ID flexible nylon tubing
Outputs	1. Cable terminated in DB9 plug with RS232 ASCII output reading power, flow rate and temperature on PC (using WaterFlowMeter PC App). Cable lengths 10 meters (recommended for access to full data). 2. Cable terminated in DB15 Ophir smart plug reading power.	1. Cable terminated in DB9 plug with RS232 ASCII output reading power, flow rate and temperature on PC (using WaterFlowMeter PC App). Cable lengths 10 meters (recommended for access to full data). 2. Cable terminated in DB15 Ophir smart plug reading power.
Dimensions	See drawing on next page	See drawing on next page
Weight kg	Beam Absorber 50kg. Power measuring unit 10kg	Beam Absorber 50kg. Power measuring unit 10kg
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		
Part number	7Z02691	7Z07152

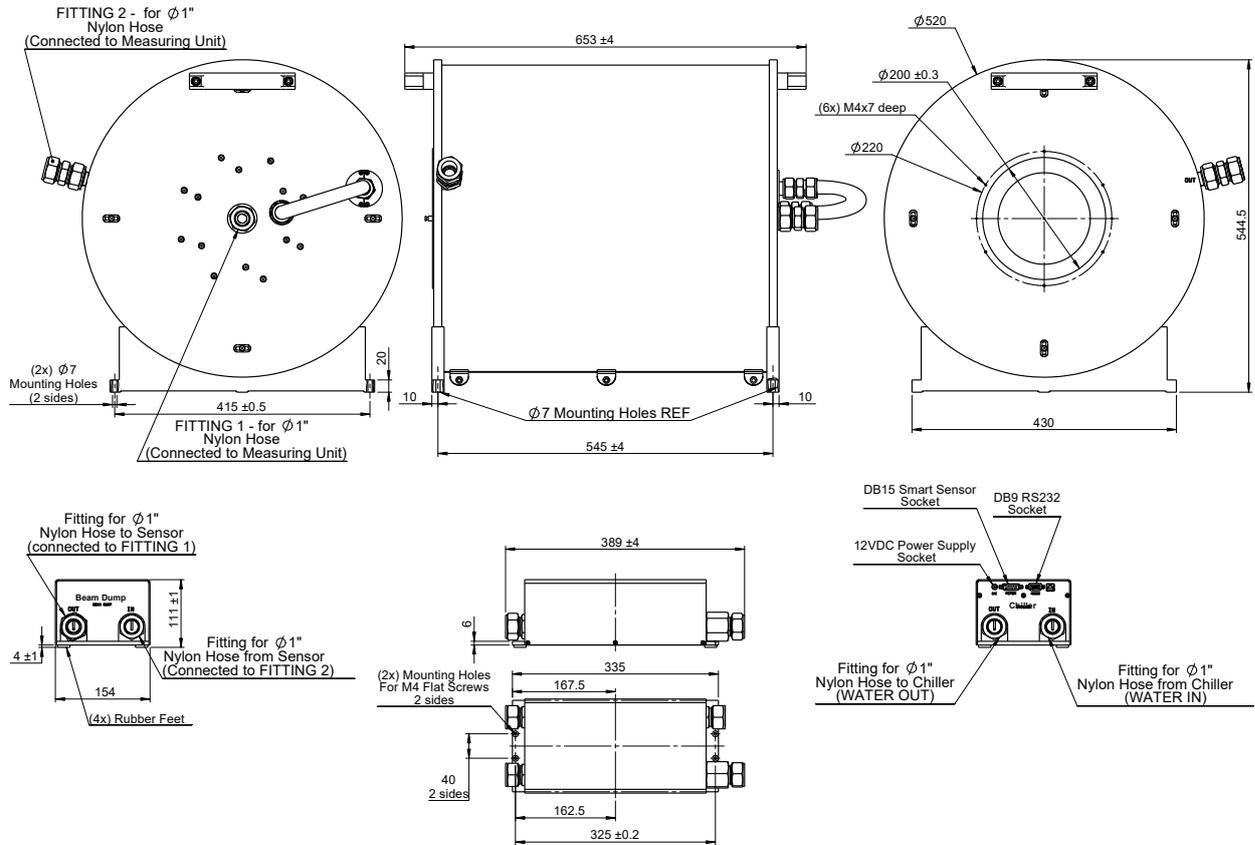
Note: (a) Calibrated for 1.07 μm

Note: (b) Minimum flow rate should not be below 20 liter/min. It is recommended that the user install a safety interlock flow switch on the return water line (after beam dump) to immediately shut down the laser if flow rate drops

Note: (c) For solutions for prolonged usage with untreated water (tap water, non DI water), please contact Ophir

* For drawings please see page 92

120K-W / 150K-W



1.1.2.9 IPM Industrial High Power Sensor

Introduction

Based on the tried-and-true 10K-W sensor, the new IPM modular industrial sensor for measuring the average power of high-power lasers up to 11kW is ideal for tough industrial use. Ruggedized by design, it has all the features needed for reliable, fail-safe operation in a tough operational environment. Its modular design provides the flexibility needed to address customers' specific needs. The IPM-10KW has heavy duty connectors and an interlock output. For more protection, the user can order the

IPM-Shutter10 which provides an automated shutter with a field replaceable anti reflective coated window (see next section). Integration into modern automation systems is available with the IPM-COM communication module (Ethernet and Profinet). With its modular architecture and ruggedness, it is ideal for high power applications such as welding and cutting and more. It is targeting machine manufacturers (R&D, production, and service) and laser-based machine users.

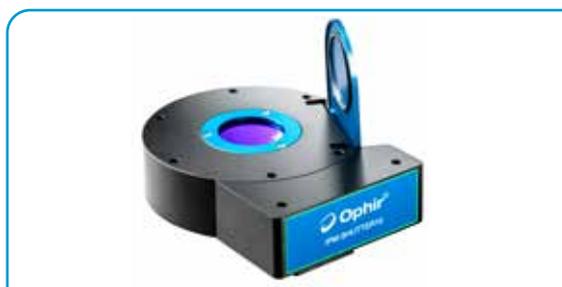
IPM-10K Base Unit - Main Features

- Measures power from 100W up to 11kW
- Wavelengths: 900 – 1100nm, 10.6µm
- Beam incidence angle, up to ±5°
- IP62 rating when used with IPM-Shutter10
- Direct connection to host using RS232 or communication module
- Interlock output reducing risk for damage due to sensor over heating
- Water cooled
- Interface for external flow meter



IPM-Shutter10 (Optional) - Main Features

- Modular, motorized shutter unit
 - Field replaceable protective window
 - Scatter shield
- Robust, dust proof, splash water resistant (IP62)
- Supports vertical (or up-side-down) installation



IPM-COM - Communication Modules (Optional) - Main Features

- Easy integration with modern automation systems
 - Profinet with AIDA connectors for power and data
 - EtherNET/IP with 7/8" connectors for power and M12 for data
- Two communication ports for daisy chain connection or local configuration and monitoring
- Two power connectors for power chaining



1.1.2.9 IPM Industrial High Power Sensor

1.1.2.9.1 IPM-10KW – Industrial Sensor

Features

- ISO/IEC 17025:2017, NIST traceable calibration
- Measure up to 11kW
- Modular architecture
- Heavy duty design with industrial interface and connectors
- Interlock to protect from overpower or cooling water failure
- Real time visibility, traceability and logging for predictive maintenance

IPM-10KW



Model	IPM-10KW	
Use	Laser power measurement in industrial environment up to 11kW	
Control	RS232	
Absorber Type	Beam deflector + broadband absorber	
Spectral Range μm ^(a)	0.9-1.1, 10.6	
Aperture mm	\varnothing 45mm	
Power Mode		
Power Range	100W – 11kW	
Power Scales	11kW / 6kW / 600W	
Power Noise Level W	5	
Backscattered Power	With IPM-SHUTTER10 or 10K-W/15K-W Scatter Shield, ~1% ^(b) Without IPM-SHUTTER10 or 10K-W/15K-W Scatter Shield 3.5 ^(b)	
Maximum Average Power Density kW/cm ²	See note ^(c) and table ⁽¹⁾ below	
Response Time with Meter (0-95%) typ. s	2.7	
Response Time with Meter (0-99%) typ. s	10	
Calibration Uncertainty $\pm\%$	1.9	
Power Accuracy $\pm\%$	5 ^(a)	
Repeatability $\pm\%$	0.4	
Linearity with Power $\pm\%$ (0-100% range)	2	
Linearity with Power $\pm\%$ (0-90% range)	1.5	
Energy Mode		
Energy Range	60J – 10kJ	
Energy Scales	10kJ / 5kJ / 500J	
Energy Accuracy	Additional 2% error to power accuracy	
Minimum Energy J	60	
Maximum Energy Density J/cm ²	See table ⁽¹⁾ below	
Cooling	Water ^(d)	
Minimum Water Flow Rate	8 liter/min at full power ^(d)	
Water Connectors	Quick connector for 12mm OD nylon tubing (see page 102)	
Weight kg	5	
Connectors ^(e)	 Interlock, M8 male, 3-pin RS232, M12 female 5-pin Flow meter – M8 female, 6-pin Power/IPM-COM, M12 male, 5-pin	
Cables ^(e)	Part	P/N
	RS232 cable, M12 male 5-pin to D9 female, 1.8m (supplied with sensor)	7Z10532
	Power cable, M12 female 5-pin to flying leads, 1.5m (supplied with sensor)	7E01519
	Interlock cable, M8 female 3-pin to flying leads, 1.5m (not supplied)	7E01513
	Water Flow Meter cable, M8 male 6-pin to flying leads, 1.5m (not supplied)	7E01536
Related Products ^{(a) (b)}	Name	Description
	IPM-SHUTTER10	Combined protective shutter with built in scatter shield, IP62 rated
	IPM-SHUTTER10 Window replacement kit	Replacement anti reflective coated window
	10K-W / 15K-W Scatter Shield	Scatter Shield for mounting on front flange
	IPM-COM-Profinet	Profinet communications adapter with AIDA connectors
	IPM-COM-EtherNet/IP-M	EtherNet/IP communications adapter with circular connectors (M12 & 7/8)
Compliance	CE, UKCA, China RoHS	
Part number	7Z07106	

Note: (a) Calibrated at 1.07 μm and 10.6 μm . When working at 10.6 μm (CO₂), if using the SHUTTER10 unit, the window should be removed. IPM without the IPM-SHUTTER10: For other wavelengths in the ranges of 0.8 - 0.95 μm and 1.1 - 2 μm , add up to \pm 2% to the calibration error.

Note: (b) IPM-SHUTTER10: When installed, use the NIRS or CO₂S setting to compensate for slightly higher reading.

10K-W / 15K-W Scatter Shield: When installed, use the NIRS setting to compensate for slightly higher reading. When not installed, use the NIR setting.

Note: (c) For circular beam centered within 25% of beam diameter. IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR. Maximum tilt angle \pm 5 degrees. For rectangular beam please consult Ophir representative.

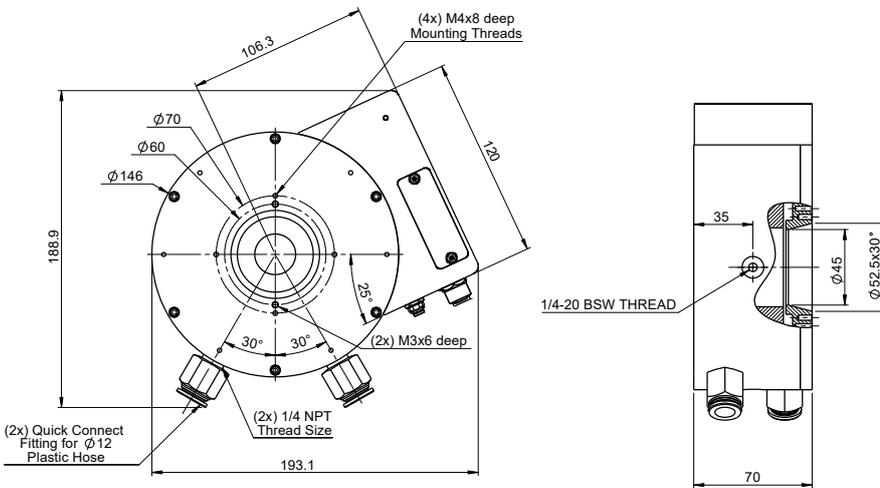
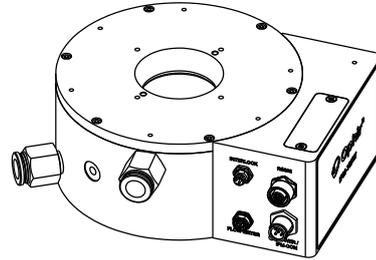
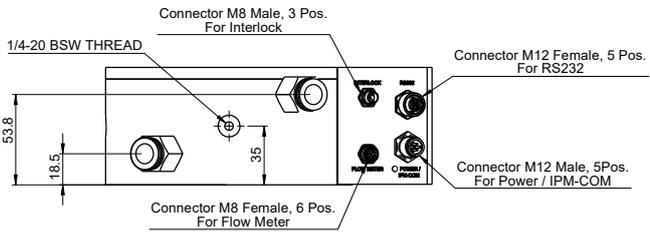
Note: (d) Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.1MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below 3 liter/min. The response time will be optimal with the recommended flow rate. For solutions for prolonged usage with untreated water (tap water, non DI water), please, contact Ophir.

