2024 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 ±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 (<1µs) 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 0.1µm) 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 50µm-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 – 1µm 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 28kW/cm^2 for low power continuous lasers.

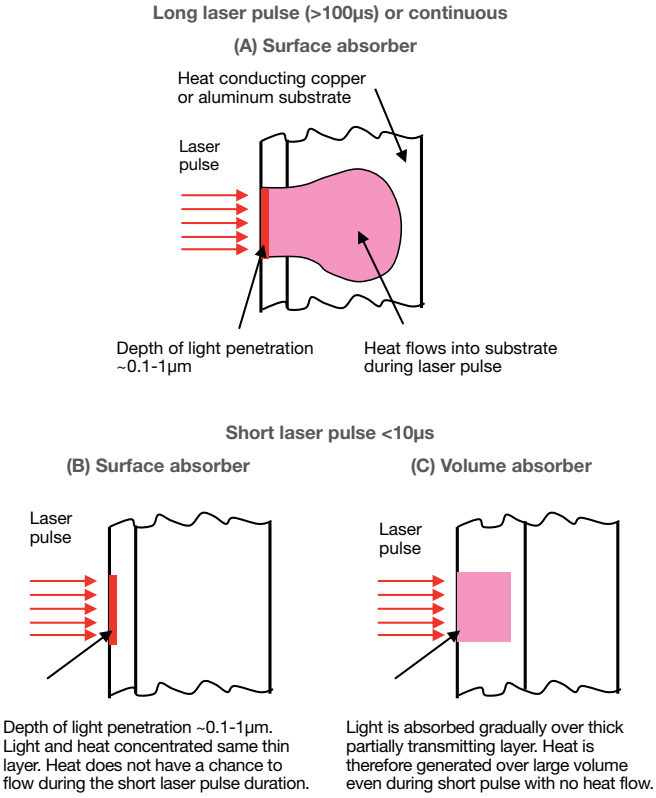
Surface Absorbers for High Power Lasers and Long Pulses

The traditional surface absorbers have a much lower damage threshold at > 1000W, where they can damage at 2-3 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 10kW/cm^2 and 300J/cm^2 for 10ms pulses. Surface absorbers are suitable for pulses longer than ~100µs.

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

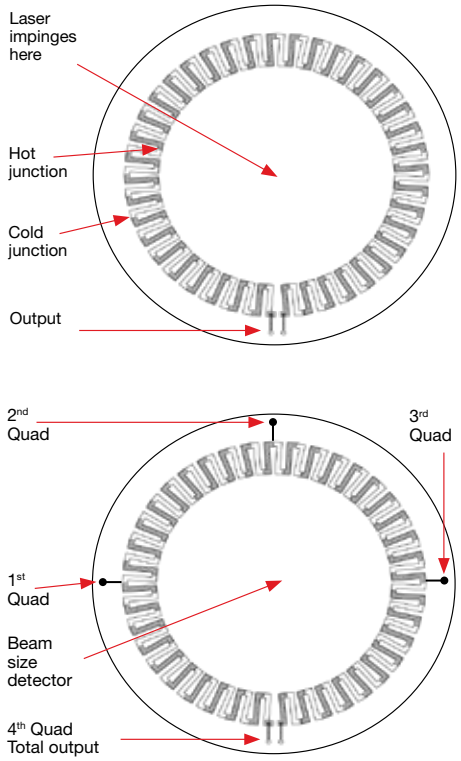
absorber which absorbs the energy in a thin surface layer is not suitable. All the energy is deposited in a thin layer and that layer is vaporized. In this case, volume absorbers are used. These have traditionally consisted of a neutral density glass thermally bonded to a heat-conducting metallic substrate. 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/cm^2 (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.



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 user the water frow 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 senor 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 as very 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, 16K-W, Comet 10K, 30K-W, and 120K-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 ±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 10µV/W (a typical value) and there is a zero offset of only 1µV, 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 ±2% (expressing the accuracy of the senor 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:

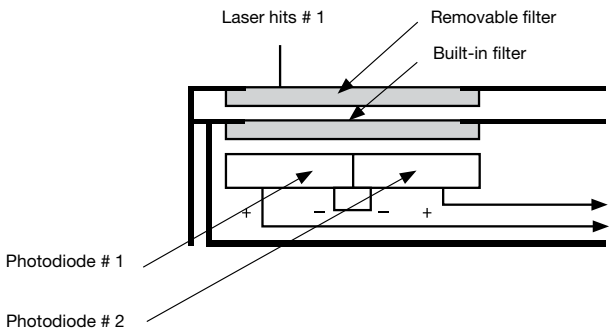
	UV & VIS Photodiode Sensors	IR Photodiode Sensors	Radiometric Sensors (PD300RM)
Calibration Uncertainty	200 to 300nm 3.2% 300 to 430nm 1.65% 430 to 1000nm 1.1% 1035 to 1065nm 4.3%	700 to 1430nm 2.4% 1430 to 1600nm 2.6%	250 to 300nm 4.5% 300 to 400nm 3.6% 400 to 1000nm 3.4%

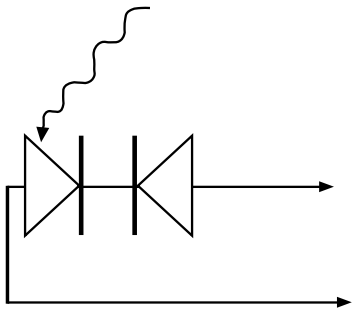
Photodiode detectors are linear by nature, and as long as they are not operated close to saturation, measurement errors due to non-linearity can be ignored.

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

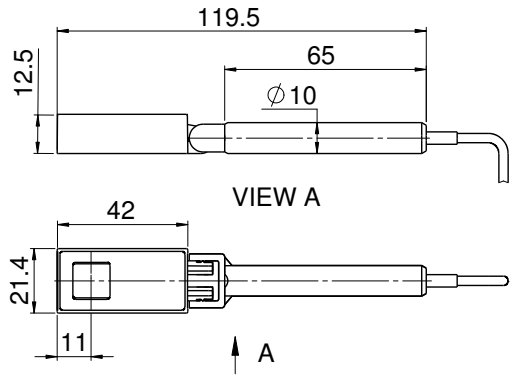
PD300-TP mounted on stand

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 nm	±1.1% 430-1000 [b]			±1.1% 430-1000 [b]			±1.1% 430-1000 [b]			±1.1% 430-1000 [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/cm²	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%	±2%		
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

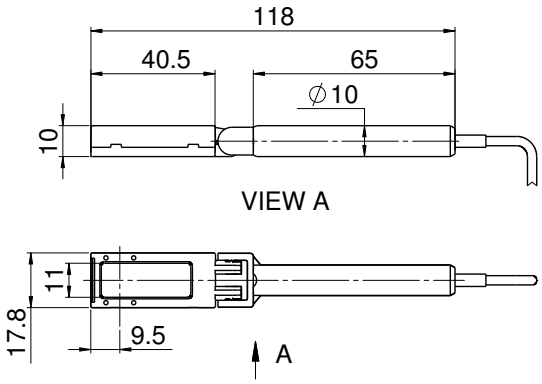
* For graphs see page 31-32
* For drawings please see page 26

PD300 / PD300-1W filter installed



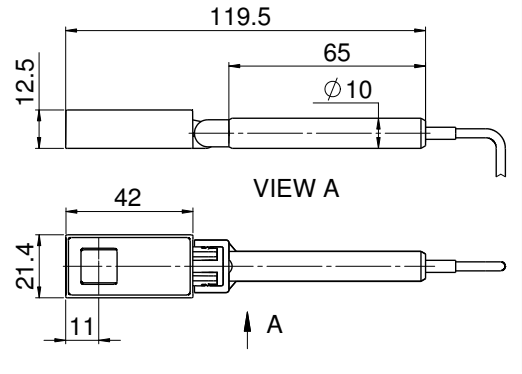
Front View

PD300 / PD300-1W filter off



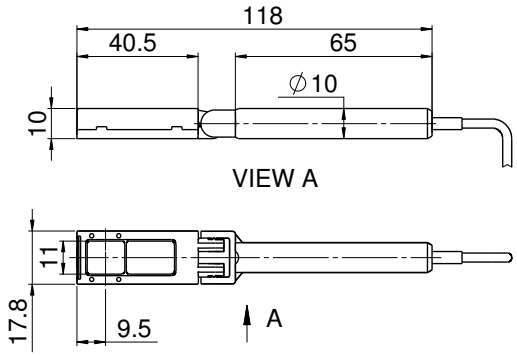
Front View

PD300-3W filter installed



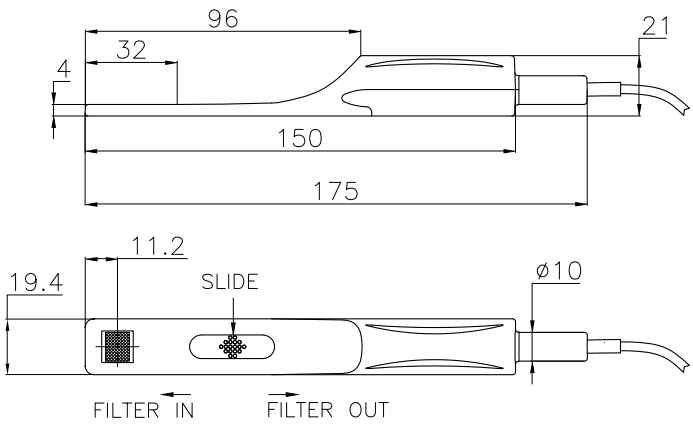
Front View

PD300-3W filter off



Front View

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

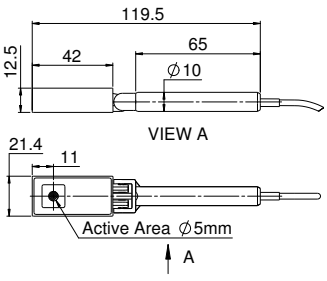
PD300-IRG with fiber input

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 nm	±1.1% 430-1000 [c]			±2.4% 700-1430 [c]			±2.4% 900-1430 [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
				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/cm²	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**		

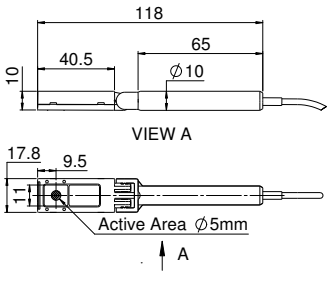
Notes: (a) Assuming temperature range between 18-26 degrees – outside of this range add additional error per temperature dependence graph
(b) Same as above with additional calibration point at 193nm accuracy ±6%
(c) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For graphs see page 31-32

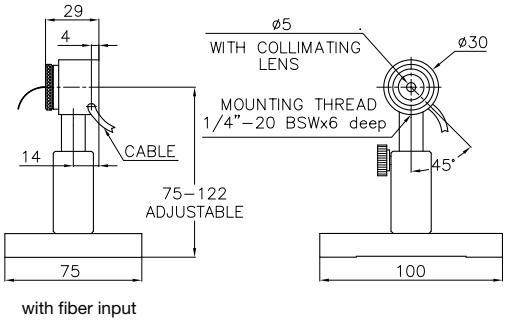
PD300-UV / PD300-IR filter installed
(Ø5mm for PD300-IR only)



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



PD300-IRG



with fiber input

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

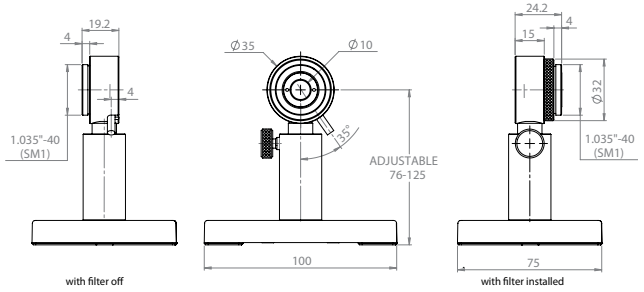
PD300R Filter installed

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 nm	±1.1% 430-1000 [a]			±1.1% 430-1000 [a]			±1.1% 430-1000 [a]			±2.4% 700-1430 [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		NA	0.1		NA	0.001		100	0.01		NA
Maximum Power vs. Wavelength	nm	mW	mW	nm	mW	mW	nm	mW	mW	nm	mW	mW
	<488	30	300	<488	100	3000	250 - 350	3	300	800	12	120
	633	20	300	633	100	3000	400	3	300	1000-1300	30	300
	670	13	200	670	100	2000	600	3	300	1400	30	250
	790	10	100	790	100	1200	800 - 950	2.5	150	1500	30	100
	904	10	100	904	100	1200	1064	3	300	1600	30	100
	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		±5 900-1700
	±5 980-1100		±7 980-1100	±4 950-1030		±6 950-1030	±3 300-420		±3 420-980	±7 1700-1800		±9 1700-1800
				±6 1030-1100		±7 1030-1100	±2 420-980		±7 980-1100			
							±7 980-1100					
Damage Threshold W/cm²	10		50	10		30	10		50	10		50
Max Pulse Energy µJ	3		30	30		400	1		50	0.75		2
Noise Level for filter out pW	20			200			±1			200		
Response Time with Meter s	0.2			0.2			0.2			0.2		
Beam Position Dependence	±2%			±2%		±3%	±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**		
Sensor with different cable length							**7Z02438C (10m cable)**					

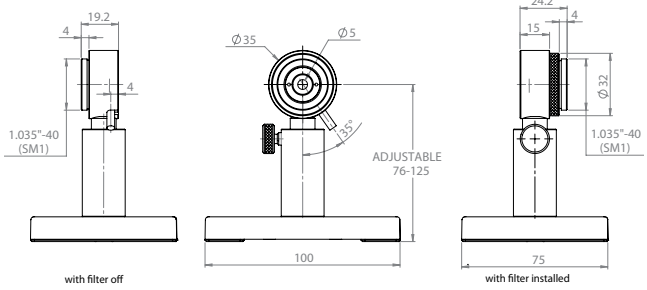
Note: (a) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For graphs see page 31-32