Note: (e) See IPM User Manual for details of connectors and cables

Table (1)	Beam diameter	Max power density	Max energy density – by pulse width			
			1ms PW	3ms PW	10ms PW	100ms PW
	<15mm	10kW/cm ²	30J/cm ²	60J/cm ²	150J/cm ²	1350 J/cm ²
	15 – 20mm	7kW/cm ²	20J/cm ²	40J/cm ²	100J/cm ²	900 J/cm ²
	20 – 40mm	5kW/cm ²	15J/cm ²	30J/cm ²	70J/cm ²	600 J/cm ²
	40 – 45mm	4kW/cm ²	12J/cm ²	25J/cm ²	60J/cm ²	500 J/cm ²

* For drawings please see page 95

IPM-10KW



1.1.2.9 IPM Industrial High Power Sensor

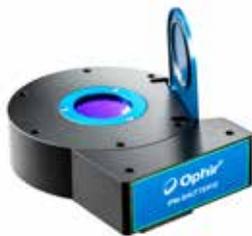
1.1.2.9.2 IPM-SHUTTER10 Shutter Assembly for IPM-10KW

For usage in a dirty industrial environment, the IPM-10KW can be fitted with an automated dust tight shutter assembly to protect the unit from dust and debris. The shutter unit has a built-in scatter shield and includes a field replaceable antireflection coated protective window.

Features

- Built-in scatter shield
- Antireflective coated window ^(a)
- Motorized dust-resistant shutter
- IP62 rated

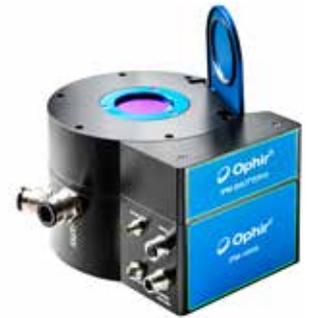
IPM-Shutter10



IPM-10KW with IPM-Shutter10



With shutter open

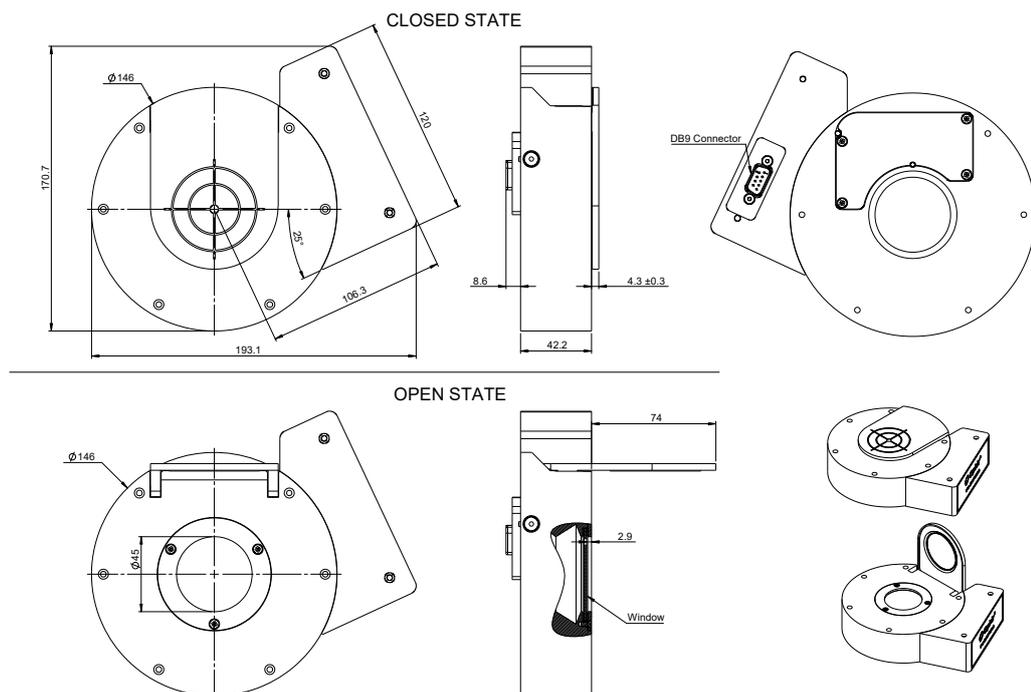


Model	IPM-SHUTTER10		
Use	Enhances IPM-KW sensor with IP62 ingress protection, and additional reduction of back		
Control	Via host IPM-10KW unit		
Aperture mm	Ø45mm		
Backscattered Power ^(b)	~1%		
Weight kg	2		
Connectors	Connection to IPM-10KW unit – D9		
Part Numbers and Optional Accessories	Name	Description	P/N
	IPM-SHUTTER10	Combined protective shutter. Includes built in scatter shield	7Z08409
	IPM-SHUTTER10 Window replacement kit	Replacement anti reflective coated window	7Z08411
Related Products	Name	Description	P/N
	IPM-10KW	IPM industrial laser power sensor	7Z07106
	IPM-COM-Profinet	Profinet communications adapter with AIDA connectors	7Z08404
	IPM-COM-EtherNet/IP-M	EtherNet/IP communications adapter with M connectors	7Z08405

Note: (a) When working at 10.6µm (CO₂), the window should be removed.

Note: (b) Using built in scatter shield, use the NIRS or CO₂S setting to compensate for slightly higher reading.

IPM-SHUTTER10



1.1.2.11 Accessories for High Power Water Cooled Sensors

1.1.2.11.1 Fiber Adapter for Ophir High Power Sensors

Adapters for high power fiber connectors are available for Ophir sensors L1500W and 5000W for use in industrial environments.

The fiber adapters allow mounting of QBH fiber terminators to Ophir sensors. When using an adapter, the fiber output is centered on the sensor surface and is isolated from surrounding dust and contaminants. Choice of the correct adapter model depends on the power and divergence angle of the laser being measured, see specs below.

QBH-L-Fiber Adapter
Mounted on 5000W sensor



Description	QBH fiber adapter for high power sensors models	
Use	Adapter for direct measurement of QBH fiber output	
Sensors Supported	L1500W-LP2-50, L1500W-BB-50, 5000W-LP2-50 and 5000W-BB-50 ^(a)	
Added Error	1% for BB type coatings	
Housing Temperature at Max Power	55°C ^(b)	
Cooling	Water, maximum temperature 30°C	
Fiber Adapter Water Flow Requirements	2 liter/min, minimum ^(c)	
Water Connectors	(2x) Quick Connect Fitting For Ø3/8 Plastic Hose ^(d)	
Model	QBH-L-Fiber Adapter	QBH-S-Fiber Adapter
Maximum Beam Divergence Half Angle ^(e)	120 mrad (180 mrad)	180 mrad (270 mrad)
Minimum Beam Divergence Half Angle	See note ^(f)	See note ^(f)
Dimensions	See drawing below	See drawing below
Part number	7Z08348	7Z08349

Note: (a) Please note that older versions of the above sensors do not have the requisite 4 threads on Ø70mm circle on their front flange and cannot be used with the QBH adapter.

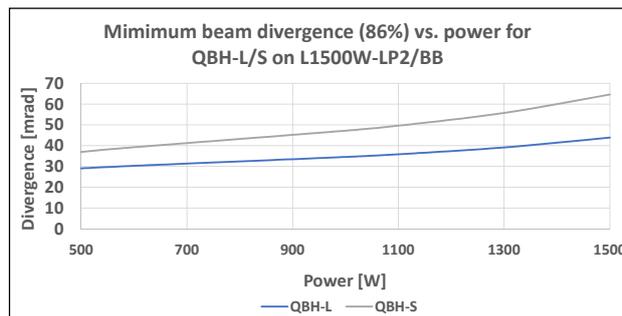
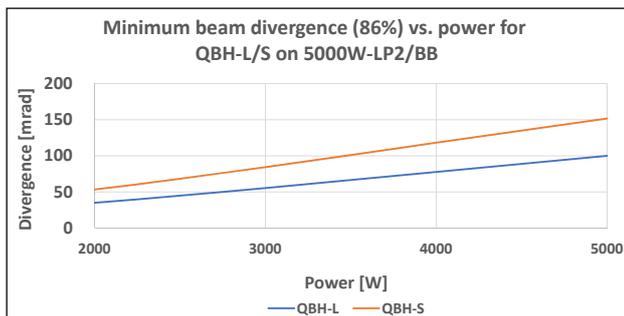
Note: (b) When using BB type coatings temperature may reach 80°C at midpoint of adapter.

Note: (c) The water flow requirements of the fiber adapter are much lower than that of the water-cooled sensor (see the sensor data sheet for details). Therefore, the fiber adapter can be connected in series with the sensor water supply but then the water flow rate of both will have to meet the sensor minimum water flow rates.

Note: (d) For Metric water connectors see page 102.

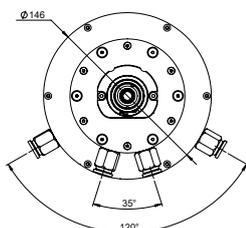
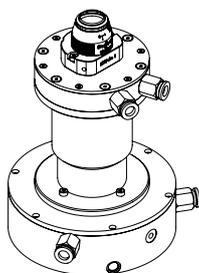
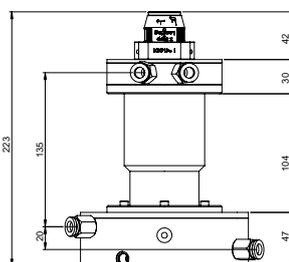
Note: (e) Divergence angle given defines radius of beam containing 86% of power, the divergence of 98% of the power is given in brackets.

Note: (f) Graphs of beam divergence:

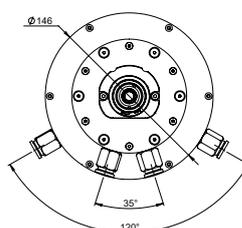
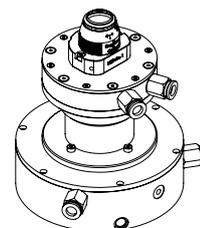
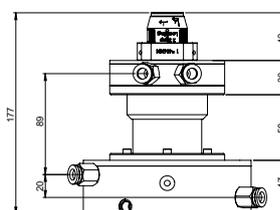


High Power QBH-Fiber Adapter Mounted on a 5000W-LP2-50 Sensor

QBH-L-Fiber Adapter



QBH-S-Fiber Adapter



1.1.2.11 Accessories for High Power Water Cooled Sensors

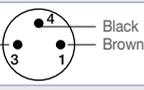
1.1.2.11.2 Protective Housing for 5000W, 10K-W and 15K-W Series Sensors

For use with 5000W, 10K-W and 15K-W sensors in industrial environments where sensors may be contaminated by debris from material working process.

The protective housing and shutter prevent contamination of the sensor, particularly the absorbing surface, by this debris. The housing has a solenoid actuated shutter that can be opened when needed for measuring and be closed otherwise. The protective housing is fastened to the front flange of the sensor ^(a).

Protective Housing for 5000W / 10K-W / 15K-W
Mounted on Sensor (shutter open)
Rear view (cables and water connector)

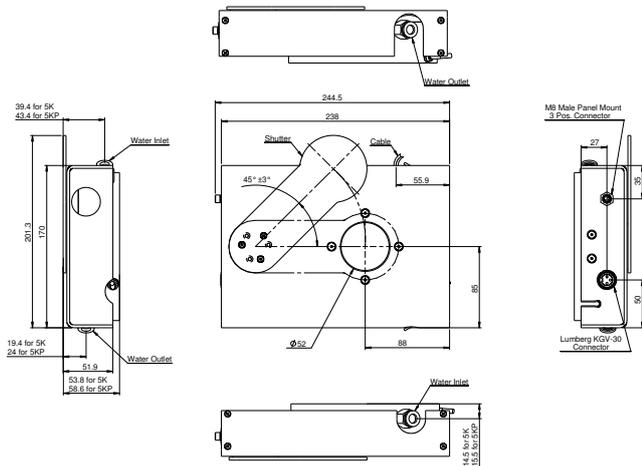


Model	5000W / 10K-W / 15K-W Protective Housing	
Use	Protection from debris of material working process	
Sensors Supported	For 5000W, 10K-W and 15K-W. Needs threaded front flange ^(a)	
Aperture	Exposes full aperture of sensors	
Solenoid Actuating Power	24VDC 1A, Shutter is normally Closed	
Electrical Connection	Lumberg SV30 male connector with 2m cable (P/N 7Z10377) as supplied. Black wire (pin3) is ground, Red wire (pin1) is +24VDC, no wire connected (pin 2)	
Interlock	Interlock switch is open if shutter is closed. This can be used to protect the shutter from accidental exposure to the laser	
Electrical Connection for Interlock	M8-3 Pin male connector (pin 1,4 connected to switch contacts). 1.5m cable (P/N 7E01513A) included, brown and black wires are the switch contacts. Pin 3 - no wire connected	Cable Plug (Female) Not connected 
Dimensions	See drawing below	
Housing Material	Sheet aluminum	
Version	V1	
Part number	7Z08344	

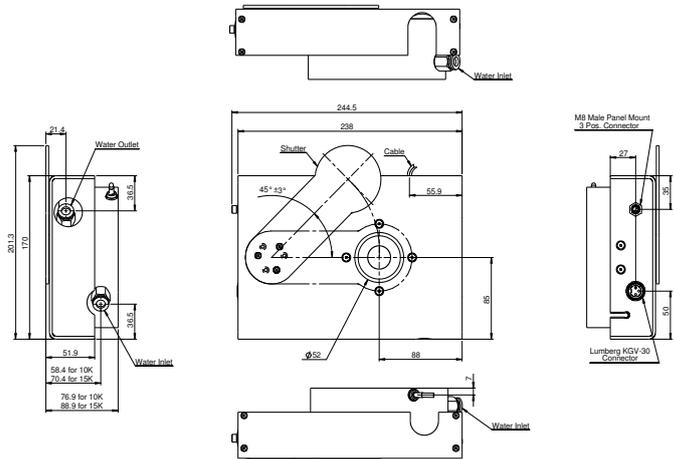
Note: (a) When fitting the housing to previous versions of the above sensors not having the requisite threads on their front flange, it will be necessary to exchange the front flange of the sensor with a new one having the requisite mounting threads. For details, consult Ophir representative.

Protective Housing for 5000W, 10K-W and 15K-W

As mounted on 5000W



As mounted on 10K-W / 15K-W



1.1.2.11 Accessories for High Power Water Cooled Sensors

1.1.2.11.3 Scatter Shield

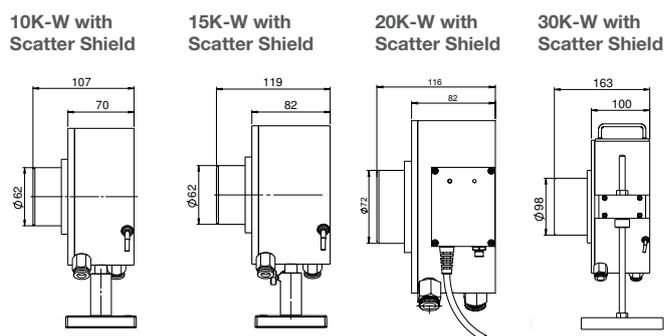
Scatter Shield for mounting on front flange of 10K-W / 15K-W, 20K-W and 30K-W to reduce backscattered power.

3 to 4% of the light impinging on the 10K-W, 15K-W, 20K-W and 30K-W is backscattered in a diffuse manner. This can cause heating of surrounding surfaces. Scatter Shields are available to greatly reduce this affect. When installed on the front flange of the sensors, they will reduce the backscatter by about 70%. The shield works in two ways:

1. By absorbing much of the backscattered light.
2. By reflecting some of it back into the sensor where that light is reabsorbed.

Since some of the light is reabsorbed, the power reading is 1-1.5% higher than without the shield, so an additional laser setting is given for use when the shield is mounted to adjust for this difference.

The scatter shield comes with a protective cover with target pattern for alignment that also can be purchased separately, (see page 102).



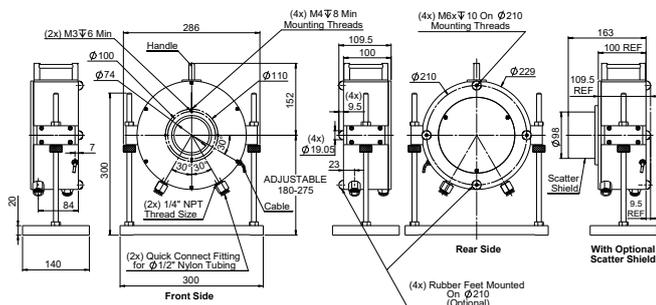
Model	10K-W / 15K-W Scatter Shield	20K-W Scatter Shield	30K-W Scatter Shield
Wavelength range of use	0.8 – 2µm	0.8 – 2µm	0.8 – 2µm
Laser setting with and without shield	with NIRS, without NIR	with NIRS, without NIR	with 107S, without 107
Backscatter with and without shield	with 1%, without 3.5%	with 1%, without 3.2%	with 1.4%, without 4.3%
Part number	7Z08295	7Z08355 (a)	7Z08293

Note: (a) The scatter shield is compatible also with the 16K-W-BB-55 sensor P/N 7Z07131

1.1.2.11.4 Heavy Duty Stand for 10K-W and 15K-W

For sustained use in an upright position, it may be advisable to purchase the heavy duty stand for the 10K-W and 15K-W due to their large size and weight. The heavy duty stand bolts onto existing threads on the rear of the 10K-W and 15K-W.

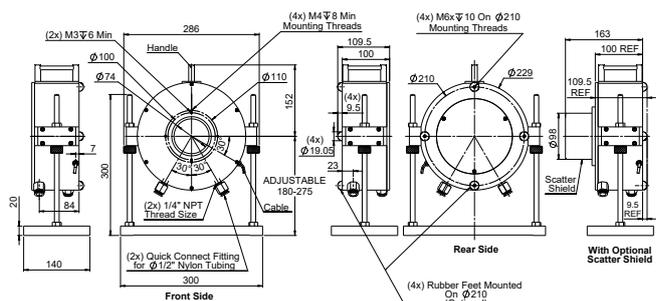
Model	Heavy Duty Stand for 10K-W and 15K-W
Part number	7Z08330



1.1.2.11.5 30K-W Rubber Feet Assembly

The rubber feet make it possible to lean the sensor on its rear side for better stability when used with a vertical beam. The kit has 4 feet which can be screwed into the existing threads.

Model	30K-W Rubber Feet Assembly
Part number	7Z08217



1.1.2.11 Accessories for High Power Water Cooled Sensors

1.1.2.11.6 Metric Water Connectors for Water Cooled Sensors

The standard water connection supplied with Ophir water cooled sensors are quick connect fittings for 3/8" and 1/2" plastic tubing. Metric water connectors are available as follows:

Connector (set of 2 ea.)	For use with	Part Number
1/4" NPT to 12mm O.D. tubing	20K-W & 30K-W	7Z08352 ^(a)
1/8" NPT to 10mm O.D. tubing	All other water cooled sensors & QBH Adapters	7Z08353

Note: (a) The water connector is compatible also with the 16K-W-BB-55 sensor P/N 7Z07131



1.1.2.11.7 Protective Covers with Target Pattern for High Power Sensors and for Scatter Shields

All the protective covers are made of black anodized aluminum, and have a cross pattern for alignment. Sensors: The 5000W, 10K-W, 15K-W sensors are supplied with the 10K-W Protective Cover. This protective cover also fits the 1000W and L1500W sensors, but is not supplied with these sensors. The protective cover can be ordered separately for these sensors. The 20K-W sensor is supplied with the 20K-W Protective Cover. The 30K-W sensor is supplied with the 30K-W Protective Cover.

Scatter Shields: 10K-W / 15K-W Scatter Shield (P/N 7Z08295), 20K-W scatter shield (P/N 7Z08355) and 30K-W Scatter Shield (P/N 7Z08293) are supplied with their respective protective covers (P/N 7Z08345 for 10K-W / 15K-W and P/N 7Z08346 for 30K-W).

For more information on scatter shields see page 101.

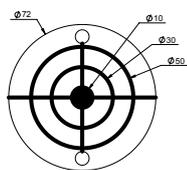
All protective covers can also be ordered separately (see table below).



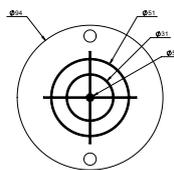
Protective Cover	For use with	Part Number
10K-W Protective Cover	15K-W, 10K-W, 5000W, L1500W, 1000W without scatter shield	1G01332
10K-W / 15K-W Scatter Shield Cover	10K-W and 15K-W with Scatter Shield	7Z08345
20K-W Protective Cover	20K-W without Scatter Shield	1G02813 ^(b)
30K-W Protective Cover	30K-W without Scatter Shield	1G02406
30K-W Scatter Shield Cover	30K-W with Scatter Shield	7Z08346

Note: (b) The protective cover is compatible also with the 16K-W-BB-55 sensor P/N 7Z07131

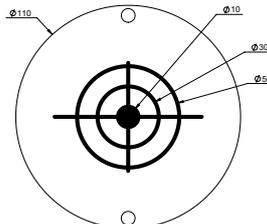
10K-W Protective Cover



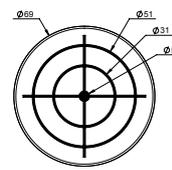
20K-W Protective Cover



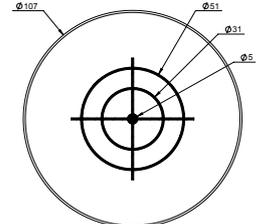
30K-W Protective Cover



10K-W / 15K-W Scatter Shield Cover



30K-W Scatter Shield Cover



1.1.2.12 Short Exposure High Power Sensors

1.1.2.12.1 Helios Pro

100W to 12,000W

Features

- No water cooling, up to 12,000W
- Profinet / EtherNet/IP / EtherCAT and RS232 interfaces
- Remote actuated protective cover
- Dual wavelength range IR & visible spectrum
- Optional Diffuser for small beam sizes
- Field replaceable protective window
- Pulse characterization: Rise time, power at the end of the pulse, stabilization of the pulse and pulse shape

Helios Pro



The Helios Pro measures high power industrial lasers of up to 12kW by measuring the energy of a short time exposure to this power. The laser is set to a pulse of from 0.3 to several seconds. The Helios Pro measures the energy and exposure time of this sample of the power, and from this calculates the power. Helios Pro provides additional characteristics of the pulse such as: rise time, power and level of stability of the pulse in the last 50 milliseconds and can also display the shape of the pulse. In the version with a diffuser Helios Pro can handle small beam size down to 2 mm. By keeping the pulse energy under 5kJ, there is no need for water cooling and the sensor can be kept to a compact size. It works in two wavelength ranges:

900-1100nm (Near IR) and 450-550nm (Blue-Green). The sensor is housed in a dust-resistant industrial body to keep the Helios Pro in clean working order even under harsh factory conditions. Its protective cover can be opened and closed remotely to protect the sensor when not in use. Its protective window is antireflection coated to reduce back reflection from high power beams. The Helios Pro offers three industrial communication protocols: Profinet, EtherNet/IP and EtherCAT, with an additional RS232 interface. It is equipped with two power and two data ports for easy integration into existing line or ring topologies as well as an RS232 connection. The Helios Pro comes with a simple PC application for easier integration into the customer's system.

Helios Pro Model Table:

Model	Description	Communication	Data connectors	Power connectors	P/N
Helios Pro - Profinet	Profinet, AIDA compatible connectors for power and data	Profinet, RS232	2x AIDA compatible RJ45 connectors, 1x RS232 - DB9 connector	2x AIDA compatible connectors	7Z07146
Helios Pro - Profinet, Diffuser	Profinet, AIDA compatible connectors for power and data	Profinet, RS232	2x AIDA compatible RJ45 connectors, 1x RS232 - DB9 connector	2x AIDA compatible connectors	7Z07147
Helios Pro - EtherNet/IP	EtherNet/IP, AIDA compatible connectors for power and data	EtherNet/IP, RS232	2x AIDA compatible RJ45 connectors, 1x RS232 - DB9 connector	2x AIDA compatible connectors	7Z07142
Helios Pro - EtherNet/IP, Diffuser	EtherNet/IP, AIDA compatible connectors for power and data	EtherNet/IP, RS232	2x AIDA compatible RJ45 connectors, 1x RS232 - DB9 connector	2x AIDA compatible connectors	7Z07143
Helios Pro - EtherNet/IP-M	EtherNet/IP, M12 connector for data, Mini 7/8" connector for power	EtherNet/IP, RS232	2x M12 D - coded connectors, 1x RS232 - DB9 connector	2x Mini 7/8" connectors (male / female)	7Z07140
Helios Pro - EtherNet/IP-M, Diffuser	EtherNet/IP, M12 connector for data, Mini 7/8" connector for power	EtherNet/IP, RS232	2x M12 D - coded connectors, 1x RS232 - DB9 connector	2x Mini 7/8" connectors (male / female)	7Z07139
Helios Pro - EtherCAT	EtherCAT, AIDA compatible connectors for power and data	EtherCAT, RS232	2x AIDA compatible RJ45 connectors	2x AIDA compatible connectors	7Z07144
Helios Pro - EtherCAT, Diffuser	EtherCAT, AIDA compatible connectors for power and data	EtherCAT, RS232	2x AIDA compatible RJ45 connectors, 1x RS232 - DB9 connector	2x AIDA compatible connectors	7Z07145

* For specifications please see page 104 and for drawings see page 105

Specifications of Helios Pro (following the Model Table on page 103)