PD300R / PD300R-3W / PD300R-UV



PD300R-IR



1.1.1.3 Special Photodiode Sensors

3µW to 1W

Features

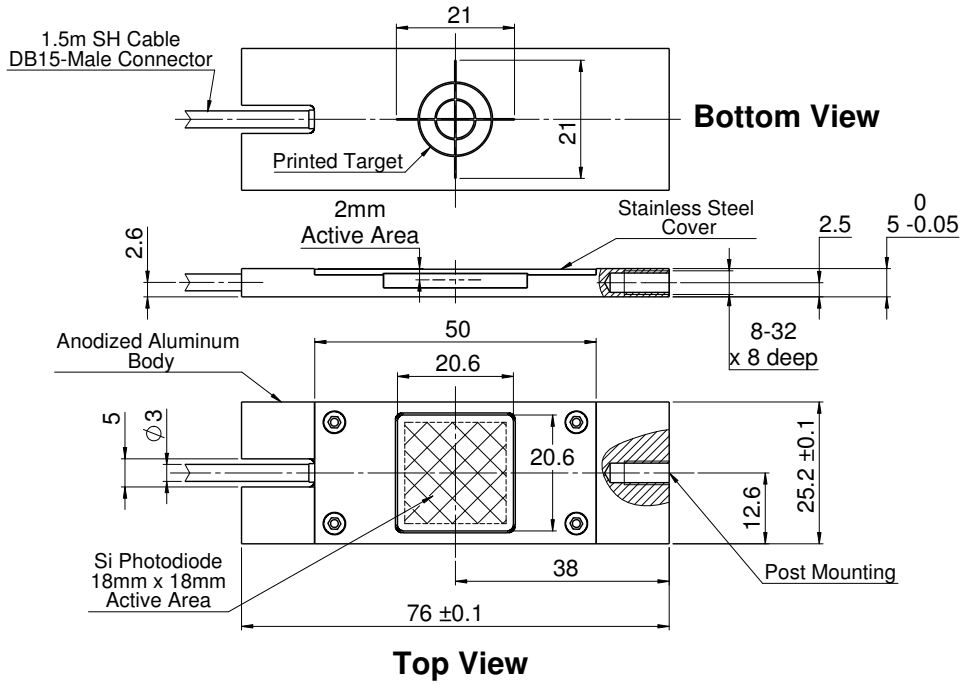
- PD300-MS for measurement of optical intensity after the microscope objective.
- Low angular dependence for high N.A. objectives.
- Can be used with air, water or oil immersion objectives.

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 nm	±1.1% 430-1000 [b]	
Maximum Power vs. Wavelength	Wavelength, nm	Power Range
	350 - 650	6µW to 1W
	650 - 800	3µW to 800mW
	800 - 1000	3µW to 600mW
	>1000	6µW to 700mW
Accuracy (including errors due to temp. variations)		
% error vs Wavelength nm [a]	±7 350 - 400	
	±5 400 - 1100	
Linearity	1%	
Additional Error with Converging Beam	3% for N.A. 0.9	
Damage Threshold W/cm²	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

PD300-BB / PD300-BB-50mW

PD300-CIE

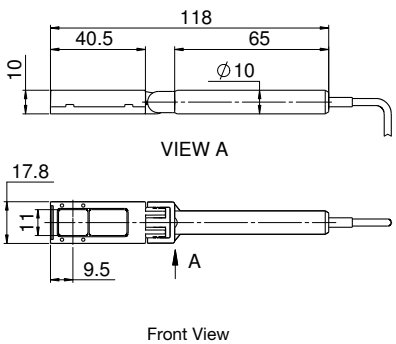
BC20

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 nm	±1.1% 430-1000 [d]	±1.1% 430-1000 [d]		NA	NA
Filter Mode		Filter out	Filter in		
Power Range	50pW to 4mW	50pW to 4mW	1nW to 50mW	20mLux to 200kLux	0.1mW to 20mW
Power Scales	4mW to 8nW and dBm	4mW to 8nW and dBm	50mW to 80nW and dBm	200kLux to 200mLux	20mW to 2mW
Resolution	1pW	1pW	10pW	1mLux	1µW
Accuracy	Maximum deviation from flat spectrum (see graph)	Maximum deviation from flat spectrum (see graph)		(see graph)	±3% for >10% of full scale. Deviation from calibration -3% at 30,000 inch/s scan rate on sensor
	±10%	±10%	430-910nm, ±12% flatness		
Damage Threshold W/cm²	10	10	100	10	50
Max Pulse Energy µJ	1	1	10	1	NA
Noise Level pW	2	2	30	±1mLux	5µW
Response Time with Meter s	0.2	0.2	0.2	0.2	Two modes of operation: Hold: holds highest reading for 5s then updates. No Hold: updates reading 3 times per second
Beam Position Dependence	±2% for broadband light sources	±2% for broadband light sources	±3% for broadband light sources	NA – source overfills detector	±2%
Background Subtraction	NA	NA	NA	NA	Background is automatically subtracted from both scanned and static beams
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]

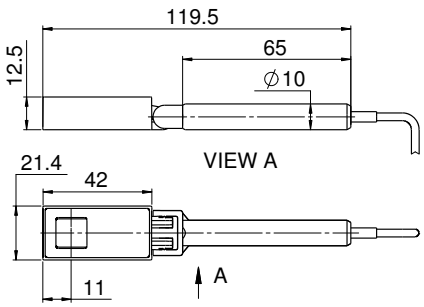
Notes:
(a) The PD300-CIE sensor is not under ISO/IEC 17025:2017 accreditation
(b) Swivel stand for BC20 sensor P/N 1Z09004
(c) The user can select up to 5 wavelengths from the spectral range. When used with the Nova or LaserStar meters, the sensor will only have the discrete wavelengths 405nm, 633nm, 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

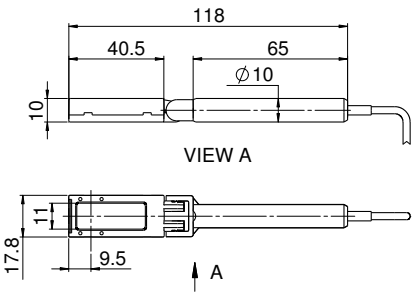
PD300-CIE / PD300-BB / PD300-BB-50mW with filter off



PD300-BB-50mW with filter installed

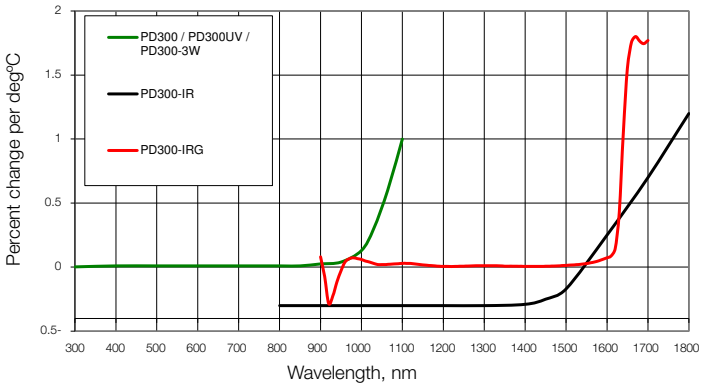


BC20

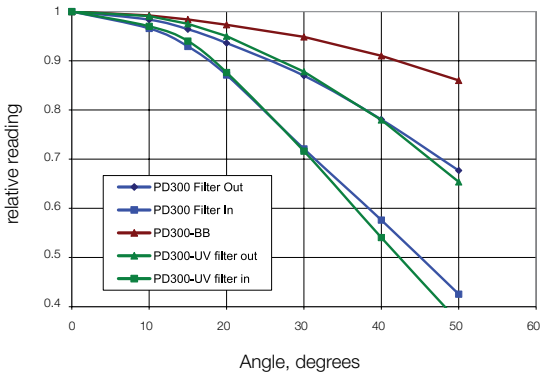


1.1.1.4 Graphs

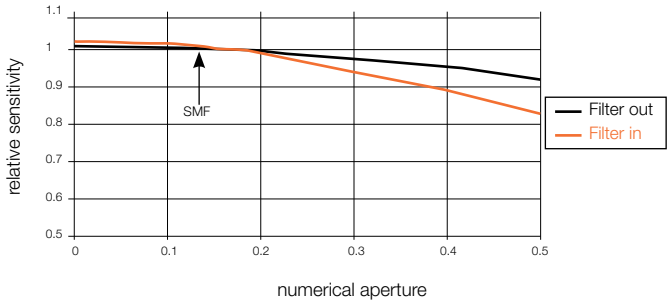
Temperature Coefficient of Sensitivity



PD300 Angle Dependence

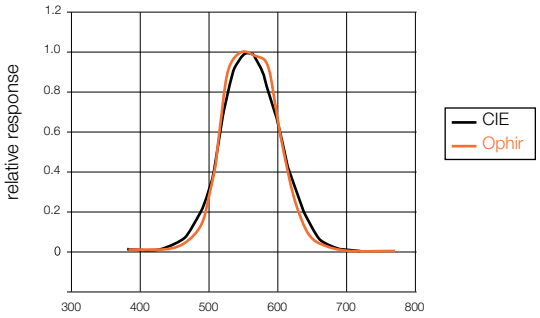


Dependence of Sensitivity on Numerical Aperture (PD300 - IRG)

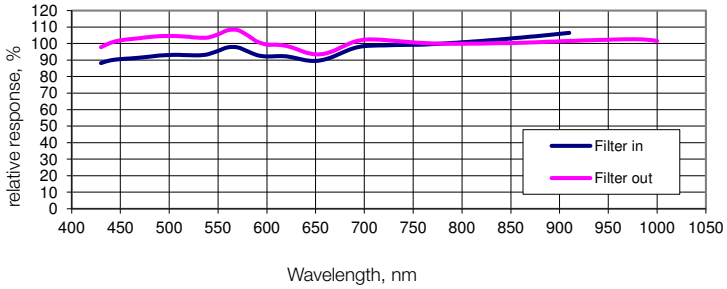


Note:
1. Graph assumes equal intensity into all angles up to maximum N.A.
2. Calibration is done with SMF, N.A. 0.13

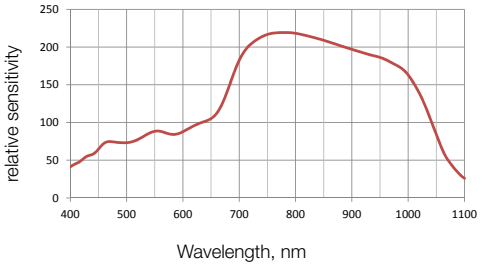
PD300-CIE Spectral Response vs. CIE Curve