Use	High power industrial laser measurement			
Absorber Type	LP2, absorption ~94%			
Power Range	100W - 12kW			
Energy Range	100J - 5kJ			
Exposure Time (see table below)	0.3- 4s ^(a)			
Wavelength	Without Diffuser 450 - 550nm, 900 - 1100nm With Diffuser 450-550nm, 940-1100nm			
Aperture	Without Diffuser ϕ 50mm With Diffuser ϕ 35 mm			
Max Beam Diameter	Without Diffuser 35mm With Diffuser 20mm			
Calibration Uncertainty \pm %	1.9			
Accuracy ^(b)	Without Diffuser: \pm 3% (900 - 1100nm, 532nm); \pm 3.5% (450 - 550nm) With Diffuser: \pm 3% (940 - 1100nm); \pm 4% (450 - 550nm)			
Linearity with Energy	\pm 1.5% ^(c)			
Reproducibility	\pm 1%			
Response Time	3s			
Waiting Time for Next Measurement	12s			
Pro mode: Power range Rise time Slope Instability	100W - 12kW ^(d) 0-95% % of measured (Pro Mode) power ^(e)			
Maximum Exposure Before Cooling Down is Necessary	Maximum operating temperature of 60°C will be reached after exposure to 30kJ (e.g. 6 shots at 5000W, 1s). Cooling down time before another 5kJ shot, 3min.			
Power Supply	24 VDC \pm 5%, max 2A (for daisy-chaining)			
Power Consumption	4.8W			
Dimensions	Model: Profinet, EtherNet/IP, EtherCAT - (L x W x H) mm - 200 x 103 x 86 (closed); 200 x 114 x 146 (open) Model: EtherNet/IP-M - (L x W x H) mm - 200 x 125 x 86 (closed, connectors included); 200 x 135 x 146 (open, connectors included)			
Position of Mounting Holes	6.6 mm holes spaced at 90x190 mm			
Weight	Model: Profinet, EtherNet/IP, EtherCAT - 2.5kg, EtherNet/IP-M - 2.7 kg			
Indicators	7 indicator LEDs			
Operating Temperature	10 - 60°C			
Humidity	10 - 80%			
Recommended exposure times and 1/e ² Gaussian beam diameters	Laser Power W	Recommended Exposure s	Min 1/e ² beam dia. Without diffuser [mm]	Min 1/e ² beam dia. With diffuser (max dia. is 20mm) [mm]
	50	2	9	2
	100	2	9	2
	500	2	9	2
	1000	1	9	2
	2000	1	12	2
	5000	1	18	6
	10000	0.3	22	11
12000	0.3	25	11	
Cover	Motor driven cover opens sideways			
Accessories Supplied with Helios Pro	Model: Profinet, EtherNet/IP, EtherCAT - 1. Power Supply Cable, AIDA to flying leads termination 5m (P/N 7Z10458A) 2. Data Cable, Ethernet AIDA to RJ-45 5m (P/N 7E01299) Model: EtherNet/IP-M - 1. Power Supply Cable, 7/8" to flying leads termination 2m (P/N 7E01535) 2. D9F to D9M Shielded 3m RS232 Cable (P/N 7E11216A)			
Optional Accessories	Model: EtherNet/IP-M For all Modes: - 1. Data Cable, Ethernet M12 to RJ-45 plug IP67 3m Cable (P/N 7E11211) - 1. D9F to D9M Shielded 3m RS232 Cable (P/N 7E11216A) 2. D9F to D9M Shielded 10m RS232 Cable (P/N 7E01209) 3. Helios Pro Window Replacement Kit (P/N 7Z08447)			
Compliance	CE, UKCA, China RoHS			
Part number	See P/Ns in Helios Pro Model Table on previous page			

Notes: (a) Repetitive pulses can also be measured as long as the total exposure time is within this range.

(b) The power is calculated by measuring the energy and exposure time. The laser pulse is assumed to be rectangular for this calculation.

(c) For pulse widths in the range 0.3 – 4s.

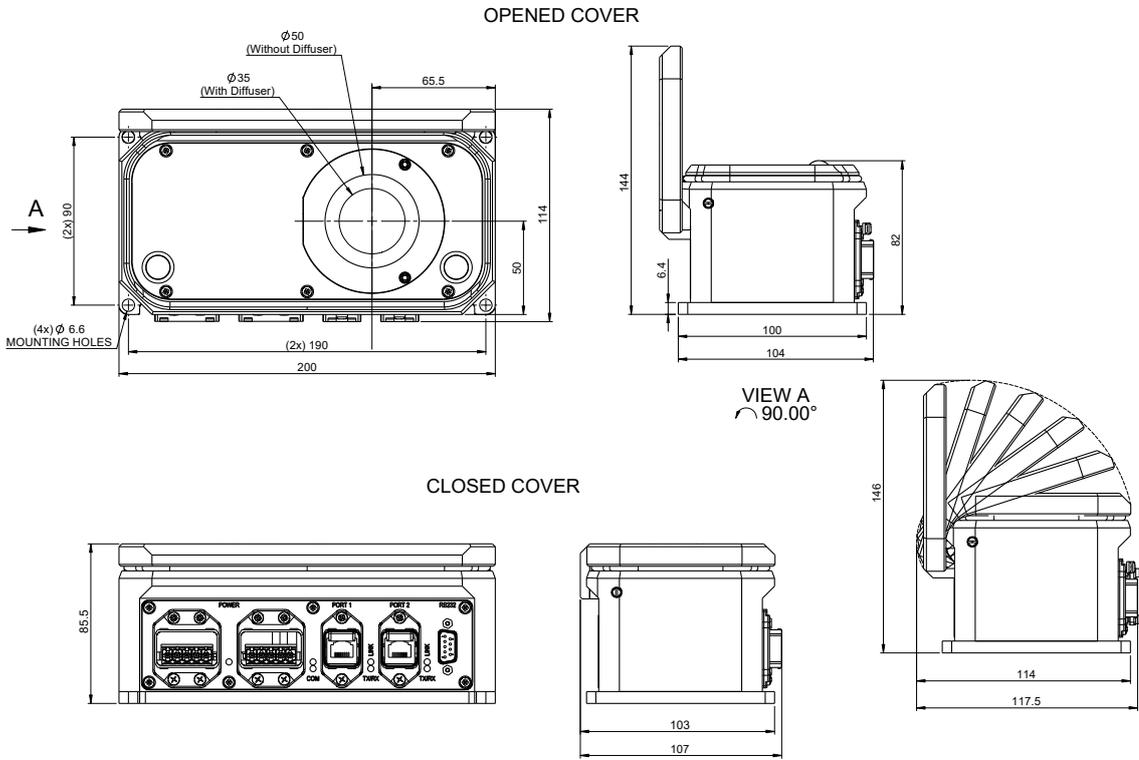
(d) Calculated for the last 50ms before the end of the pulse, the pulse shape is obtained without noise from the 300W and up.

(e) The slope is calculated as the best fit straight line through the pulse data for the last 50ms before the end of the pulse. It is in units of percentage of the Pro Mode power measurement and the value returned is limited to max/min values of +12.8% and -12.7%, if the measured slope goes beyond any measured values beyond these values will return the max or min values.

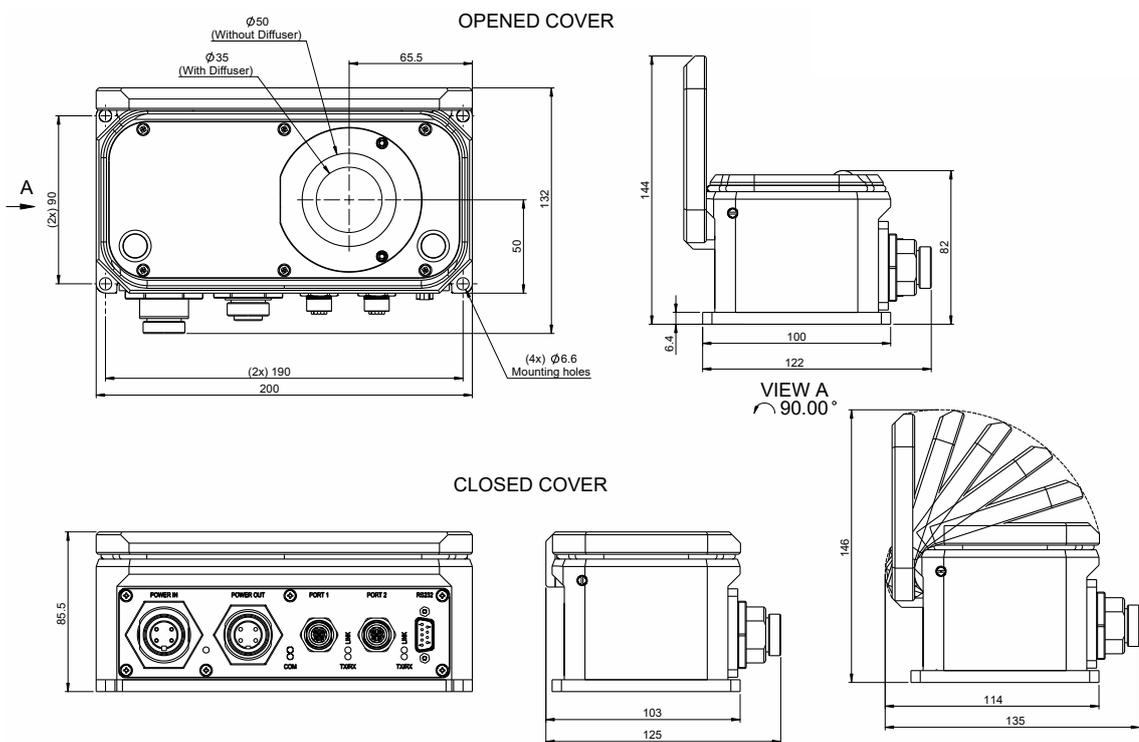
* For drawings please see page 105

Helios Pro Drawings

Helios Pro - Profinet / Helios Pro - EtherNet/IP / Helios Pro - EtherCAT



Helios Pro - EtherNet/IP-M



1.1.2.12 Short Exposure High Power Sensors

1.1.2.12.2 Ariel

200mW to 8000W

Features

- Measures up to 8000W
- Wavelengths: 440 - 550nm, 900 - 1100nm, 2.94µm, 10.6µm
- No Water Cooling IP62 rated
- Only 3 seconds to display measurement
- High thermal capacity of 14KJ for uninterrupted consecutive measurements

Ariel with window attached



The Ariel measures high power industrial lasers of up to 8kW by measuring the energy of a short exposure to this power. The laser is set to deliver a pulse of from 0.05 to several seconds. It then measures the energy and duration of the

laser pulse and calculates the power. Ariel can also measure continues power up to 500W intermittently. It is ideal for usage in tight spaces such as additive manufacturing chambers as well as for production process quality control and R&D.

Model	Ariel			
Use	High power laser measurement by short exposure			
Absorber Type	LP2			
Power Range	200mW - 8,000W			
Exposure Time (see table below)	Pulsed Mode: 0.05 - 2s. ^(a) CW mode: 10s to continuous depending on power level			
Wavelength	Window: 440 - 550nm, 900 - 1100nm ^(b) Diffuser: 440 - 550nm, 940 - 1100nm ^(b) Without window or diffuser: 2.94µm ^(c) , 10.6µm ^(c)			
Aperture	Ø32mm. Maximum beam diameter for Gaussian beam 22mm. With diffuser Maximum beam diameter for Gaussian beam 10mm.			
Calibration Uncertainty ±%	1.9			
Power Accuracy	900 - 1100nm, 2.94µm, 10.6µm: ±3%; 440 - 550nm: ±3.5% ^(a) ^(b)			
Minimum Power for Pulse Width Measurement	440 - 800nm, >20W; 800 - 1100nm, >10W; >1100nm, not available ^(c)			
Maximum Beam Incidence Angle	Without diffuser: ±30 degrees for <12mm Gaussian beam, With diffuser: ±25 degrees for <10mm Gaussian beam ^(d)			
Backscattered Power	LP2 absorber: <2200nm: 4%; 2940nm: 10%; 10.6µm: 25% With window: 5% With Diffuser: 25%			
Reproducibility	±1%			
Power Range vs. Irradiation Time	200mW - 30W: CW; 500W: up to 20s; 1,000W - 8,000W: 0.05 - 1s.			
Linearity	±1.5%			
Time to Reading	3s after end of exposure			
Waiting Time for Next Measurement	12s			
Maximum Energy for Single Pulse	2.4kJ ^(e)			
Maximum Exposure Before Cooling Down is Necessary	Maximum operating temperature of 60°C will be reached after exposure to 14kJ (e.g. 10 shots at 2,000W, 0.7s) ^(e) . Cooling down time before another 14kJ series of shots is ~10 minutes ^(f) .			
Over Temperature Warning	Flashing display			
Cooling	Convection ^(f)			
Battery	Rechargeable, 1100mAh, lifetime >15 hours			
Interface	128x64 pixel LCD Display, Bluetooth 5.1 (compatible with Bluetooth 4 and above), USB-C			
Dimensions (L x W x H)	70 x 70 x 80 mm (see drawing)			
Weight	0.8kg			
Operating Temperature	10 - 40°C			
Permissible Relative Humidity (non-condensing)	10 - 80%			
Ingress Protection	IP62			
Compatible Client Applications	StarLab (PC, USB), StarViewer (iOS or Android, Bluetooth)			
Recommended Exposure Times and 1/e ² Gaussian Beam Diameters	Laser Power W	Recommended Exposure s	Min 1/e ² beam dia. Without diffuser [mm]	Min 1/e ² beam dia. With diffuser (max dia. is 10mm) [mm]
Continuous Power Measurement	30	Continuous ^(f)	1	0.3
	500	20 ^(f)	4	2
	500	2	4	1
	1000	1	6	1
Power Measurement from Short Exposure	2000	0.7	10	1.5
	4000	0.5	16	3.5
	8000	0.3	22	N.A.
Compliance	CE, UKCA, China RoHS			
Version	V2			
Part number	7Z07137			

Notes: (a) The power is calculated by measuring the pulse energy and exposure time. A rectangular pulse is assumed for this calculation. Diffuser mode is calibrated with protective window, working without window may have small effect on measurement results.

(b) May be used at 550 - 900nm with decreased accuracy and higher reflection (up to 10%).

(c) Use without window or diffuser. The sensor does not measure pulse width above 1100nm. For pulsed power measurement at >1100nm, a short pulse with known duration should be applied. A pulse energy measurement is performed and divided by the known pulse width to obtain the power. When working without window and without diffuser, the sensor is not sealed against dust or water.