Typical Sensitivity Curve of PD300-BB Sensors



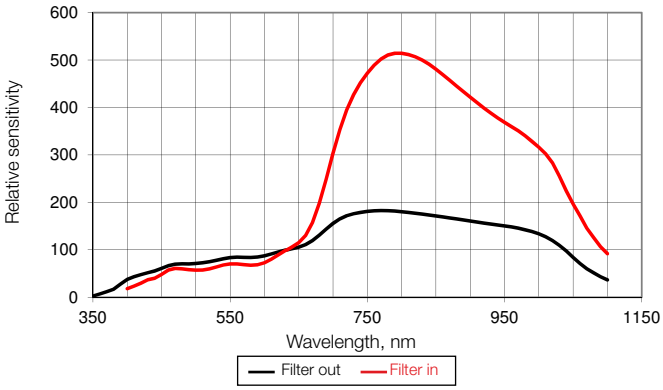
BC20 Relative Spectral Response



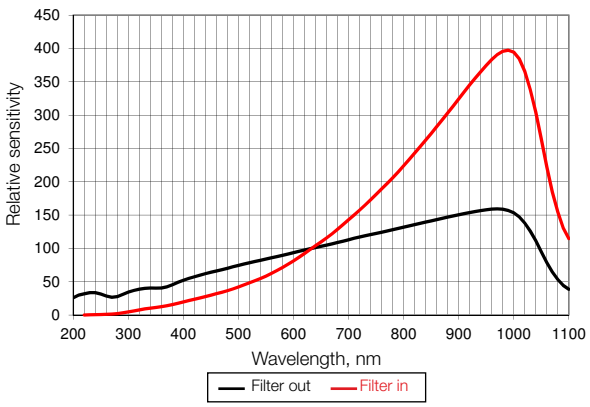
Approximate Spectral Response

Relative to 633nm or 1550nm

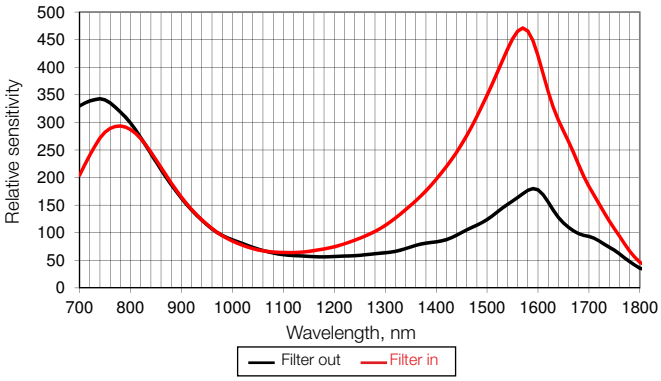
PD300 / PD300R



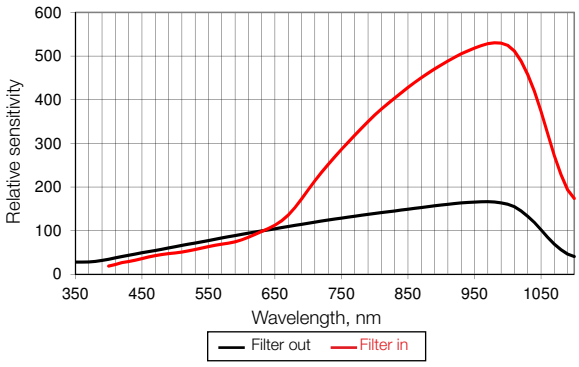
PD300-UV / PD300R-UV



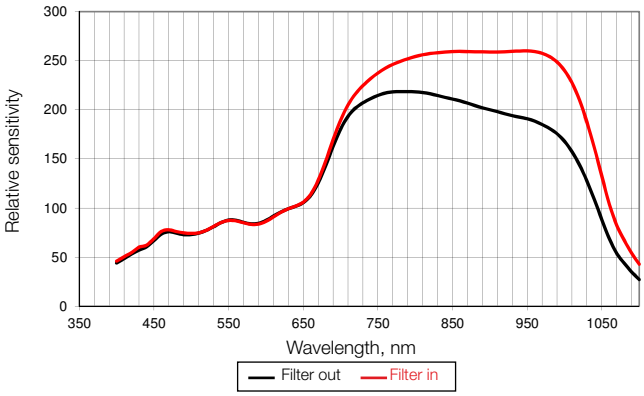
PD300-IR / PD300R-IR



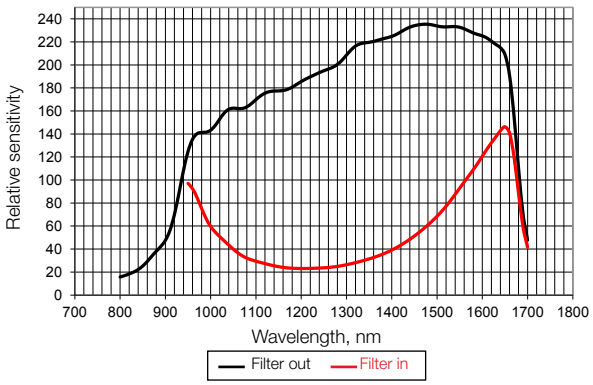
PD300-TP



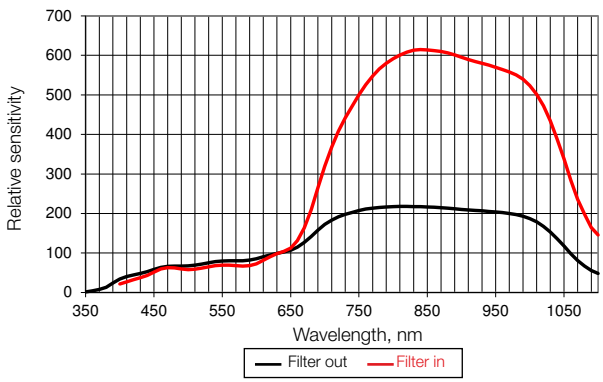
PD300-3W / PD300R-3W



PD300-IRG



PD300-1W



1.1.1.5 Accessories for Photodiode Sensors

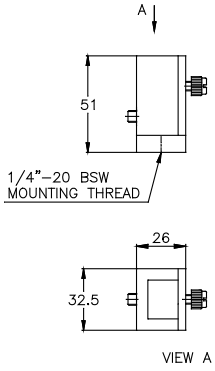
Fiberoptic Adapters and Other Accessories

Accessories and Fiberoptic Adapters for PD300 series

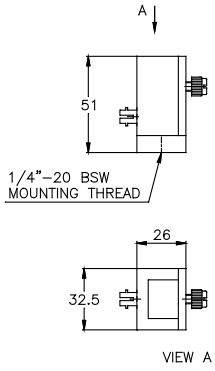
Accessory	Description	Part number			
PD300-CDRH-7mm	Ø7mm aperture adapter for CDRH measurements for PD300	7Z02418			
PD300-CDRH-3.5mm	Ø3.5mm aperture adapter for CDRH measurements for PD300	7Z08336			
Fiber Adapters for Sensor Series	**Adapters for mounting fibers to PD300 sensors as shown below**	**SC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

PD300 with F.O. Adapter Mounted

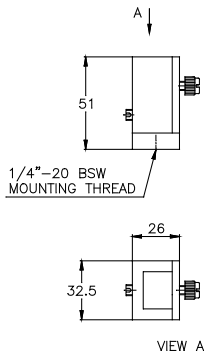
PD300-FO-SMA



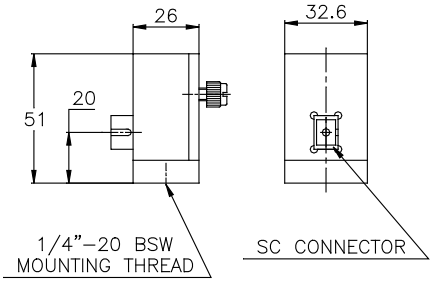
PD300-FO-ST



PD300-FO-FC



PD300-FO-SC



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**
FPD 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 FPD series

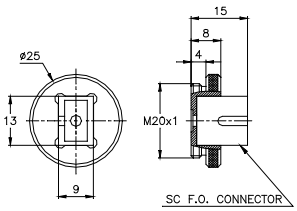
SC fiber adapter

ST fiber adapter

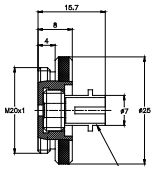
FC fiber adapter

SMA fiber adapter

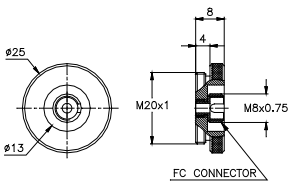
SC fiber adapter



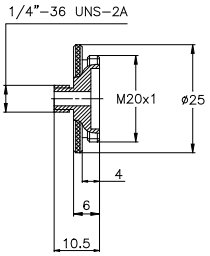
ST fiber adapter



FC fiber adapter



SMA fiber adapter



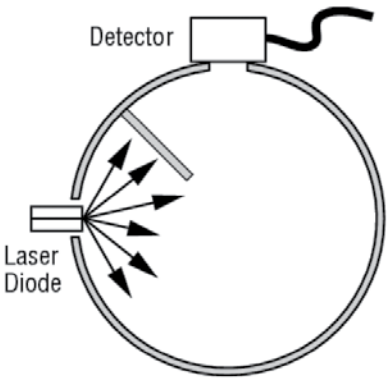
Female SM1 to SM1 Adapter

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.

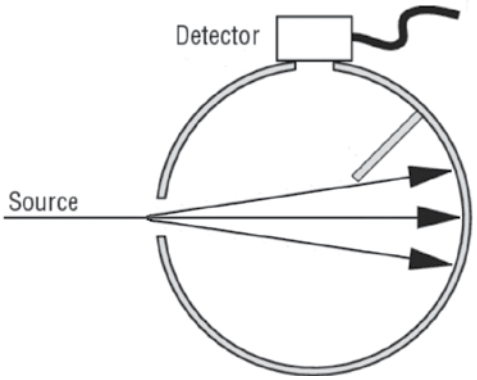
Ophir integrating spheres have a highly reflecting diffuse white coating for high efficiency and readings that are independent of beam size, position and divergence.



This integrating sphere configuration is ideal for a diverging beam

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.



This integrating sphere configuration is ideal for a collimated beam

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.

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

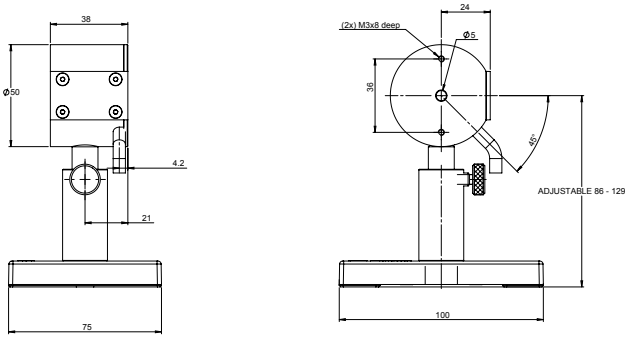
Features

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

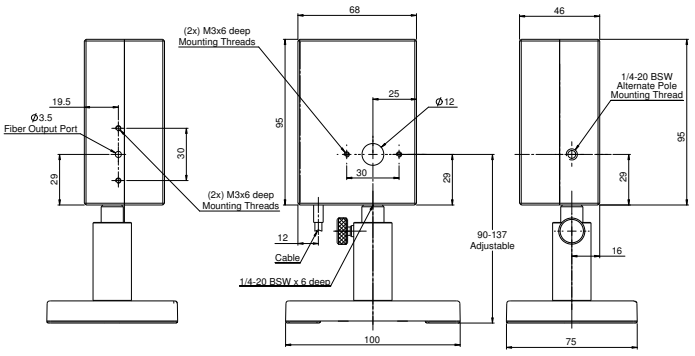
Model	IS-1-2W	3A-IS	3A-IS-IRG
Use	**Divergent beams to 2W for UV to NIR**	**Divergent beams to 3W for visible and NIR**	**Divergent beams to 3W for IR**
Detector Type	Si	Si	InGaAs
Input Port Aperture mm	Ø5mm	Ø12mm	Ø12mm
Spectral Range µm	0.22 - 1.1	0.35 - 1.1	0.8 – 1.7
Power Range	500nW – 2W	1µW – 3W	1µW – 3W
Power Scales	2W to 20µW and dBm	3W to 3µW and dBm	3W to 3µW and dBm
Calibration Uncertainty nm	±1.1% 430-1000 (b)	±1.1% 430-1000 (b)	±2.4% 800-1430 (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/cm²	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

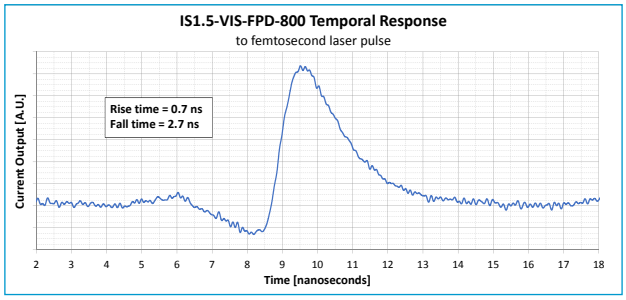
Features

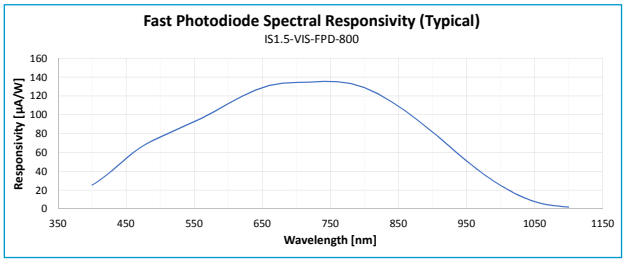
- Fast photodiode for pulse shape characterization of VCSELs
- Built in SMA fiber adapter for connection to a spectrometer
- Large, 20mm input port enabling long working distance
- Accepts beams with divergence angles up to ±60°
- Small integrating sphere with short time constant

IS1.5-VIS-FPD-800

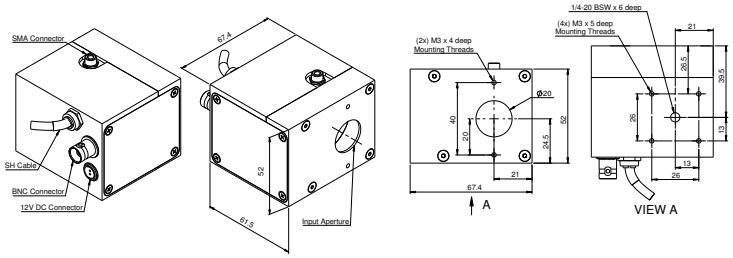
Model	IS1.5-VIS-FPD-800		
Use	**Multi-functional Integrating Sphere**		
Specifications			
Input Port Aperture mm	Ø20	Cooling	Convection
Maximum Beam Divergence Degrees	±60 [a]	Operating Temperature Range °C	+15 to +40
Sensitivity to Beam Size and Angle	±2% [b], [c]	Storage Temperature Range °C	-20 to +60
Damage Threshold on Integrating Sphere Surface W/cm²	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	±3% 430nm – 1000nm, ±4% < 430nm, ±7% >1000nm	Dark Current nA	0.3 typ., 1 max
Linearity with Power ±%	2	Noise Current fA/√Hz	18 typ.
Power Noise Level nW	20 typ.	Output	Analog current
Saturation Pulse Energy mJ	2 typ.		
Calibration Uncertainty nm	±1.1% 430-1000 [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 ±45° 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 < ±40°, the maximum acceptance angle of the sphere is ±50°
(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

1.1.1.6.3 NIR 1.5” High Speed Response, Multi-functional Integrating Sphere

600nW – 3W

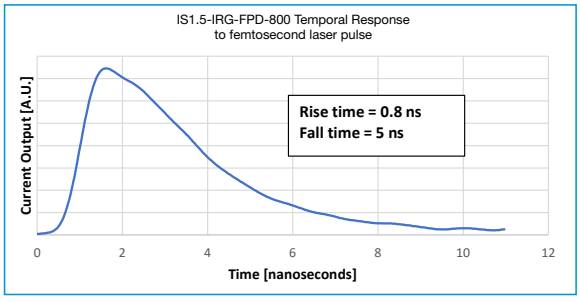
Features

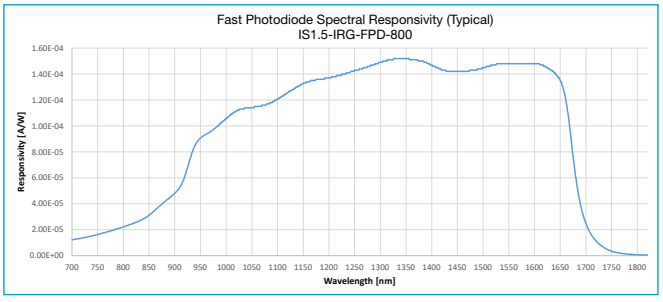
- Fast photodiode for pulse shape characterization of VCSELs
- Built in SMA fiber adapter for connection to a spectrometer
- Large, 20mm input port enabling long working distance
- Accepts beams with divergence angles up to ±60°
- Small integrating sphere with short time constant