(d) With diffuser, reading will be up to 10% lower than vertical beam and beam should be offset from center in opposite direction to beam incidence by ~10mm.

(e) At room temperature.

(f) Faster cooling can be achieved by attaching the Ariel to a heat sink using the mounting threads at the bottom.

* For drawings and pictures please see page 107

1.1.2.12 Short Exposure High Power Sensors

1.1.2.12.3 Pulsed Power Mode

300mW to 10,000W

Features

- No water cooling
- Measure up to 10kW
- Cost Effective
- Diffuser for concentrated beams

L40(250)A-LP2-50



L40(500)A-LP2-DIF-35



L30C-LP2-26-SH



If the full features of the Helios Pro or Ariel including protective cover, Profinet interface and pulse width measurement are not needed, similar performance can be obtained with the L40(250)A-LP2-50 and L40(500)A-LP2-DIF-35. The L40(250)A-LP2-50 has the same sensor as the Helios Pro. It can measure powers from short exposure from 500W up to 10,000W. The user measures the energy of the pulse and knowing the pulse width calculates the power (e.g. 5000J in a 0.5s pulse = 10,000W). If using the Centauri and

StarBright meters or Juno/Juno+/Juno-RS PC interfaces this can be calculated directly by inputting the laser pulse width into the Pulsed Power screen of the Meter/Interface or the equivalent StarLab screen and exposing the sensor to the power for the requisite pulse width. The meter will then directly give the power reading from the pulse energy measured. For lower powers, the L30C-LP2-26-SH will give similar performance for energies up to 2000J. For further information see pages 66 & 153.

Model	L40(250)A-LP2-50	L40(500)A-LP2-DIF-35	L30C-LP2-26-SH						
Absorber Type	LP2	LP2 + Diffuser	LP2						
Spectral Range	0.25 – 2.2µm, 2.94µm	0.44 – 2.2µm ^(e)	0.25 – 2.2µm						
Aperture	Ø50mm	Ø35mm	Ø26mm						
Absorption	>94% from 0.25 to 1.1µm	~14% backscatter from diffuser	>94% from 0.25 to 1.1µm						
Power Range for continuous use	300mW - 40W	300mW - 40W	300mW - 10W						
Maximum Intermittent CW power	250W for 1.5min, 150W for 3min, 80W for 6min, 40W continuous	500W for 45s, 250W for 1.5min, 150W for 3min, 80W for 6min, 40W continuous	10W continuous, 100W for 2min, 100W heat sunk						
Maximum CW power density	20kW/cm ² at 250W	>150kW/cm ² at 500W	42kW/cm ² at 100W						
Aperture	Ø50mm	Ø35mm	Ø26mm						
Max Beam Diameter for Gaussian beam	Ø35mm for up to 30deg incidence	Ø25mm for normal incidence Ø15mm for 20deg incidence ^(f) Ø10mm for 30deg incidence ^(f)	Ø17mm for up to 30deg incidence						
Pulsed Power Mode									
Exposure Time For Pulsed Power Mode (see table below)	0.3s - 2s ^(b)	0.3s - 4s ^(b)	0.5s - 4s ^(b)						
Energy Range	100mJ – 10,000J	100mJ – 2000J	30mJ – 2000J						
Energy Accuracy	±5% 700 – 1100nm ^{(a), (c)}	±5% 900 – 1100nm ^(c)	±5% 700 – 1100nm ^{(a), (c)}						
Linearity with Energy	±1.5% ^(d)	±1.5% ^(d)	±1.5% ^(d)						
Reproducibility	±1%	±1%	±1%						
Response Time	2.5s	2.5s	1.5s						
Waiting Time for Next Measurement	12s	12s	12s						
Maximum Exposure Before Cooling Down is Necessary	20kJ (e.g. 4 shots of 5000Wx1s). Cooling down time before another 20kJ series, 10min.	8kJ (e.g. 4 shots of 2000Wx1s). Cooling down time before another 8kJ series, 10min.	10kJ (e.g. 5 shots of 2000Wx1s). Cooling down time before another 10kJ series, 10min.						
Recommended Exposure Times and Beam Diameters	Laser Power W	Recommended Exposure s	Min 1/e ² beam dia. mm	Laser Power W	Recommended Exposure s	Min 1/e ² beam dia. mm	Laser Power W	Recommended Exposure s	Min 1/e ² beam dia. mm
	500	2	9	100	4	1	100	4	9
	1000	1	9	500	1	1	500	1	9
	2000	1	12	1000	1	1	1000	1	13
	4000	1	16	2000	1	1.5	2000	1	17
	5000	1	18	4000	0.4	3.5	4000	0.5	22
10000	0.3	22							
Compatible Meter/PC interface	Centauri, StarBright, Juno/Juno+/Juno-RS with StarLab	Centauri, StarBright, Juno/Juno+/Juno-RS with StarLab	Centauri, StarBright, Juno/Juno+/Juno-RS with StarLab						
Weight kg	0.6	0.6	0.3						
Operating Temperature	15-60°C	15-60°C	15-60°C						
Connections	DB15 Smart Plug	DB15 Smart Plug	DB15 Smart Plug						
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS						
Part Number	7Z02794 (see page 66)	7Z02797 (see page 66)	7Z02775 (see page 153)						

Notes: (a) Above 1100nm there is an additional 1% uncertainty

(b) Repetitive pulses can also be measured as long as the total exposure time is within this range

(c) The power is calculated by measuring the energy and exposure time. The laser pulse is assumed to be rectangular for this calculation

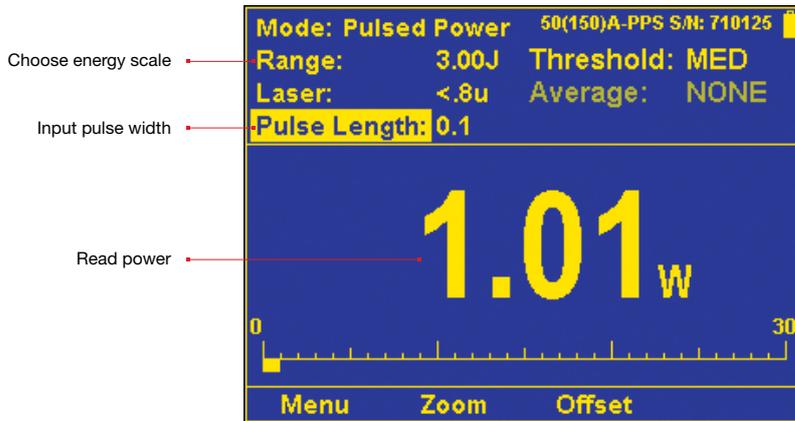
(d) For pulse widths in the range 0.3 – 4s

(e) Calibrated for 900 – 1100nm

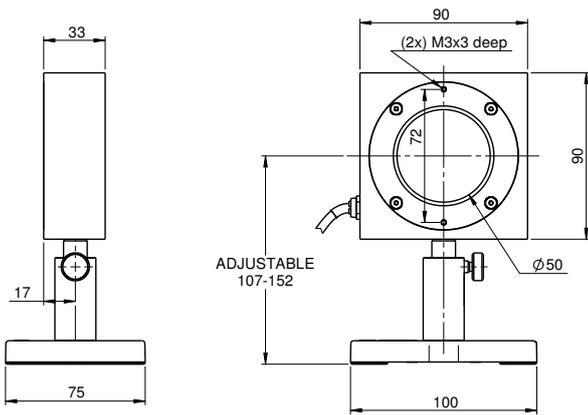
(f) At large angles of incidence, the position the beam hits the absorber should be offset into the direction of incidence by 5-10mm for correct reading and at 20deg incidence the reading will be 5% lower and at 30deg incidence 10% lower

* For drawings please see page 109

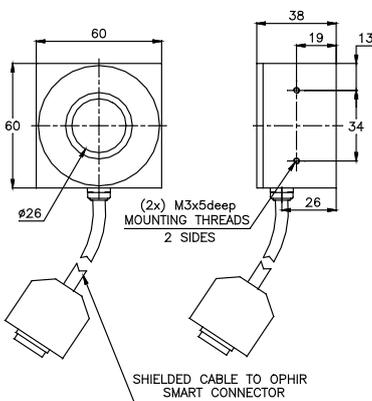
Pulsed Power Mode Screen:



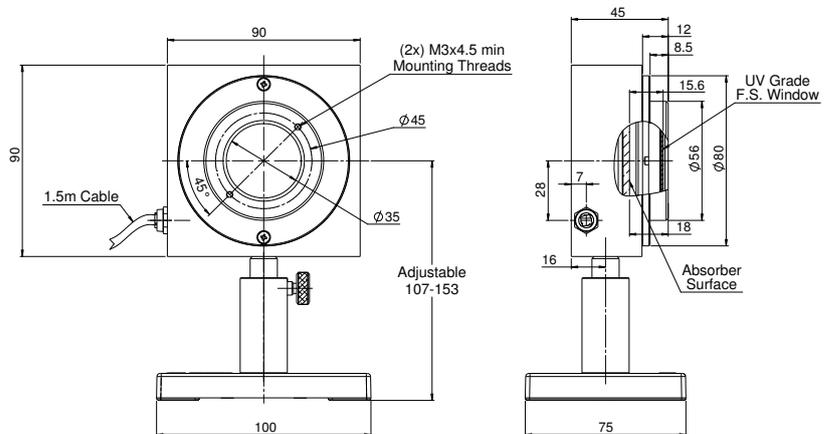
L40(250)A-LP2-50



L30C-LP2-26-SH



L40(500)A-LP2-DIF-35



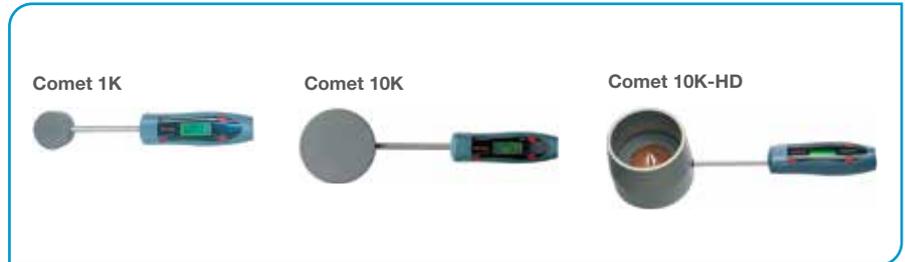
1.1.2.12 Short Exposure High Power Sensors

1.1.2.12.4 Comet Power Pucks

20W to 10kW

Features

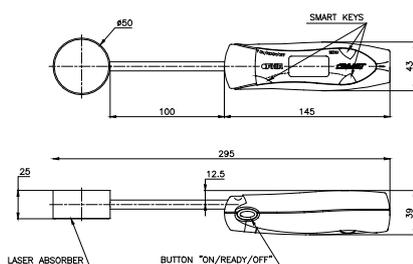
- Comet power pucks measure heat rise from 10s exposure to laser
- Accurate, built in temperature compensation algorithm
- Up to 10kW
- Up to 100mm apertures



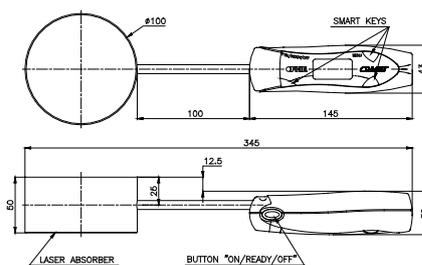
Model	Comet 1K ^(a)	Comet 10K ^(a)	Comet 10K-HD ^(a)
Use	For powers to 1kW	For powers to 10kW	For high power density beams
Absorber Type	Broadband	Broadband	Broadband with reflective cone beam spreader
Spectral Range μm	0.2 - 20	0.98-1.07 and 10.6	0.98-1.07 and 10.6
Aperture mm	$\varnothing 50\text{mm}$	$\varnothing 100\text{mm}$	$\varnothing 55\text{mm}$
Power Mode			
Power Range	20W to 1kW	200W to 10kW	200W to 10kW
Repeatability	$\pm 1\%$ for same initial temperature	$\pm 1\%$ for same initial temperature	$\pm 1\%$ for same initial temperature
Maximum Average Power Density kW/cm^2	Power Damage Threshold	Power Damage Threshold	Power Damage Threshold
	100W 10	1kW 3.5	1kW 10 7
	200W 8	2kW 2.8	2kW 10 6
	300W 6	3kW 2.5	3kW 8 5
	500W 5	5kW 1.5	5kW 6 3
	1kW 4	10kW 1	10kW 4 2
Power Accuracy $\pm\%$	5	5	5
Linearity with Power $\pm\%$	$\pm 2\% \pm 1\text{W}$ from 20W to 1kW	$\pm 2\%$ from 1kW to 10kW	$\pm 2\%$ from 1kW to 10kW
Number of readings before probe must be cooled (for 25°C starting temp.)	100W 4	1kW 4	1kW 4
	300W 3	3kW 3	3kW 3
	400W 2	4kW 2	4kW 2
	1kW 1	10kW 1	10kW 1
Maximum Energy Density J/cm^2			
<100ns	0.3	0.3	1
10 μs	0.8	0.8	3
1ms	10	10	30
10ms	50	50	150
Time to Reading	Initial reading 10s after exposure, final reading 20s after exposure	Initial reading 20s after exposure, final reading 40s after exposure	Initial reading 30s after exposure, final reading 70s after exposure
Temperature Compensation	Temperature compensated to give accurate readings independent of starting probe temperature		
Maximum Permitted Probe Temperature	70°C before measurement, 140°C after measurement		
Display	2x8 character LCD. Character height 5mm. CE Approved.		
Operation Mode	AUTO: Automatic measurement with laser set to 10s timed exposure. Unit senses temperature rise and measures automatically. MANUAL: User places probe in front of beam for 10s. Unit beeps to indicate start and stop measurement points. History: Stores last three readings. Calibration: Can be recalibrated by user.		
Battery	2 x AA. Lifetime in normal use approximately 1 year.		
Weight kg	0.3	1.2	1.2
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		V1	V2
Part number	7Z02702	7Z02705	7Z02706

Notes: (a) The Comet 1K, Comet 10K & Comet 10K-HD sensors are not under ISO/IEC 17025:2017 accreditation.

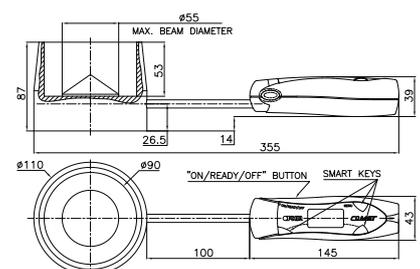
Comet 1K



Comet 10K



Comet 10K-HD

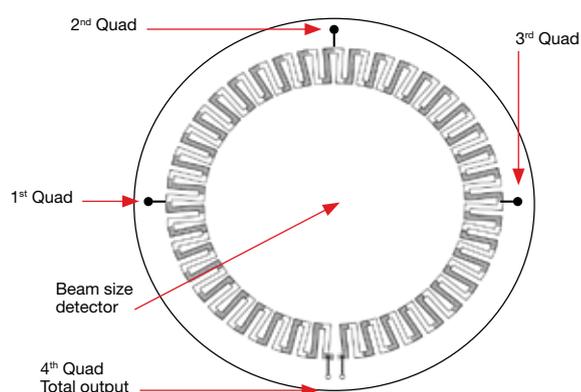


1.1.3 BeamTrack Power / Position / Size Sensors

1.1.3.1 Introduction

Ophir offers the BeamTrack line of thermal sensors that can measure beam position and beam size while measuring power. This innovative device will provide an additional wealth of information on your laser beam – centering, beam position, beam wander, beam size as well as power and single shot energy. The BeamTrack sensor is illustrated schematically here and works as follows: the signal coming from the sensor is divided into 4 quadrants so by measuring and comparing the output from the 4 sections we can

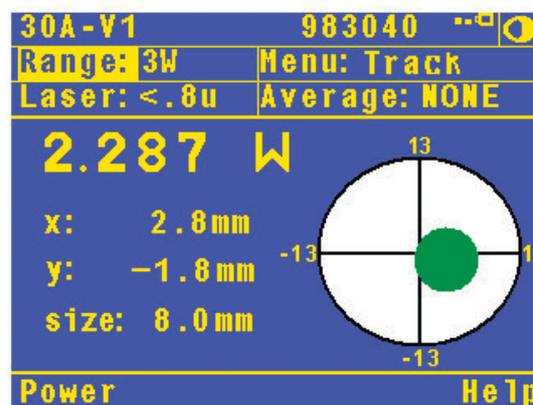
determine the position of the center of the beam to a high degree of accuracy. In addition to the 4 quadrants, there is now a special patented beam size detector. After processing outputs from these various detectors, the user is presented with the beam position as well as beam size. Note that the beam size is calibrated only for Gaussian beams but for other beams it will give relative size information and will indicate if the beam is changing size.



Operation of BeamTrack Sensors

BeamTrack sensors look similar to Ophir thermal sensors of the same type except that there is a small electronics module on the cable from the sensor to the smart plug. When BeamTrack sensors are plugged into compatible displays or PC interfaces (Centauri, StarBright, StarLite, Nova II, Vega, Juno, Juno+, Juno-RS and EA-1), along with the power measurement, there is a visual display of the beam position and beam size. The beam position can be accurately tracked and logged for beam wander measurements.

The beam size is calibrated only for Gaussian beams but other beams may be measured and the sensor will give a repeatable measurement of the relative beam size for tracking changes in the size of the beam over time.



Model	Sensor Type	Max Power [W]	Position	Size
3A-QUAD	TH	3	√	
3A-P-QUAD	TH	3	√	
10A-BB-16-PPS	TH	10	√	√
50(150)A-BB-26-QUAD	TH	50 (150 intermittent)	√	
50(150)A-BB-26-PPS	TH	50 (150 intermittent)	√	√
F150A-BB-26-PPS	TH	150	√	√
FL250A-BB-50-PPS	TH	250	√	√
1000W-BB-34-QUAD	TH	1000	√	

PD = Photodiode, TH = Thermal

1.1.3.2 BeamTrack Device Software Support

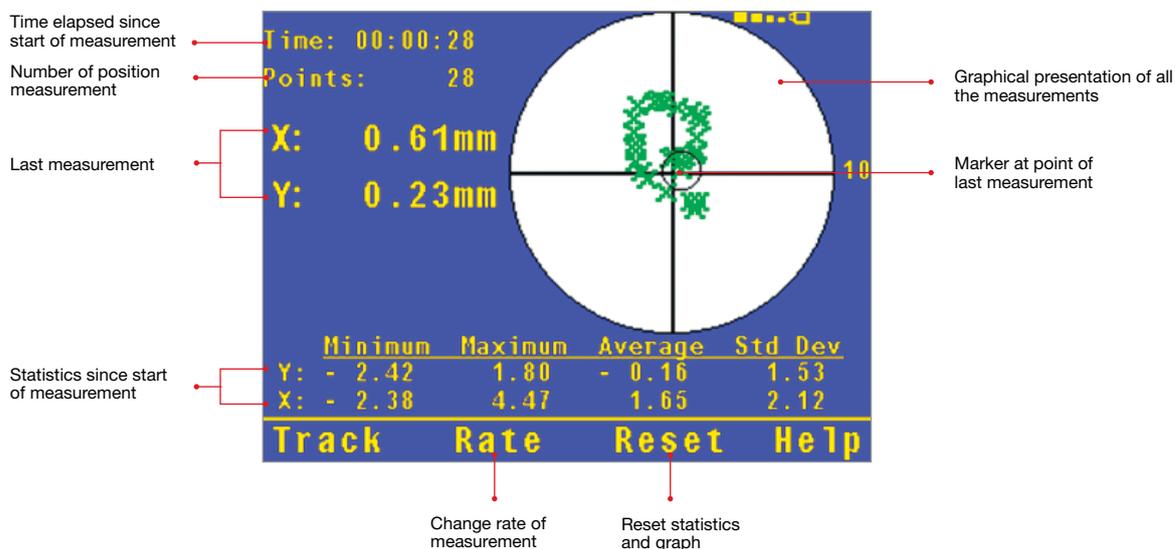
Features

- BeamTrack sensors are fully supported by the Centauri, StarBright, StarLite, Vega, Nova II, Juno, Juno+, Juno-RS and EA-1 devices
- Attach the sensor to the meter. On startup, it will be recognized as a BeamTrack sensor and tracking options will be enabled
- Use the Track screen to measure power, position and size simultaneously
- Use the Stability screen to measure pointing stability (also known as beam wander) over time

Track Screen of Centauri



Pointing Stability Screen of Vega



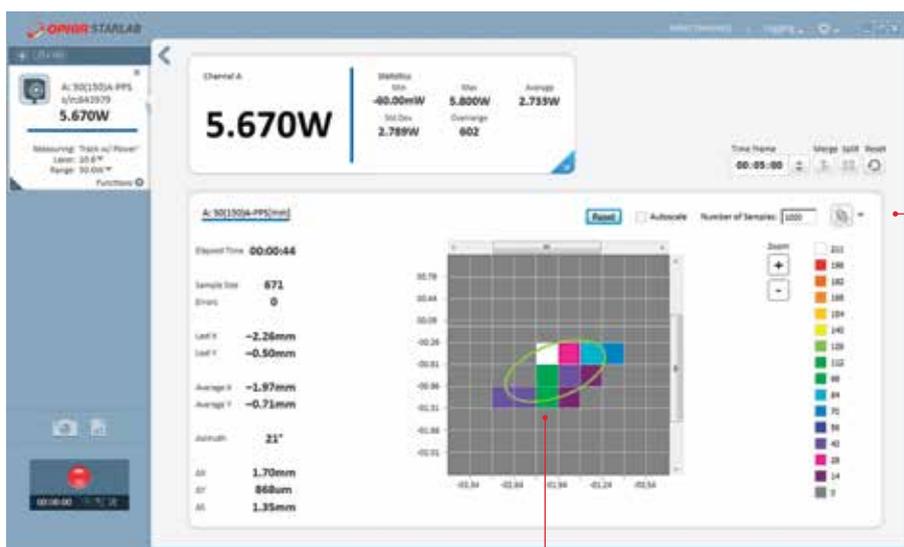
1.1.3.3 BeamTrack PC Software Support

Features

- StarLab
- COM Object for System Integrators including demo applications in VB, VC+ and MatLab the Track screen to measure power, position and size simultaneously
- LabVIEW Demo Application

Examples of some StarLab Screens

Stability Screen

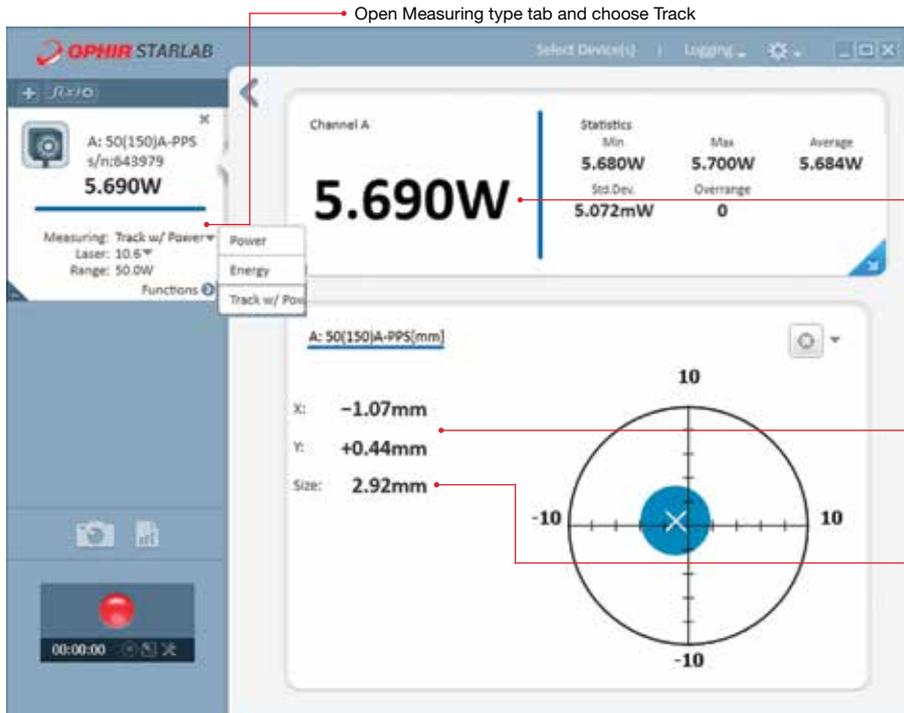


Click on this tab and choose "stability"

Position stability screen

Displays beam center wander weighted for dwell time at each position

Position & Size Screen



Open Measuring type tab and choose Track

Power

Position

Size

Power / Position / Size screen

1.1.3.4 Low Power BeamTrack-Power / Position / Size Sensors

100μW to 10W

Features

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

3A-QUAD / 3A-P-QUAD



10A-BB-16-PPS



Model	3A-QUAD ^(a)	3A-P-QUAD ^(a)	10A-BB-16-PPS ^(a)
Use	General purpose	Short pulses	Low power
Functions	Power / Energy / Position	Power / Energy / Position	Power / Energy / Position / Size
Absorber Type	Low power broadband	P type	Broadband
Spectral Range μm	0.19 - 20	0.15 - 8	0.19 - 11
Aperture mm	Ø9.5mm	Ø12mm	Ø16mm
Power Mode			
Power Range	100μW - 3W	160μW - 3W	20mW - 10W
Power Scales	3W to 300μW	3W to 300μW	10W / 5W / 0.5W
Power Noise Level	5μW	10μW	1mW
Thermal Drift (30min)%	10 - 40μW ^(b)	10 - 40 μW ^(b)	NA
Maximum Average Power Density kW/cm ²	1	0.05	28
Response Time with Meter (0-95%) typ. s	1.8	2.5	0.8
Calibration Uncertainty ±%	1.9	1.9	1.9
Power Accuracy ±% ^(g)	3	3	3 ^(h)
Linearity with Power ±%	1	1	1
Energy Mode			
Energy Range	20μJ - 2J	30μJ - 2J	6mJ - 2J
Energy Scales	2J to 200μJ	2J to 200μJ	2J / 200mJ
Minimum Energy	20μJ	30μJ	6mJ
Maximum Energy Density J/cm ²			
<100ns	0.3	1 ^(f)	0.3
0.5ms	1	1 ^(f)	2
2ms	2	1 ^(f)	2
10ms	4	1 ^(f)	2
Beam Tracking Mode			
Position			
Beam Position Accuracy mm ^(c)	0.15	0.15	0.15
Beam Position Resolution mm	0.02	0.02	0.02
Min Power for Position Measurement	300μW	400μW	50mW
Size ^(d)			
Size Accuracy ^(e)	NA	NA	±(5%+50μm) for centered beam
Size Range mm (4σ beam diameter)	NA	NA	1.5 - 10
Min Power for Size Measurement	NA	NA	50mW
Cooling			
Weight kg	Convection	Convection	Convection
Fiber Adapter Available (see page 120)	0.3	0.3	0.3
Compliance	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Version	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Part number	7Z07934	7Z07935	7Z07905

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) Depending on room airflow and temperature variations.