IS1.5-IRG-FPD-800

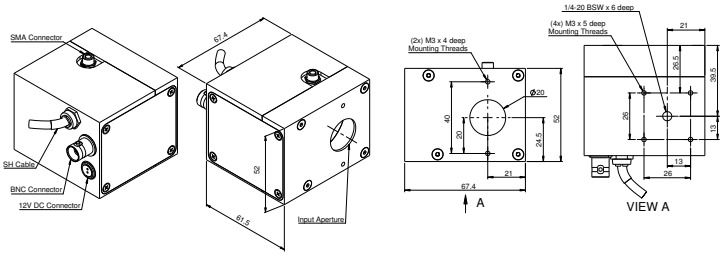
Model	IS1.5-IRG-FPD-800		
Use	**Multi-functional Integrating Sphere**		
Specifications			
Input Port Aperture mm	Ø20	Cooling	Convection
Maximum Beam Divergence Degrees	±60 [a]	Operating Temperature Range °C	+15 to +40
Sensitivity to Beam Size and Angle	±2% [b], [c]	Storage Temperature Range °C	-20 to +60
Damage Threshold on Integrating Sphere Surface W/cm²	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	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	InGaAs photodiode, calibrated	Type	Fast InGaAs photodiode
Function	Average power	Function	Temporal pulse shape detection
Spectral Range µm	0.94 – 1.64	Spectral Range µm	0.94 – 1.64
Power Range	600nW – 3W	Rise Time (10% to 90%) nsec	0.8
Pulse Width	Not limited	Fall Time (90% to 10%) nsec	5
Pulse Repetition Rate [d]	Not limited	Bias Voltage Input V	9
Power Scales	3W to 3µW	Typical CW Responsivity mA/W [e]	0.14 @ 1100 - 1500nm
Power Accuracy	±3% 940nm - 1100nm, ±4% 1100nm - 1640nm	Dark Current nA	1
Linearity with Power ±%	2	Noise Current fA/√Hz	15.5
Power Noise Level nW	30.	Output	Analog current
Saturation Pulse Energy mJ	1.3mJ		
Calibration Uncertainty nm	±2.4% 940-1430 ±2.6% 1430-1600		
Output	Smart Head, D15		
Part number	**7Z02493**		

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 ±45° 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 < ±40°, the maximum acceptance angle of the sphere is ±50°
(d) Below 200Hz use low frequency mode in meter
(e) Responsivity data provided with sensor





IS1.5-IRG-FPD-800



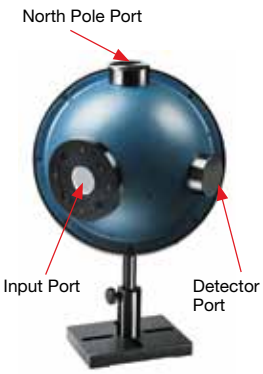
1.1.1.6 Integrating Spheres

1.1.1.6.4 Large Dimensions 5.3”

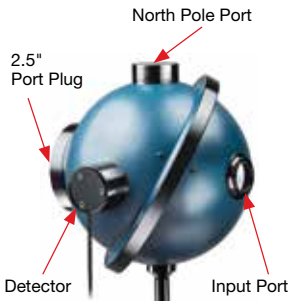
Features

- 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

IS6-D without detector



IS6-C-XXX with detector for collimated beams

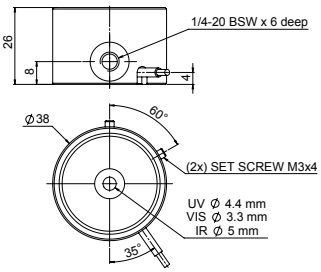


IS6-C-UV-2.5" with detector for large collimated beams

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 ±%	3 [c]		1
Power Range	Depends on detector – see below		
Damage Threshold kW/cm²	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 ±1%.
(d) For central 5mm of aperture, for 10mm aperture maximum beam divergence is ±56°.

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



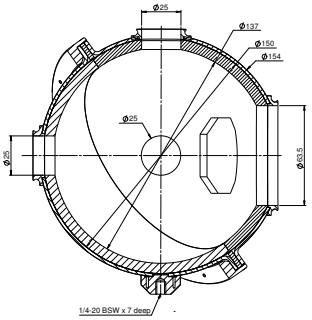
IS6 with Detectors for Collimated Beams - calibrated - VIS, UV & IR types

-Recommended for beam divergence <15°
-Comes with calibrated wavelength curve

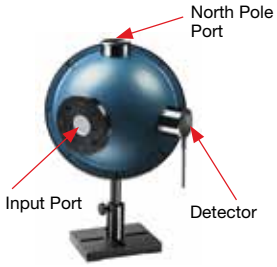
Model	IS6-C-VIS		IS6-C-UV		IS6-C-IR		IS6-C-UV-2.5"	
Detector type	**VIS**		**UV**		**IR**		**UV**	
Use	**High powers**		**Low powers**		**Low powers**		**Large beams**	
Type	Si with filter		Si		Germanium		Si	
Spectral Range µm	0.4 – 1.1		0.2 – 1.1		0.7 – 1.8		0.2 – 1.1	
Power Range (approx.)	20µW to 30W		300nW to 1W		100µW to 30W		300nW to 2W	
Power Scales	30W to 300µW		1W to 3µW		30W to 300µW		2W to 3µW	
Linearity with Power ±%	1						1	
Power Noise Level	1µW		15nW		5µW		15nW	
Calibration Uncertainty nm	±1.1% 430-1000 [b]		±1.1% 430-1000 [b]		±2.4% 700-1430 [b]		±1.1% 430-1000 [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, ±2% over central 50mm
(b) For calibration uncertainty of wavelengths outside of this range see table on page 24

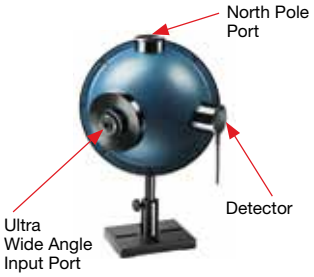
IS6



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 141) 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.

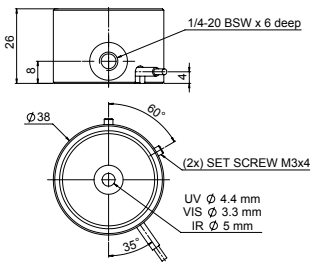
IS6 with Detectors for Divergent Beams– calibrated – VIS, UV & IR types

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

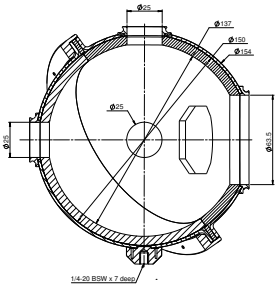
Model	IS6-D-VIS		IS6-D-UV		IS6-D-IR		IS6-D-IR-170	
Detector type	**VIS**		**UV**		**IR**		**IR**	
Use	**High powers for divergent beams**		**Low powers for divergent beams**		**Low powers for divergent beams**		**Low powers for highly divergent beams (up to 170°)**	
Type	Si with filter		Si		Germanium		Germanium	
Spectral Range µm	0.4 – 1.1		0.2 – 1.1		0.7 – 1.8		0.7 – 1.8	
Power Range (approx.)	20µW to 30W		300nW to 1W		100µW to 30W		20µW to 30W	
Power Scales	30W to 300µW		1W to 3µW		30W to 300µW		30W to 300µW	
Linearity with Power ±%	1		1		1		1	
Power Noise Level	1µW		15nW		5µW		1µW	
Calibration Uncertainty nm	±1.1% 430-1000 (c)		±1.1% 430-1000 (c)		±2.4% 700-1430 (c)		±2.4% 700-1430 (c)	
Maximum Pulse Energy mJ	5		0.15		0.3		0.7	
Maximum Beam Divergence deg°	±60 (b)						> ±85	
Input Port Aperture mm	Ø26						Ø8	
Sensitivity to Beam Divergence ±%	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 ±1%
(b) For central 6mm of aperture, for 12mm aperture maximum beam divergence is ±50°
(c) For calibration uncertainty of wavelengths outside of this range see table on page 24

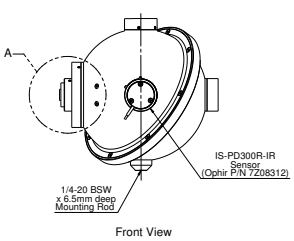
Incorporated Detectors: IS6-D-VIS / IS6-D-UV / IS6-D-IR

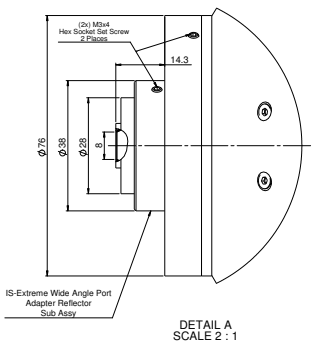


IS6



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	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.

IS-2.5” Port Plug

IS-1” Port Plug

IS-2.5” Port Cover

IS-1” Port Cover

FPD to IS6 Adapter

2.5” to 1” Port Reducer

Aperture Mask

Flange Attachment

1” FC Fiber Adapter

1” to SM1 Adapter

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

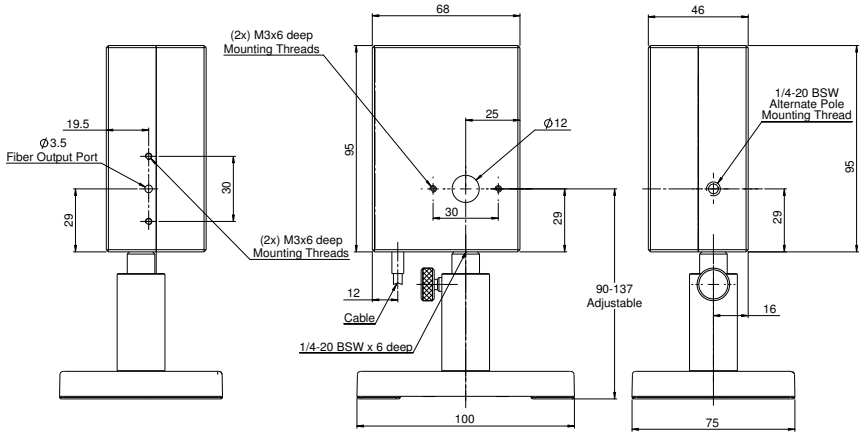
- 20pW to 3W
- 200nm to 1100nm
- Photodiode detectors – spectrally calibrated for LEDs and lasers
- Thermal sensors – power measurement is insensitive to wavelength
- Fiber or free space input
- Compatible with all Ophir meters, acquisition devices and StarLab PC software

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	±10 200-230	±10 220-300	±10 200-230	±10 220-300	±3%
	±10 1000 – 1100	±7 230-300	±4 300-420	±7 230-300	±4 300-420	
		±3 300-420	±3 420-980	±3 300-420	±3 420-980	
		±2 420-980	±7 980-1100	±2 420-980	±7 980-1100	
		±7 980-1100		±7 980-1100		
Damage Threshold W/cm²	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 & 118)	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**

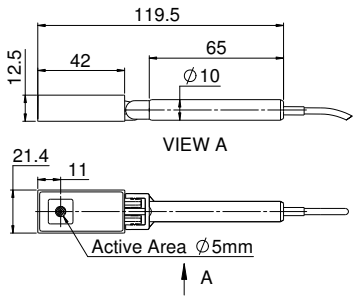
Notes: (a) One fiber output port available with output = 2E-4 of input power/mm² of fiber area.
(b) For calibration uncertainty of wavelengths outside of this range see table on page 24

* For sensors drawings please see page 42

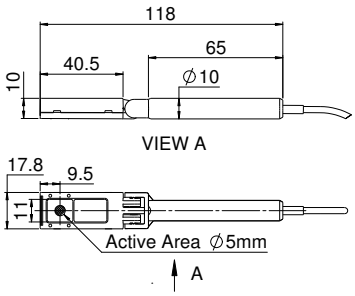
3A-IS



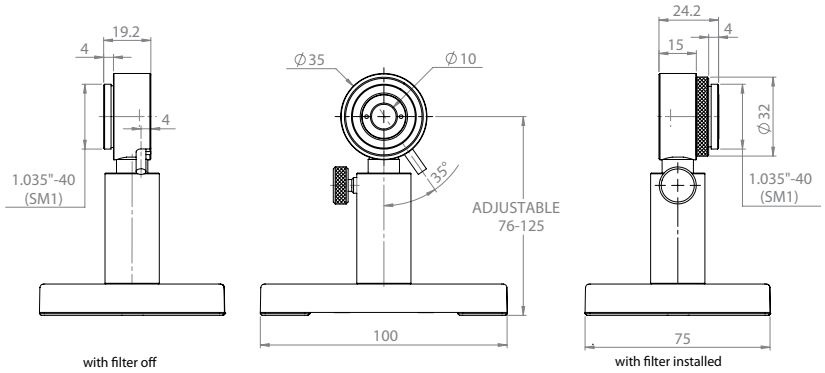
PD300-UV / PD300-IR Filter installed
(Ø5mm for PD300-IR only)



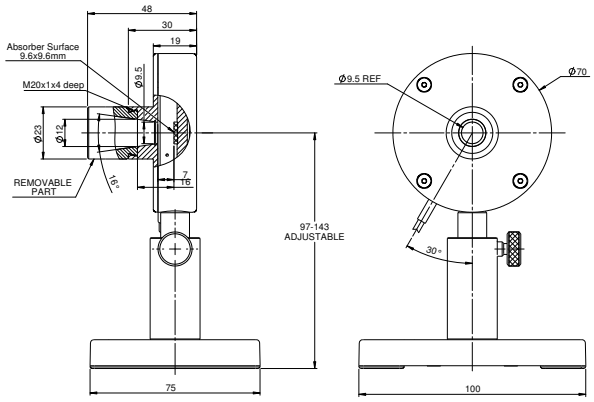
PD300-UV / PD300-IR Filter off
(Ø5mm for PD300-IR only)