Note: (c) For position within inner 30% of aperture. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

Note: (d) Assumes laser beam with circular Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams ≥1.8 mm not deviating from center by more than 15% of beam diameter.

Note: (f) For P type and shorter wavelengths derate maximum energy density as follows:

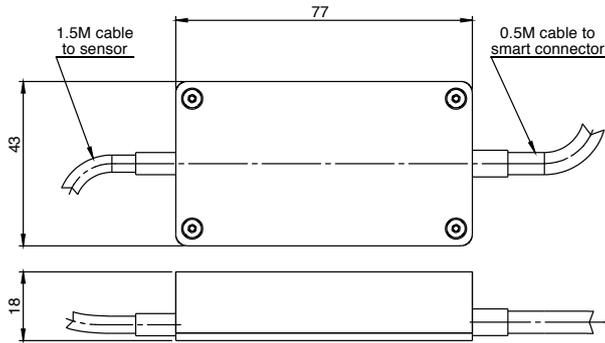
Wavelength	Derate to value not derated
1064nm	not derated
532nm	not derated
355nm	40% of stated value
266nm	10% of stated value
193nm	10% of stated value

Note: (g) The 3A-QUAD has a relatively large spectral variation in absorption and has a calibrated spectral curve at all wavelengths in its spectral range to the above specified accuracy. Nova and LaserStar meters do not support this feature and when used with those meters, the accuracy will be ±3% as above for 532nm, 905nm, 1064nm and 10.6μm but there will be an additional error of up to 3% at other wavelengths in the spectral range 190 – 3000nm.

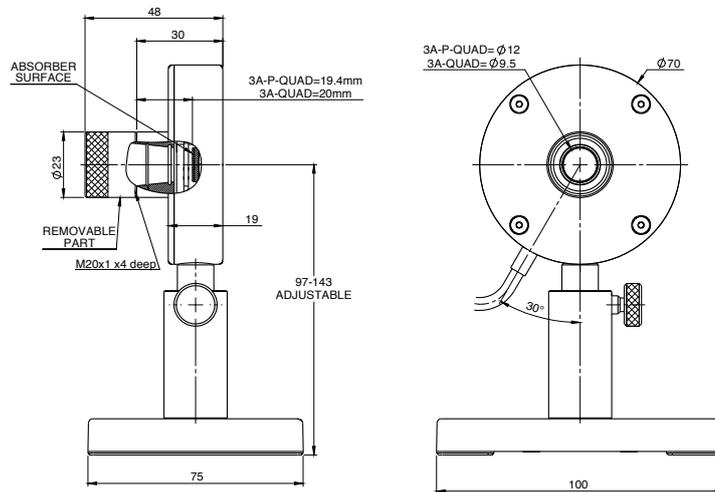
Note: (h) ±4%. For wavelengths <240nm

* For drawings please see page 115

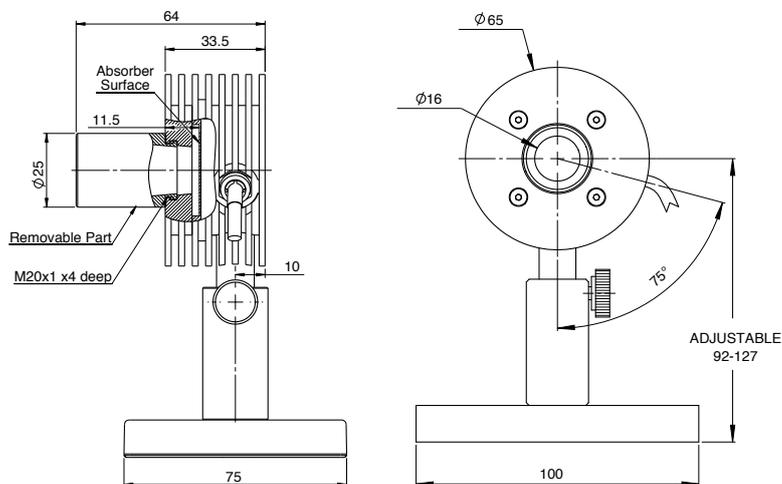
Interface Module on cable



3A-QUAD / 3A-P-QUAD



10A-BB-16-PPS



1.1.3.5 Medium Power BeamTrack-Power / Position / Size Sensors

40mW to 150W

Features

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

50(150)A-BB-26-QUAD /
50(150)A-BB-26-PPS



F150A-BB-26-PPS



Model	50(150)A-BB-26-QUAD ^(a)	50(150)A-BB-26-PPS ^(a)	F150A-BB-26-PPS ^(a)
Use	General purpose	General purpose	General purpose
Functions	Power / Energy / Position	Power / Energy / Position / Size	Power / Energy / Position / Size
Absorber Type	Broadband	Broadband	Broadband
Spectral Range μm	0.19 - 11	0.19 - 11	0.19 - 11
Aperture mm	$\varnothing 26\text{mm}$	$\varnothing 26\text{mm}$	$\varnothing 26\text{mm}$
Power Mode			
Power Range	40mW - 150W	40mW - 150W	50mW - 150W ^(b)
Maximum Intermittent Power	150W for 1.5min, 100W for 2.2min, 50W continuous	150W for 1.5min, 100W for 2.2min, 50W continuous	N.A.
Power Scales	150W / 50W / 5W	150W / 50W / 5W	150W / 30W / 3W
Power Noise Level	2mW	2mW	8mW ^(b)
Maximum Average Power Density kW/cm ²	12 at 150W, 17 at 50W	12 at 150W, 17 at 50W	12 at 150W, 17 at 50W
Response Time with Meter (0-95%) typ. s	1.5	1.5	1.5
Calibration Uncertainty $\pm\%$	1.9	1.9	1.9
Power Accuracy $\pm\%$	3 ^(f)	3 ^(f)	3 ^(f)
Linearity with Power $\pm\%$	1.5	1.5	1
Energy Mode			
Energy Range	20mJ - 100J	20mJ - 100J	20mJ - 100J
Energy Scales	100J / 30J / 3J / 300mJ	100J / 30J / 3J / 300mJ	100J / 30J / 3J / 300mJ
Minimum Energy mJ	20	20	20 ^(b)
Maximum Energy Density J/cm ²			
<100ns	0.3	0.3	0.3
0.5ms	5	5	5
2ms	10	10	10
10ms	30	30	30
Beam Tracking Mode			
Position			
Beam Position Accuracy mm ^(c)	0.1 + 5% of distance from center	0.1 + 5% of distance from center	0.1 + 5% of distance from center
Beam Position Resolution mm	0.1	0.1	0.1
Min Power for Position Measurement	1W	1W	1W
Size ^(c)			
Size Accuracy mm ^(e)	N.A.	$\pm 5\%$ for centered beam	$\pm 5\%$ for centered beam
Size Range mm (4σ beam diameter)	N.A.	$\varnothing 3 - 20$	$\varnothing 3 - 20$
Min Power Density for Size Measurement	N.A.	1 W/cm ²	1 W/cm ²
Cooling	Convection	Convection	Fan
Fiber Adapter Available (see page 120)	ST, FC, SMA, SC	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight Kg	0.4	0.4	0.45
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V1	V1	V1
Part number	7Z07938	7Z07907	7Z07906

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) For powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Note: (c) Position accuracy for the central 10mm of the aperture as limited by beam position resolution. Position can be tracked with $\pm 1\text{mm}$ accuracy over the entire aperture.

Accuracy is reduced by a factor of 3 at minimum power. Position measuring center corresponds to geometrical center within $<1\text{mm}$. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

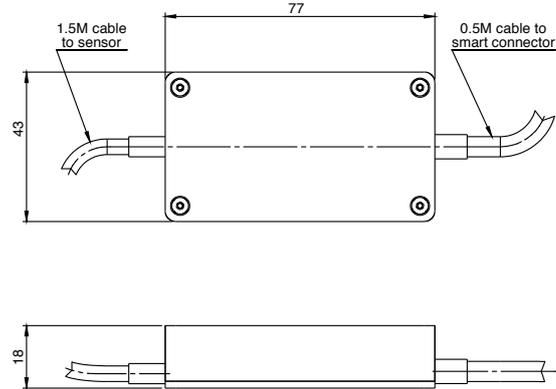
Note: (d) Assumes laser beam with Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams from 3.5 to 17mm not deviating from center more than 15% of beam diameter. For beams below 8mm in size and powers above 75W error in size can reach $\pm 10\%$.

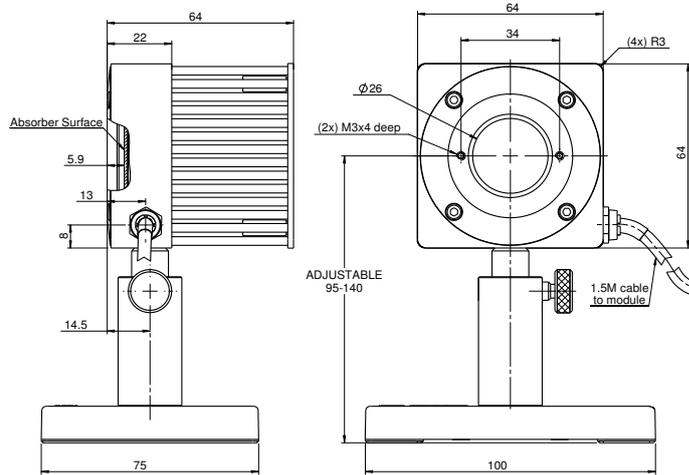
Note: (f) $\pm 4\%$. For wavelengths $< 240\text{nm}$

* For drawings please see page 117

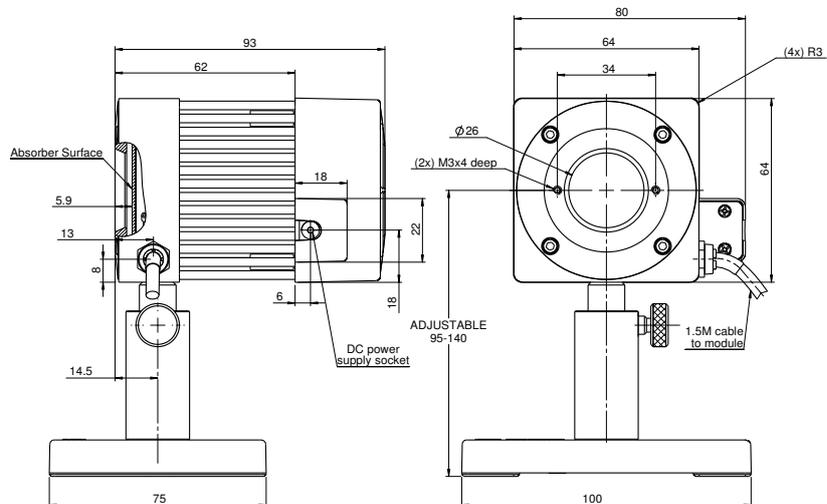
Interface Module on cable



50(150)A-BB-26-QUAD / 50(150)A-BB-26-PPS



F150A-BB-26-PPS



1.1.3.6 Medium - High Power BeamTrack-Power / Position / Size Sensors

150mW to 1000W

Features

- All the features of standard power sensors plus...
- Accurate tracking of beam position to fractions of a mm
- Monitoring of the laser beam size

FL250A-BB-50-PPS



1000W-BB-34-QUAD



Model	FL250A-BB-50-PPS ^(a)	1000W-BB-34-QUAD ^(a)
Use	General purpose	General purpose
Functions	Power / Energy / Position / Size	Power / Energy / Position
Absorber Type	Broadband	Broadband
Spectral Range μm	0.19 - 20	0.19 - 20
Aperture mm	\varnothing 50mm	\varnothing 34mm
Power Mode		
Power Range	150mW - 250W ^(b)	5W - 1000W
Power Scales	250W / 30W	1000W / 200W
Power Noise Level	15mW	200mW
Maximum Average Power Density kW/cm ²	10 at 250W, 12 at 150W	10 at 500W, 7 at 1000W
Response Time with Meter (0-95%) typ. s	2.8	2.5
Calibration Uncertainty $\pm\%$	1.9	1.9
Power Accuracy $\pm\%$	3	3 ^(f)
Linearity with Power $\pm\%$	1.5	2
Energy Mode		
Energy Range	80mJ - 300J	500mJ - 300J
Energy Scales	300J / 30J / 3J	300J / 30J
Minimum Energy mJ	80	500mJ
Maximum Energy Density J/cm ²		
<100ns	0.3	0.3
1 μ s	0.4	0.4
0.5ms	5	5
2ms	10	10
10ms	30	30
Beam Tracking Mode		
Position		
Beam Position Accuracy	0.3mm + 7% of distance from center ^(c)	0.6mm + 6% of distance from center ^(h)
Beam Position Resolution mm	0.1	0.1
Min Power for Position Measurement	2W	10W
Size ^(d)		
Size Accuracy mm ^(e)	\pm 5% for centered beam	NA
Size Range mm (4 σ beam diameter)	\varnothing 5-35	NA
Min Power Density for Size Measurement	3W/cm ²	NA
Cooling	Fan	Water
Minimum and Recommended Water Flow Rate at Full Power	NA	3 liter/min 6 liter/min ^(g)
Fiber Adapter Available (see page 120)	ST, FC, SMA, SC	Consult Ophir representative
Accessories for High Power Sensors	NA	See pages 99-102
Weight kg	0.9	0.9
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version		
Part number	7Z07902	7Z07936

Note: (a) The BeamTrack features are supported by Centauri, StarBright, StarLite, Nova II and Vega meters, Juno, Juno+, Juno-RS and EA-1 interfaces and StarLab application. Position and Size measurements work only in Power mode (but not in single shot Energy mode).