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

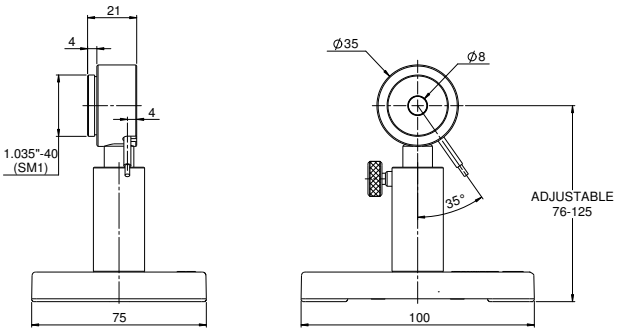
PD300RM-UV / PD300RM-8W

PD300RM-UVA

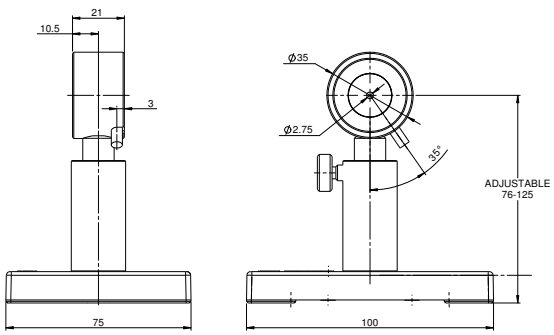
Model	PD300RM-UV	PD300RM-8W	PD300RM-UVA
Detector Type	Silicon	Silicon	Silicon
Input Port Aperture mm	Ø8	Ø8	Ø 2.75
Spectral Range nm	200-850	350-850	350-450
Functions	Irradiance [W/cm²] Dosage [J/cm²]	Irradiance [W/cm²] Dosage [J/cm²]	Irradiance [W/cm²] Dosage [J/cm²]
Irradiance Range	100nW/cm² – 250mW/cm²	1µW/cm² – 8W/cm² (d)	1.5µW/cm² – 15W/cm² (d)
Irradiance Scales	300mW/cm² to 300nW/cm² (7 scales), Auto ranging	30W/cm² to 30µW/cm² (7 scales), Auto ranging	30W/cm² to 30µW/cm² (7 scales), Auto ranging
Resolution nW/cm²	0.1	10	10
Maximum Irradiance	200nm-400nm, 250mW/cm² 400nm-550nm, 100mW/cm² 550nm-850nm, 40mW/cm²	350nm-650nm, 8W/cm² 650nm-850nm, 4W/cm²	350nm-450nm, 15W/cm²
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	N.A.	N.A.	±3%, 350-400nm, 400-450nm
Accuracy			
% error vs Wavelength nm (c)	±10%, 200-250nm	±5%, 350-400nm	±6%, 350-400nm
	±7.5%, 250-300nm	±4%, 400-850nm (a)	±5%, 400-450nm (b)
	±5%, 300-400nm		
	±4%, 400-850nm (a)		
Thermal Coefficient %/°C	-0.03	-0.03	-0.03
Damage Threshold W/cm²	10	50 (d)	50 (d)
Max Pulse Energy (for laser ns pulse) µJ	0.4	20	20
Noise Level nW/cm²	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



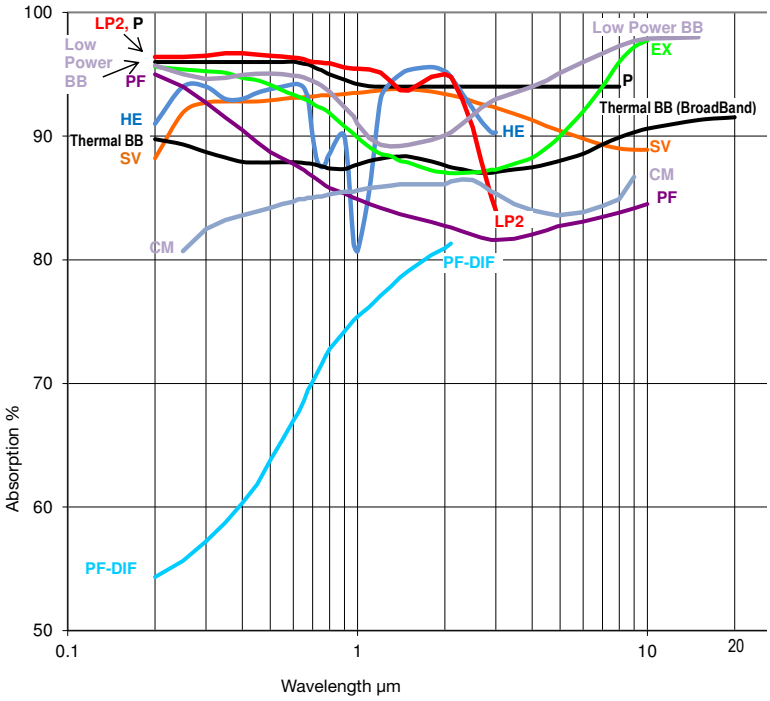
PD300RM-UVA



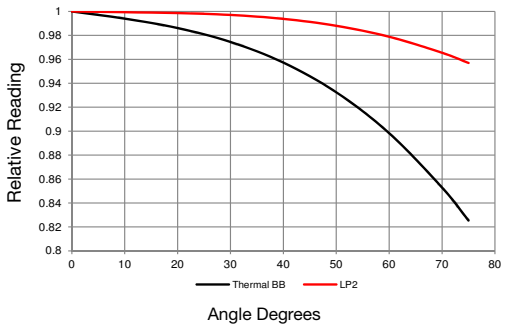
1.1.2 Thermal Power Sensors

Absorption, Angle Dependence and Damage Graphs for Thermal Sensors

Absorption vs. Wavelength

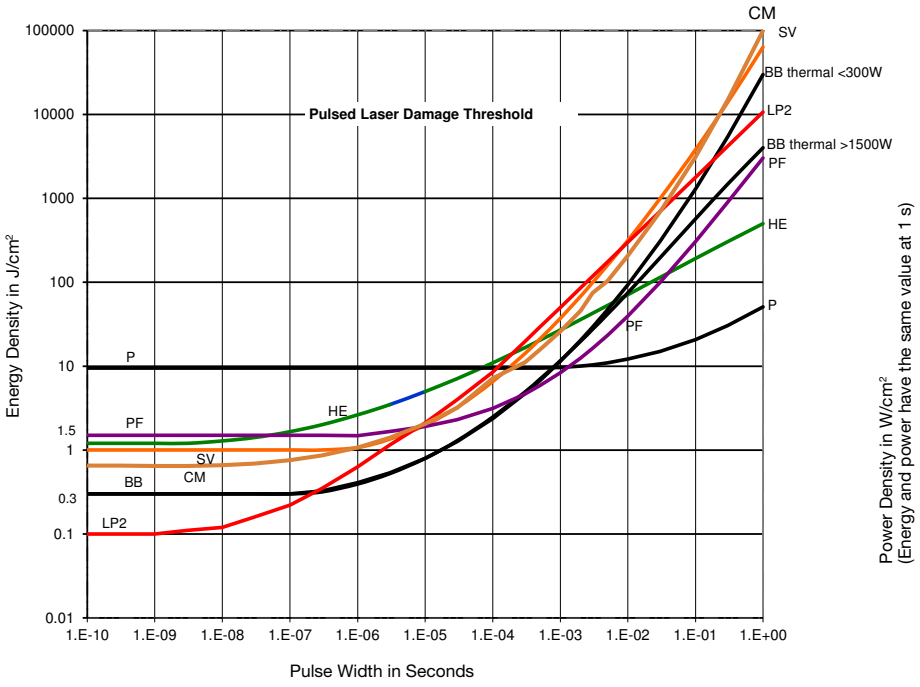


Response vs. Incidence Angle



Damage Threshold vs. Pulse Width

Note: The CW power damage threshold in W/cm² is found on the right hand side of the table at the 1s pulse width value

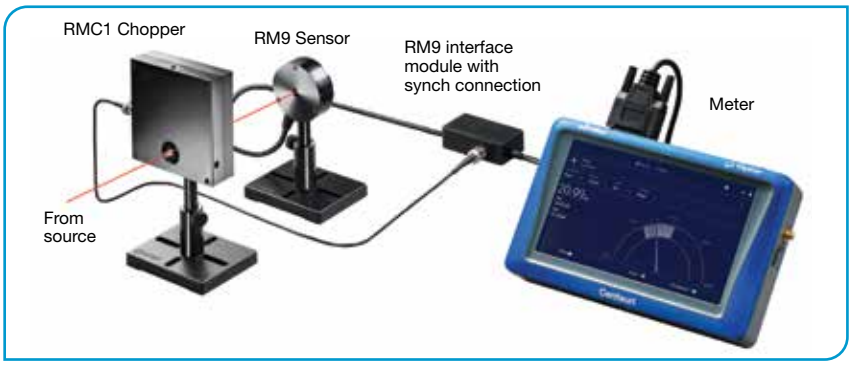


1.1.2.1 Low Noise Lock In Power Sensors

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 - 12µm [a]	0.2 - 1.1µm [b]
Aperture mm	Ø8mm	Ø10mm
Surface Reflectivity % approx.	50	50
Power Range [c]	100nW – 100mW	300fW – 300nW
Power Scales	100mW to 3µW	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**

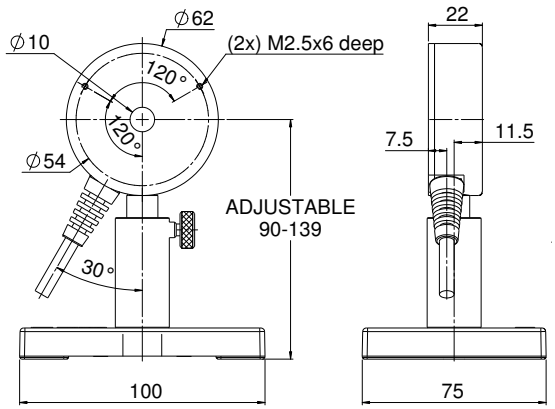
Note: (a) At calibrated wavelengths 500 – 1100nm. At other wavelengths, there is an additional error as follows: <500nm add ±8%, 1100 – 3000nm add ±5%, 10.6µm add ±15%
Note: (b) At calibrated wavelengths 200 – 1100nm. For <700nm add ±2% additional error
Note: (c) For LaserStar, Pulsar, USBI, Quasar and Nova/Orion, 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

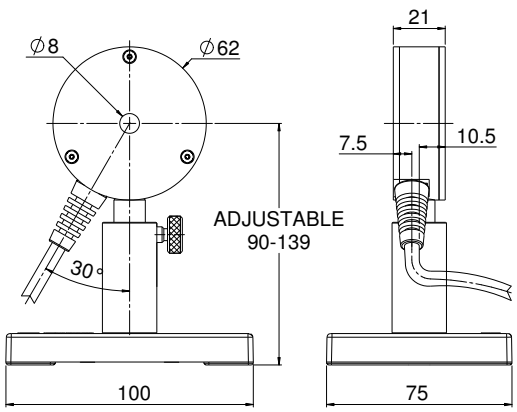
Model	RMC1 Chopper
Use	**Chopper for RM9 series**
Aperture	Ø22mm
Chopping Frequency [a]	18Hz
Power Consumption	85mA
Connections:	
1. BNC to interface module	
2. 12V wall cube power supply (included)	
3. Mini USB connector (factory use only)	

Note: (a) not adjustable by user.

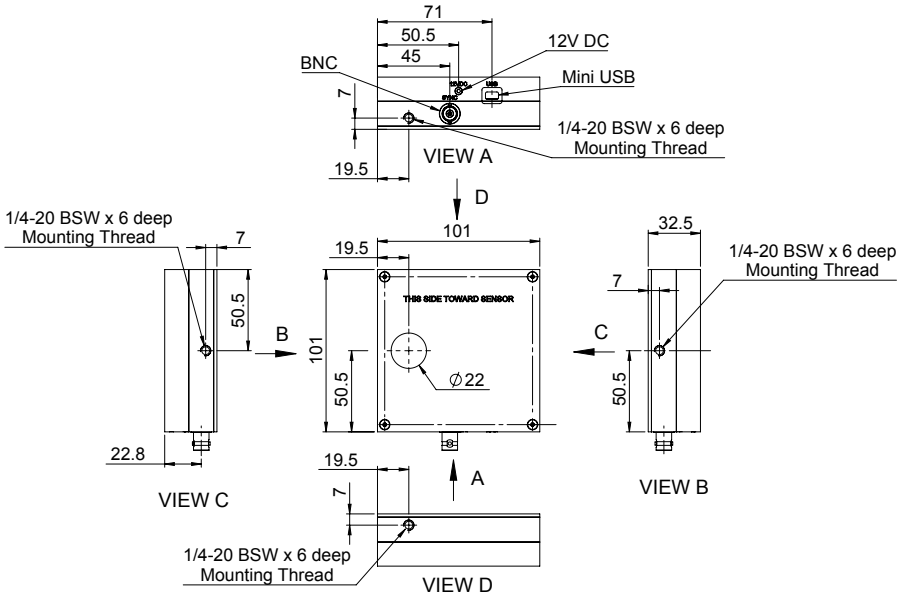
RM9-PD Sensor



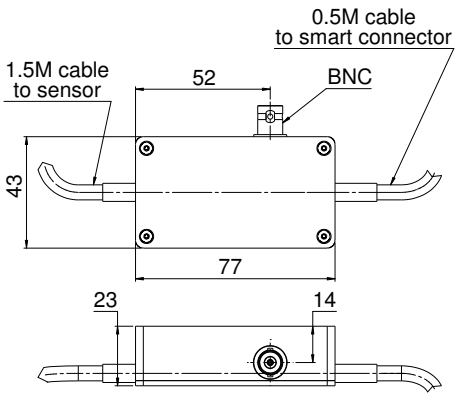
RM9 Sensor



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

2A-BB-9

3A / 3A-P / 3A-PF-12

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 118)	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:

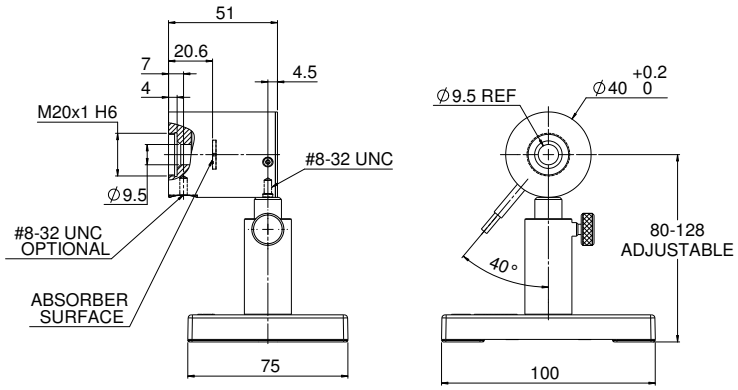
Wavelength	P type Derate to value	PF type Derate to value
1064nm	Not derated	Not derated
532nm	Not derated	Not derated
355nm	40% of stated value	70% of stated value
266nm	5% of stated value	15% of stated value
193nm	10% of stated value	5% of stated value

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

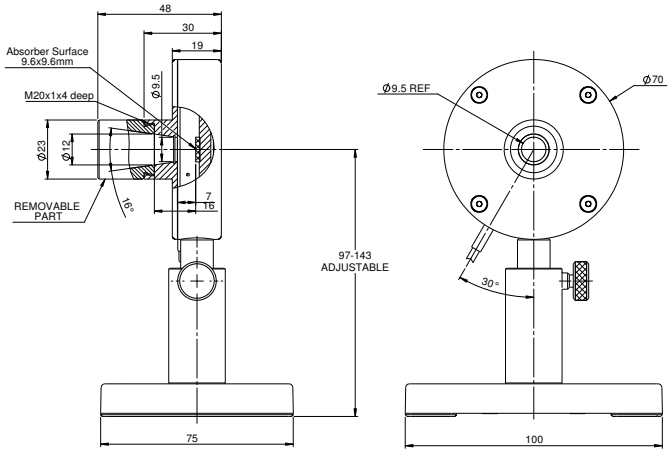
Note: (d) The 3A and 2A-BB-9 sensors have a relatively large spectral variation in absorption and has a calibrated spectral curve at all wavelengths in its spectral range to the above specified accuracy. Nova, Orion and LaserStar meters do not support this feature and when used with those meters, the 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

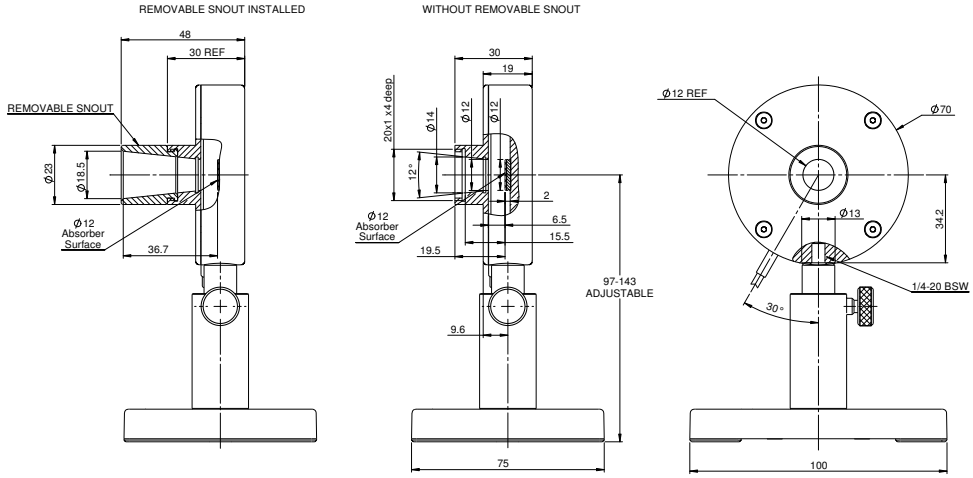
2A-BB-9



3A



3A-P / 3A-PF-12



1.1.2.2 High Sensitivity Thermal Sensors

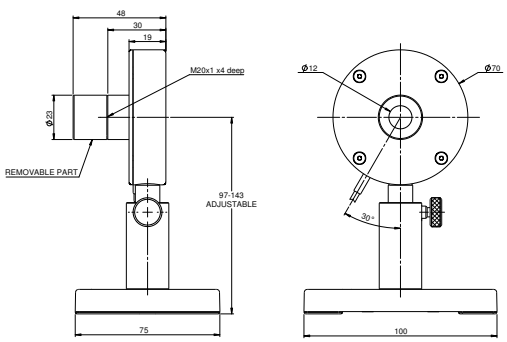
8µW to 3W

Features

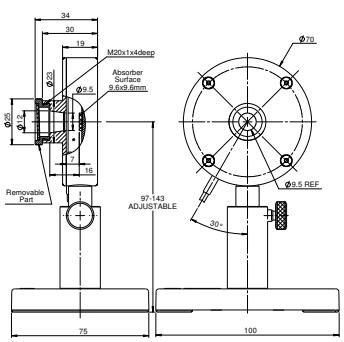
- Very low noise and drift to measure very low powers and energies
- Broadband and P absorbers for CW and short pulses
- Up to 3W
- Version for Terahertz

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/cm²	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/cm² (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 118)	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 / Derate to value 1064nm / Not derated 532nm / Not derated 355nm / 40% of stated value 266nm / 5% of stated value 193nm / 10% of stated value		
Note: (f)	Lowest measurable powers are achieved by thermally quiet room conditions, using removable snout, averaging and offset subtraction		

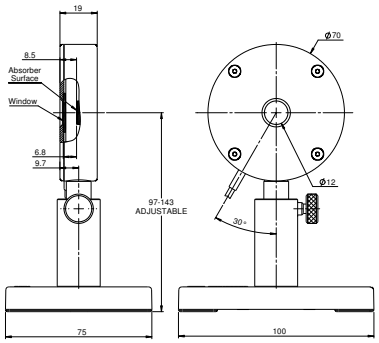
3A-P-THz



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	Ø16mm	Ø16mm	
Power Mode			
Power Range	2mW - 12W	2mW - 12W	
Power Scales	12W to 20mW	12W to 20mW	
Power Noise Level	50µW	50µW	
Thermal Drift (30min) [a]	40 - 150µW	40 - 150µW	
Maximum Average Power Density kW/cm²	25	0.05	
Response Time with Meter (0-95%) typ. s	3	3.5	
Calibration Uncertainty ±%	1.9	1.9	
Power Accuracy ±%	3	3	
Linearity with Power ±%	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/cm² [c]			
Pulse rate:		Single	10 - 30Hz
<100ns	0.3	10	1
0.5ms	5	10	1
2ms	10	10	1
10ms	30	10	1
Cooling	convection	convection	
Fiber Adapters Available (see page 118)	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**	

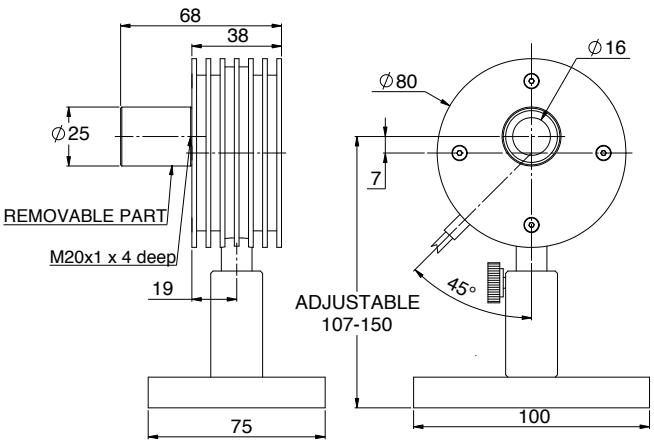
Note: (a) Depending on room airflow and temperature variations

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

10A-BB-16

30A-BB-18

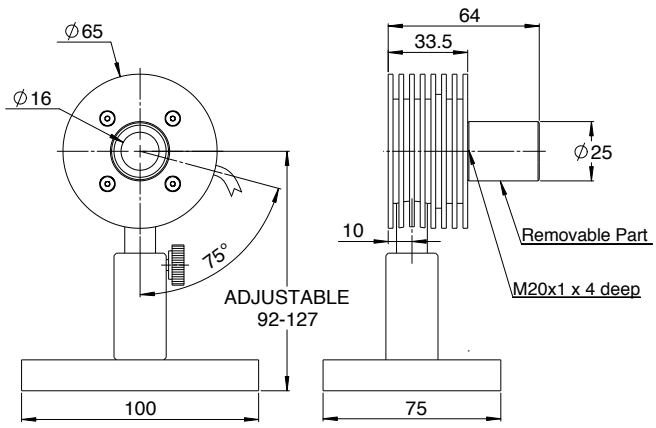
L30A-BB-26-10MM / L30A-EX-10MM

50(150)A-BB-26

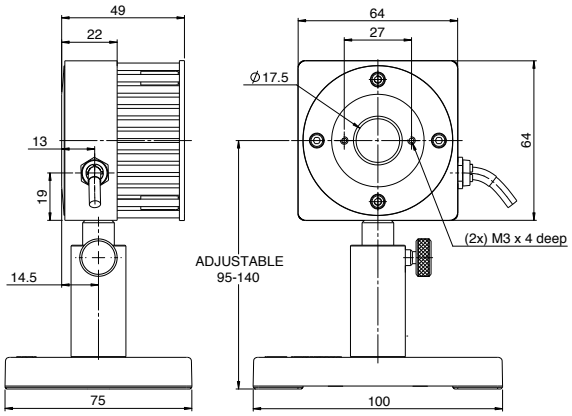
Model	10A-BB-16	30A-BB-18	L30A-BB-26-10MM	L30A-EX-10MM	50(150)A-BB-26
Use	**Low power**	**General purpose**	**Thin profile**	**Thin profile Excimer**	**General purpose**
Absorber Type	Broadband	Broadband	Broadband	EX	Broadband
Spectral Range µm	0.19 - 11	0.19 - 11	0.19 - 11	0.15 - 0.7, 10.6	0.19 - 11
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 sinked	8W free standing, 30W heat sinked	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/cm²	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 ±%	1.9	1.9	1.9	1.9	1.9
Power Accuracy ±%	3 [(a)]	3 [(a)]	3 [(a)]	3	3 [(a)]
Linearity with Power ±%	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/cm²					
<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 118)	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) ±4%. For wavelengths <240nm					

* For drawings please see page 52

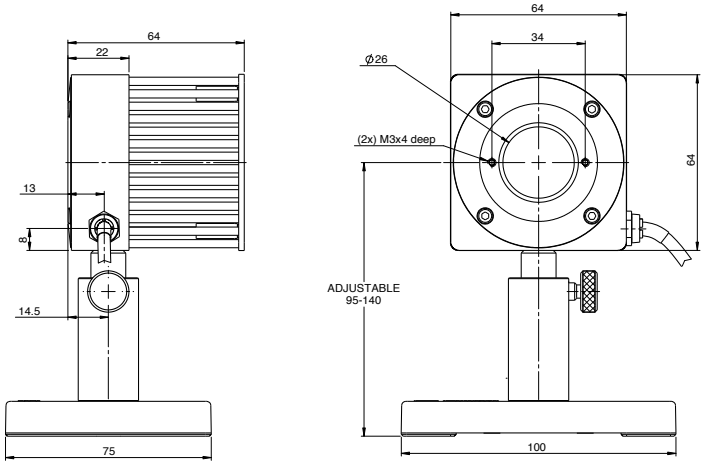
10A-BB-16



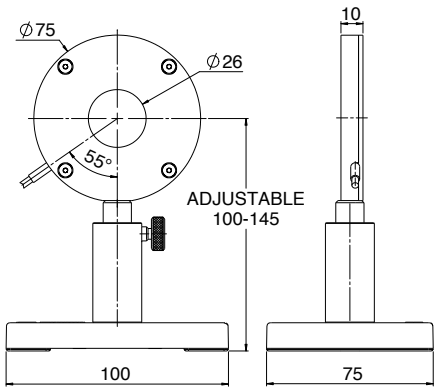
30A-BB-18



50(150)A-BB-26



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

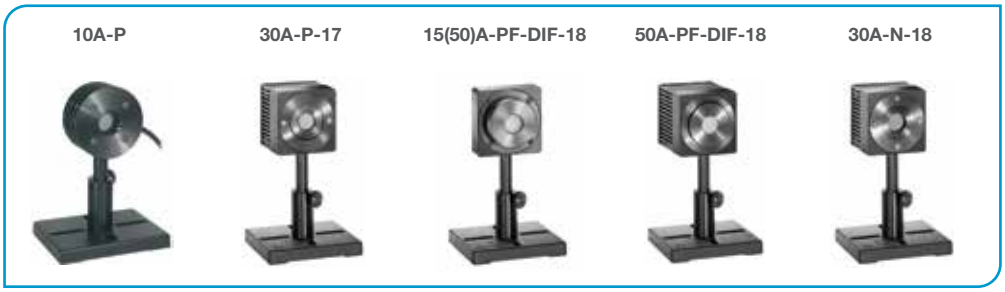


1.1.2.3 Low Power Thermal Sensors

40mW to 50W

Features

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



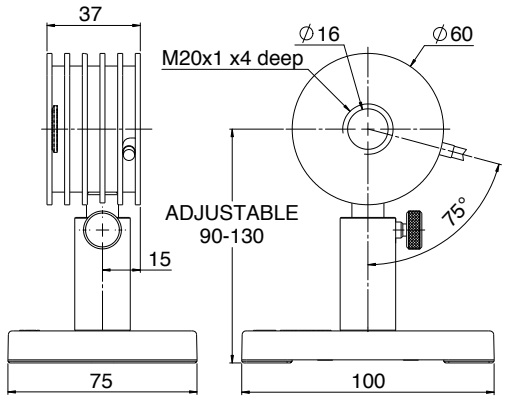
Model	10A-P	30A-P-17	15(50)A-PF-DIF-18/ 50A-PF-DIF-18	30A-N-18
Use	**Short pulse to 10W**	**Short pulse to 30W**	**High energy density pulsed beams**	**High power density pulsed YAG**
Absorber Type	P type	P type	PF type + diffuser	N type
Spectral Range µm	0.15 - 8	0.15 - 8	0.24 - 2.2	0.532, 1.064
Aperture 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/cm²	0.05	0.05	>10	5
Response Time with Meter (0-95%) typ. s	3.5	2.5	2	2
Calibration Uncertainty ±%	1.9	1.9	1.9	1.9
Power Accuracy ±%	3	3	5	3
Linearity with Power ±%	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/cm² (a)				
Pulse rate:	Single 10 - 30Hz	Single 10 - 30Hz	10 - 50Hz	10 - 50Hz
<1µs	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 118)	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:

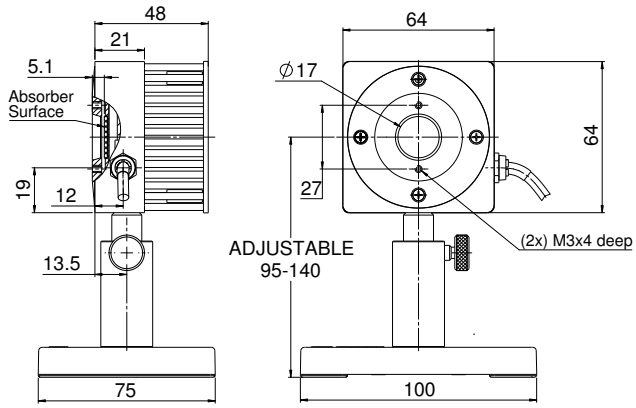
Wavelength	Derate to value	Wavelength	Derate to value
1064nm	Not derated	1064nm	Not derated
532nm	Not derated	532nm	80% of stated value
355nm	40% of stated value	355nm	60% of stated value
266nm	10% of stated value	266nm	40% of stated value
193nm	10% of stated value	193nm	N.A.