Note: (b) For powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Note: (c) Position accuracy for the central 20mm of the aperture as limited by beam position resolution. Position can be tracked with \pm 1mm accuracy over central 32mm of the aperture. Accuracy is reduced by a factor of 3 at minimum power. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

Note: (d) Assumes laser beam with Gaussian (TEM₀₀) distribution. For other modes, size measurement is relative.

Note: (e) Accuracy spec will be maintained for beams from 6 to 35mm not deviating from center more than 15% of beam diameter.

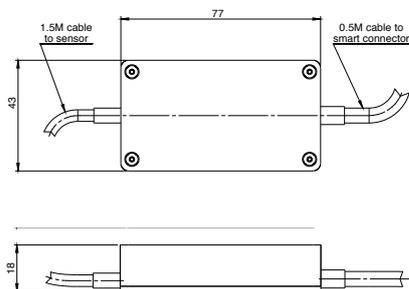
Note: (f) Calibrated for -0.8 μm , 1.064 μm and 10.6 μm

Note: (g) Water temperature range 18-30°C, Water temperature rate of change <1°C/min. Pressure drop across sensor 0.03MPa.

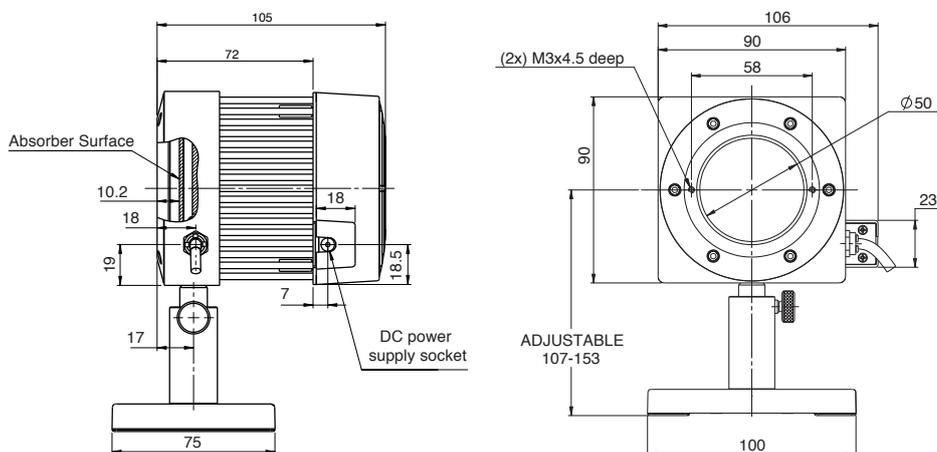
Note: (h) Position accuracy for the central 10 mm of the aperture as limited by beam position resolution. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

* For drawings please see page 119

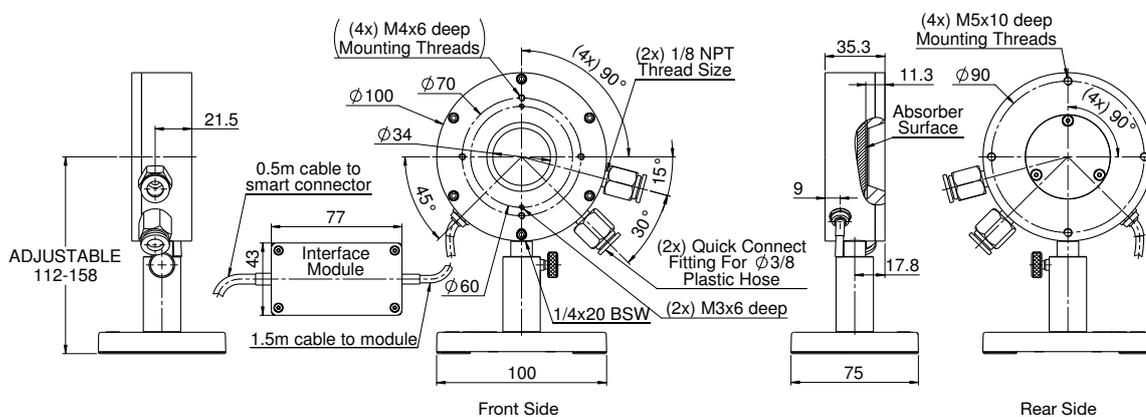
Interface Module on cable



FL250A-BB-50-PPS



1000W-BB-34-QUAD



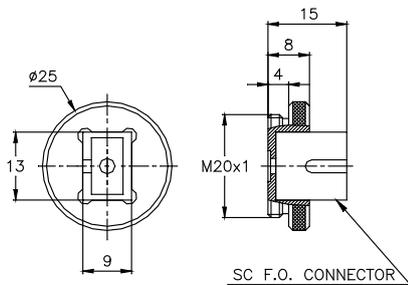
1.1.4 Accessories for Thermal Sensors

1.1.4.1 Fiberoptic Adapters

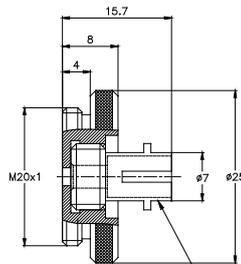
Sensor Series	Fiber adapter mounting bracket (1 bracket fits all fiber adapters)	SC fiber adapter	ST fiber adapter	FC, FC/APC fiber adapter	SMA fiber adapter
Thermal Sensors					
2A-BB-9 / 3A / 3A-QUAD / 3A-P / 3A-P-QUAD / 3A-PF-12 / 3A-FS / 3A-P-THz	not needed				
10A / 10A-BB-16-PPS / 10A-P	not needed				
12A / 12A-P	not needed				
30A-BB-18 / 30A-N-18 / 30(150)A-BB-18 / 30(150)A-LP2-18 / F50A-BB-18	7Z08211				
50(150)A-BB-26 / 50(150)A-BB-26-PPS / 50(150)A-BB-26-QUAD / F150A-BB-26 / F150A-BB-26-PPS	7Z08210	7Z08227	7Z08226	7Z08229	1G01236A
L50(150)A-BB-35 / L50(150)A-LP2-35 / L50(150)A-PF-35 / FL250A-BB-35 / FL250A-LP2-35	7Z08265				
30A-P-17 / 30(150)A-SV-17 / 30(150)A-HE-17	7Z08230				
L40(250)A-BB-50 / L40(250)A-LP2-50 / L50(250)A-BB-50	7Z08238 ^(a)				
FL250A-BB-50 / FL250A-BB-50-PPS / FL400A-BB-50 / FL400A-LP2-50	7Z08212				
L100(500)A-PF-120 / FL600A-BB-65 / FL600A-LP2-65 / 1000WP-BB-34 / 1000W-BB-34 / 1000W-BB-34-QUAD / 1000W-LP2-34 / FL1100A-BB-65 / FL1100A-LP2-65 / L1500W-BB-50 / L1500W-LP2-50 / L2000W-BB-120 / L2000W-PF-120 / 5000W-BB-50 / 5000W-LP2-50 / 5000WP-LP2-50	Threaded holes exist	Consult Ophir representative			

Note: (a) The fiber mounting bracket for these sensors is a triple adapter for mounting up to three different fibers looking at same spot

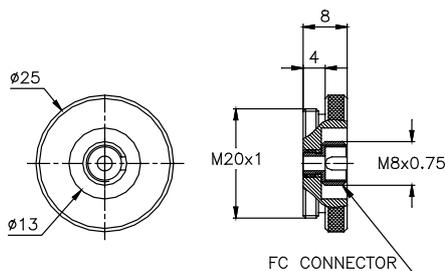
SC fiber adapter



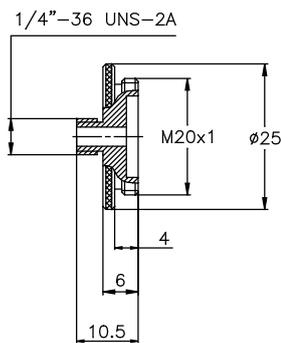
ST fiber adapter



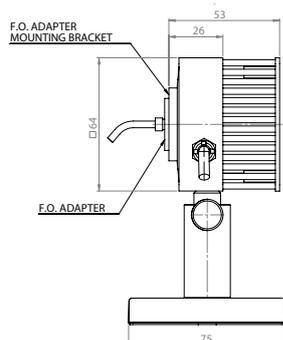
FC fiber adapter



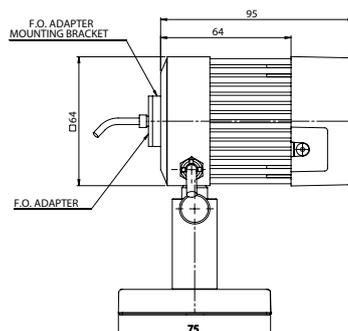
SMA fiber adapter



30A with F.O. input



FL250A with F.O. input



SC fiber adapter



ST fiber adapter



FC fiber adapter



SMA fiber adapter



1.1.4.2 Other Accessories

Accessories for High Power Sensors	Description	P/N	Ref
High Power QBH-Fiber Adapters for L1500W-LP2-50, L1500W-BB-50, 5000W-LP2-50 and 5000W-BB-50 Sensors	QBH-Fiber Adapters for mounting fibers with QBH termination to Ophir power sensors	7Z08348 (QBH-L-Fiber Adapter model) 7Z08349 (QBH-S-Fiber Adapter model)	See page 99
Protective Housing for 5000W, 10K-W and 15K-W Sensors	Protective Housing with shutter to protect from debris	7Z08344 (for 5000W / 10K-W / 15K-W)	See page 100
Scatter Shield for 10K-W, 15K-W, 20K-W and 30K-W Sensors	Scatter Shield to reduce backscattered power (including protective cover)	7Z08295 (for 10K-W / 15K-W) 7Z08355 (for 20K-W) ^(a) 7Z08293 (for 30K-W)	See page 101
Protective Covers for Scatter Shields with Target Pattern for 10K-W, 15K-W and 30K-W sensors	Protective Covers for Ophir scatter shields. The cover has a target pattern for directing the beam using a pointer	7Z08345 (for 10K-W / 15K-W) 7Z08346 (for 30K-W)	See page 102
Protective Covers with Target Pattern for 1000W, L1500W, 5000W, 10K-W, 15K-W, 20K-W and 30K-W Sensors	Black anodized aluminum cover with a target pattern for directing the beam using a pointer	1G01332 (all except 20K-W & 30K-W) 1G02813 (for 20K-W) ^(a) 1G02406 (for 30K-W)	See page 102
Metric Water Connectors for Water Cooled Sensors	Metric Water Connectors are quick connect fittings for 3/8" and 1/2" plastic tubing (set of 2 ea.)	7Z08353 (all except 20K-W & 30K-W) 7Z08352 (for 20K-W & 30K-W)	See page 102
Heavy Duty Stand for 10K-W and 15K-W	For continuous use in vertical position, heavy duty stand is recommended	7Z08330	See page 101
30K-W Rubber Feet Assembly	The rubber feet make it possible to lean the sensor on its rear side for better stability when used with a vertical beam. The kit has 4 feet which can be screwed into the existing threads	7Z08217	See page 101
General Accessories			
SH to BNC Adapter	Allows connection of sensor to current or voltage measuring device for measurement of raw sensor output. Current meter should be used for photodiode sensors. Current or voltage meter can be used for thermal sensors	7Z11010	
Replacement Parts			
N Polarity Power Supply/Charger 12V 2A N-2.1x5.5	Application	P/N	
	For: Centauri, Vega, Nova II, Nova, EA-1, Pulsar, Quasar, LaserStar, 6K-W, 120K-W, 150K-W, Fan Cooled Sensors	7E05029	
P Polarity Power Supply/Charger 12V 2A P-1.35x3.5	For: StarLite, StarBright, RM9 Chopper	7E05047	
Push-Pull 2 Pin Power Supply 12V 2A	For: IS1.5-VIS-FPD-800, IS1.5-IRG-FPD-800	7E05047A	
Note: (a) The scatter shield and protective cover are compatible also with the 16K-W-BB-55 sensor P/N 7Z07131			

Protective Housing



7Z08352 1/4" - 12mm

30K-W Scatter Shield



7Z08353 1/8" - 10mm

Protective Cover on Scatter Shield



QBH-Fiber Adapter



10K-W with 34-50mm Aperture Protective Cover



Heavy Duty Stand for 10K-W and 15K-W (Shown with a 15K-W Sensor)



SH to BNC Adapter



N Polarity Power Supply/Charger P Polarity Power Supply/Charger Push-Pull 2 Pin Power Supply