* For drawings please see page 54

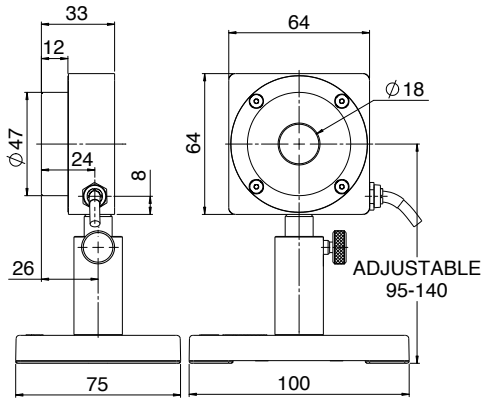
10A-P



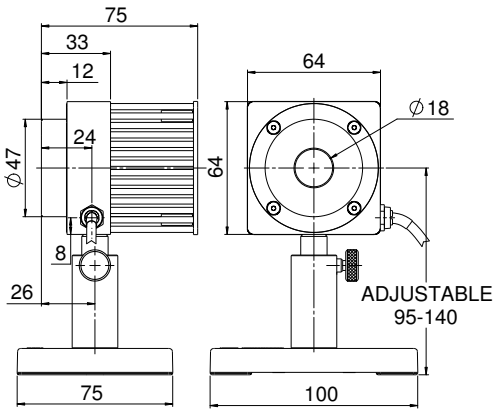
30A-P-17



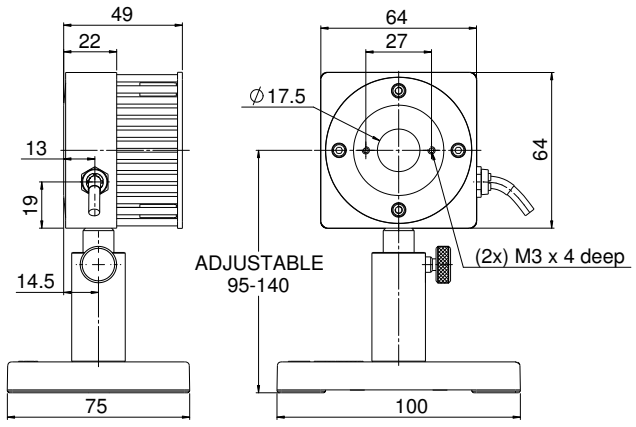
15(50)A-PF-DIF-18



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 109-111)

- 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/cm²	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/cm²			
<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 118)	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 (TEM_{00}) 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:

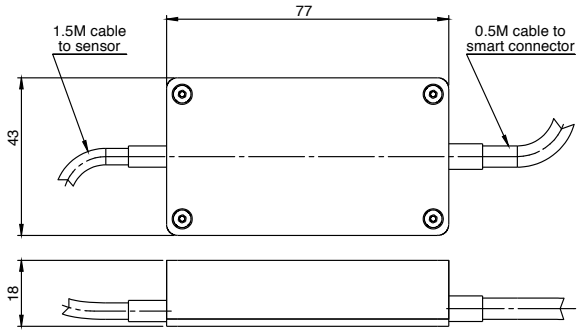
Wavelength	Derate to value
1064nm	not derated
532nm	not derated
355nm	40% of stated value
266nm	10% of stated value
193nm	10% of stated value

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, Orion 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.

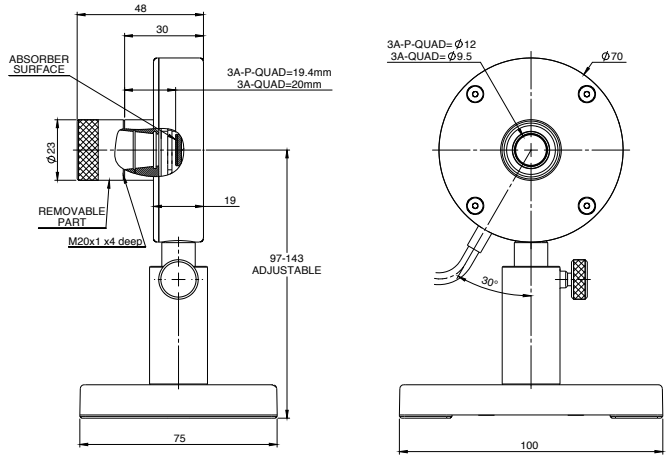
Note: (h) ±4%. For wavelengths <240nm

* For drawings please see page 56

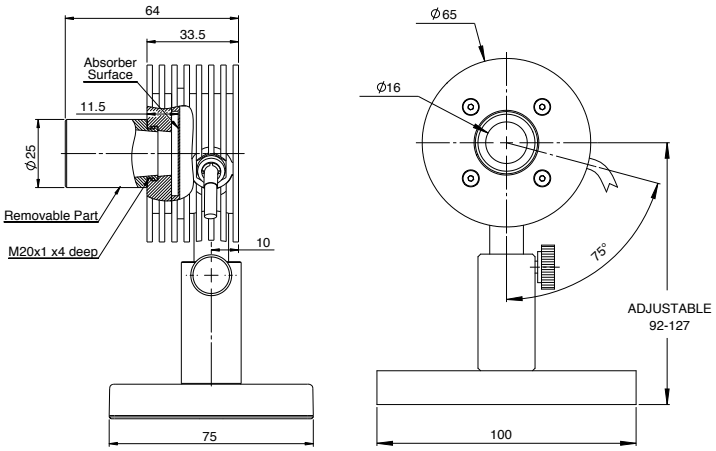
Interface Module on cable



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

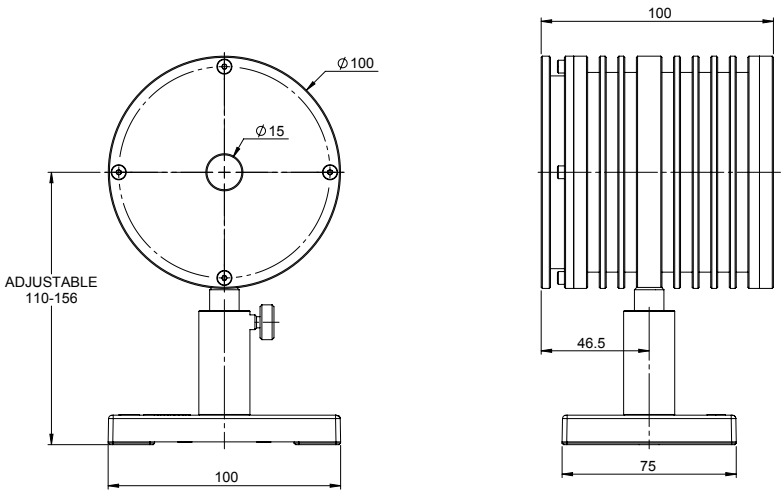
BT50A-15

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/cm²
Maximum Energy Density	<100ns pulses 4J/cm² 2ms pulses 100J/cm²
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

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 1.1µm	>85%	>94% from 0.25 to 1.1µm	>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/cm²	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 ±%	1.9	1.9	1.9	1.9	1.9
Power Accuracy ±%	3 [g]	3 [a]	3 [g]	3 [a]	4 [d]
Linearity with Power ±%	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/cm²					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. 118)	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 1.1µm 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 106

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/e² 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) ±4%. For wavelengths <240nm

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

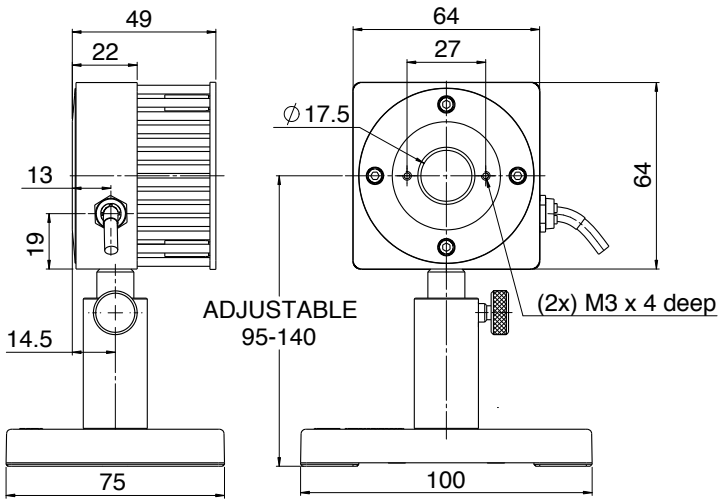
Notes: (e) For 10-50Hz, derate as follows:

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

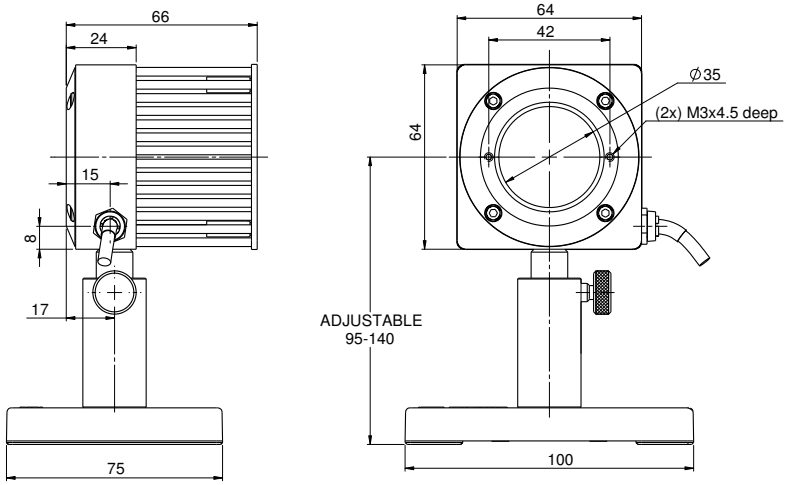
Notes: (f) Damage threshold 1.5J/cm² for wavelengths <500nm

* 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

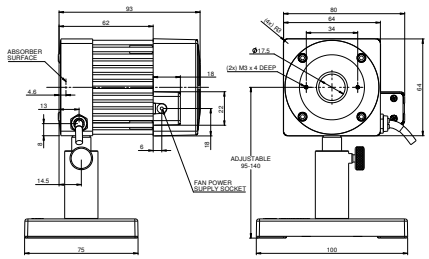
30(150)A-SV-17

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	Ø17.5mm	Ø16mm	Ø17mm
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/cm²	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/cm² (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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3	3	3
Linearity with Power ±%	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/cm²	Pulse width (a)	Pulse width (a)	Pulse width (a)
	<100ns 0.7	<100ns 0.7	<100ns 1
	0.5ms 16	0.5ms 16	0.5ms 20
	2ms 45	2ms 45	2ms 50
Cooling	Fan	Fan	Convection
Fiber Adapters Available (see page 118)	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**

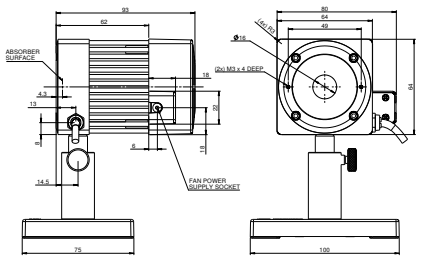
Notes:

(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 0.25-2.2µm
(c) At 1064nm
(d) For repetition rates ≥100kHz
(e) at 200W add additional linearity error of ±0.5%

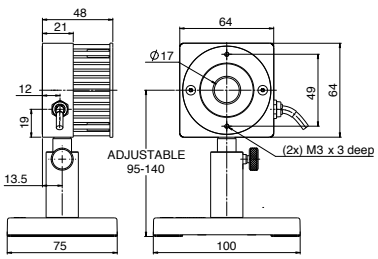
F80(120)A-CM-17



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

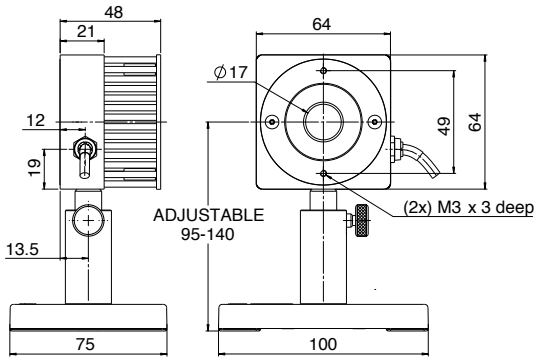
30(150)A-HE-DIF-17

30(150)A-HE-17 | Diffuser installed | Diffuser off

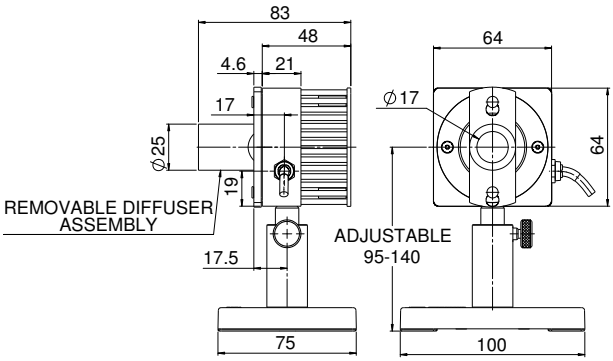
Model	30(150)A-HE-17			30(150)A-HE-DIF-17		
Use	**High energy pulsed lasers**			**Concentrated beam high energy pulsed lasers - has removable diffuser**		
Absorber Type	HE			HE		
Spectral Range µm	0.19 - 0.625, 1.064, 2.1, 2.94			0.19 - 3 except for 0.625 - 0.9 (b)		
Aperture mm	Ø17mm			Ø17mm		
Power 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/cm²	0.5			0.5		
Pulsed Maximum Average Power Density kW/cm² (c)	NA			NA		
Response Time with Meter (0-95%) typ. s	3.8			3.8		
Calibration Uncertainty ±%	1.9			1.9		
Power Accuracy ±%	3			5 (b)		
Linearity with Power ±%	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/cm²	Pulse width (a)	Single	10-50Hz	Pulse width <100ns, 10 - 50Hz		
				Wavelength	DIF IN	DIF OUT
	<100ns	5	2	1064nm	5	2
	0.5ms	100	25	532nm	4	2
	2ms	150	40	355nm	1.5	1
Cooling	Convection			Convection		
Fiber Adapters Available (see page 118)	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 ≥100kHz

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 109-111)

- 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	Ø26mm	Ø26mm	Ø26mm
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/cm²	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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3 [f]	3 [f]	3 [f]
Linearity with Power ±%	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/cm²			
<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.	±5% for centered beam	±5% for centered beam
Size Range mm (4σ beam diameter)	N.A.	Ø3 - 20	Ø3 - 20
Min Power Density for Size Measurement	N.A.	1 W/cm²	1 W/cm²
Cooling	Convection	Convection	Fan
Fiber Adapter Available (see page 118)	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 ±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.

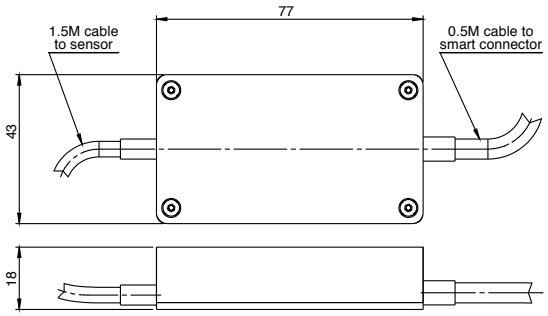
Note: (d) Assumes laser beam with Gaussian (TEM_{00}) distribution. For other modes, size measurement is relative.

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 ±10%.

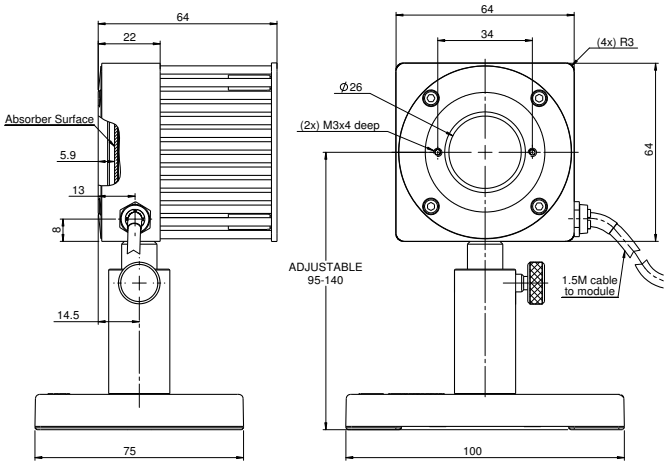
Note: (f) ±4%. For wavelengths <240nm

* For drawings please see page 63

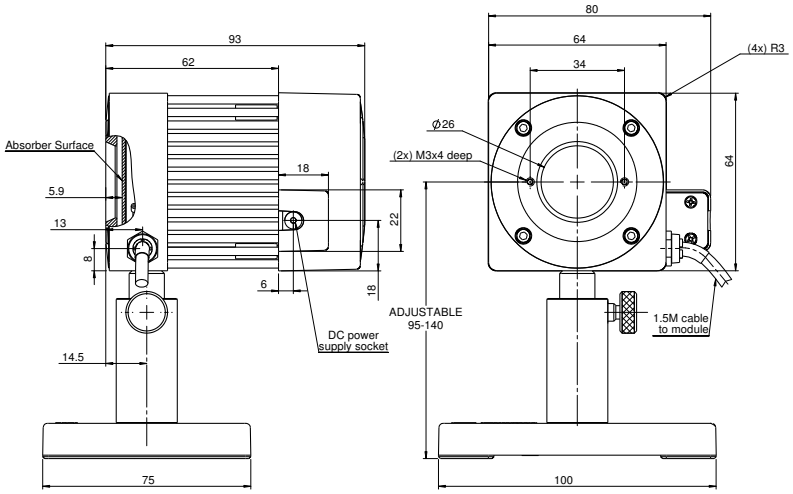
Interface Module on cable



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 1.1µm	~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,	10W continuous,	10W continuous,	4W	5W continuous,
	20W for 1.8min	100W for 2min	100W for 2min		150W for 1min
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/cm²	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 ±%	1.9	1.9	1.9	1.9	1.9
Power Accuracy ±%	3	3	3 [(b)]	3	3
Linearity with Power ±%	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/cm²					
<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 1.1µm there is an additional calibration uncertainty of up to 2%

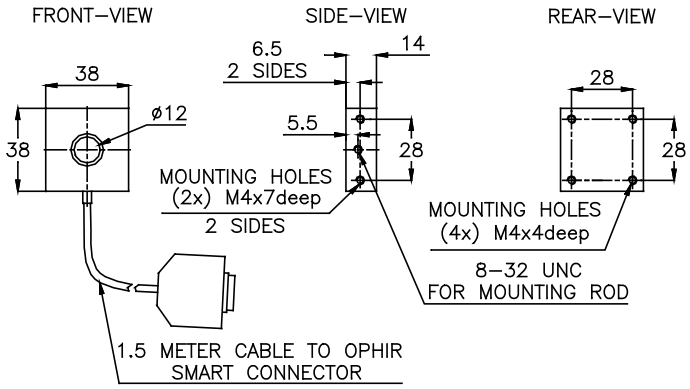
Note: (c) Long pulses (0.5 – 4s) can be used to measure power of high power lasers by measuring the energy of a short exposure. The StarBright, Juno, Juno+, Juno-RS and Centauri meters have a Pulsed Power mode where the user may specify the pulse width and get a reading directly in units of power for this short exposure energy measurement. See also page 106

Note: (d) Recommended exposure times and 1/e² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 2kJ. Recommended time between shots 12s.

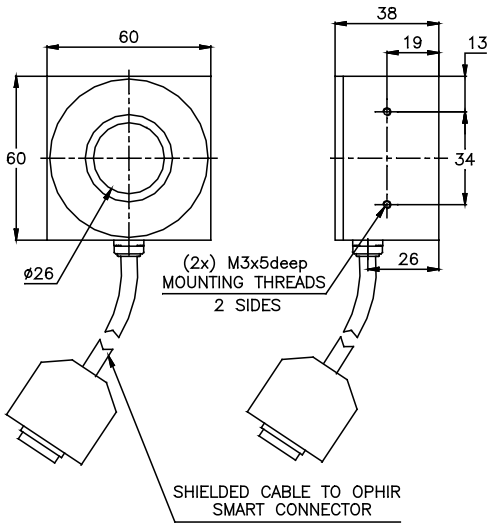
Laser Power W	Recommended Exposure s	Number of shots before cooling down	Min 1/e² beam dia. mm
100	4	20	9
500	1	20	9
1000	1	10	13
2000	1	5	17
4000	0.5	5	22

* For drawings please see page 65

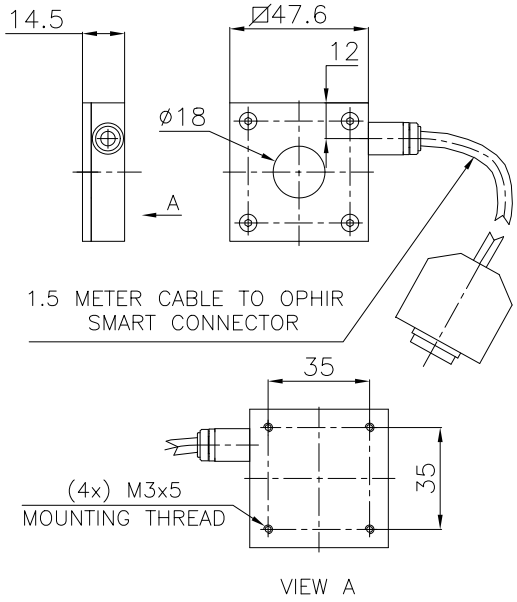
20C-BB-12-SH



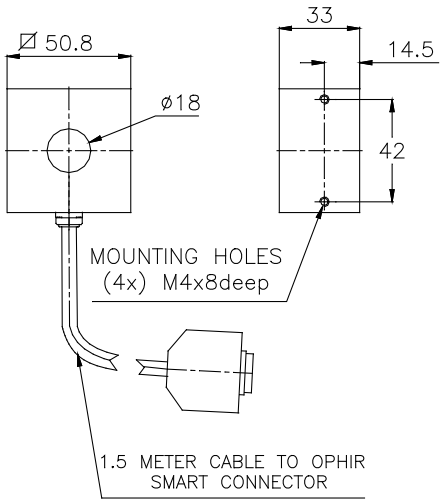
L30C-SH / L30C-LP2-26-SH



100C-BB-18-SH



150C-SH

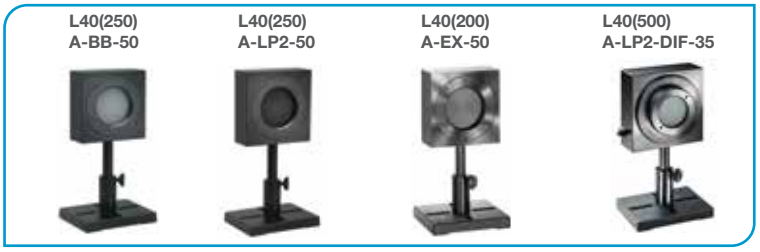


1.1.2.5 Medium Power Large Aperture Thermal Sensors - Apertures 50mm

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 1.1µm	~95%	~14% backscatter from diffuser
Aperture mm	Ø50mm	Ø50mm	Ø50 mm	Ø35mm
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/cm²	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 ±%	1.9	1.9	1.9	1.9
Power Accuracy ±%	3 [f]	3 [a]	3	3
Linearity with Power ±%	1	1	1	1
Beam Size Dependence	<1% for beams up to 35mm diameter			
Max Beam Diameter for Gaussian beam	Ø35mm	Ø35mm for up to 30deg incidence	Ø35mm	Ø25mm for normal incidence Ø15mm for 20deg incidence [d] Ø10mm 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	±5%	±5% 700 – 1100nm [a, b]	±5%	±5% 900 – 1100nm [b]
Maximum Exposure Before Cooling Down is Necessary	NA	See page 106	NA	See page 106
Minimum Energy mJ	100	100	100	100
Maximum Energy Density J/cm²				
<100ns	0.3	0.1	0.5	3
1µs	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 118)	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 1.1µm there is an additional calibration uncertainty of up to 2% except at the additional calibration point of 2.94µm 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 106

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/e² 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.

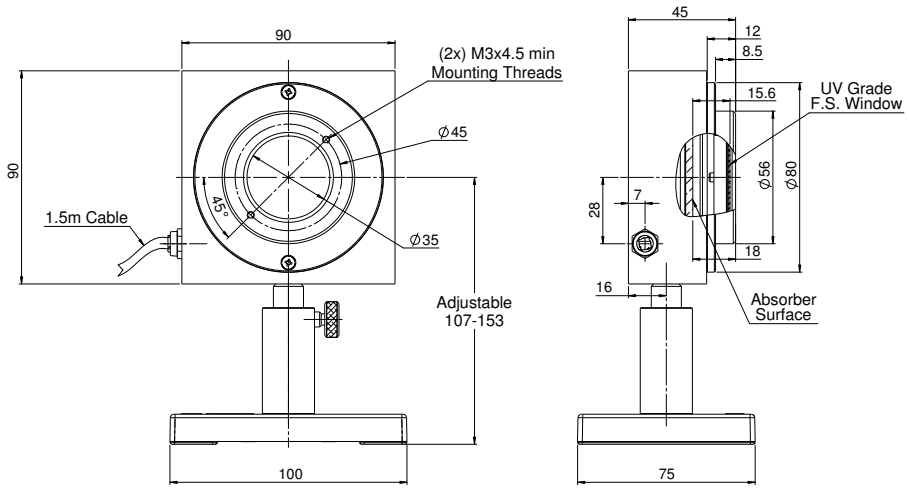
* for L40(500)A-LP2-DIF-35

Laser Power W	Recommended Exposure s		Number of shots before cooling down	Min 1/e² 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

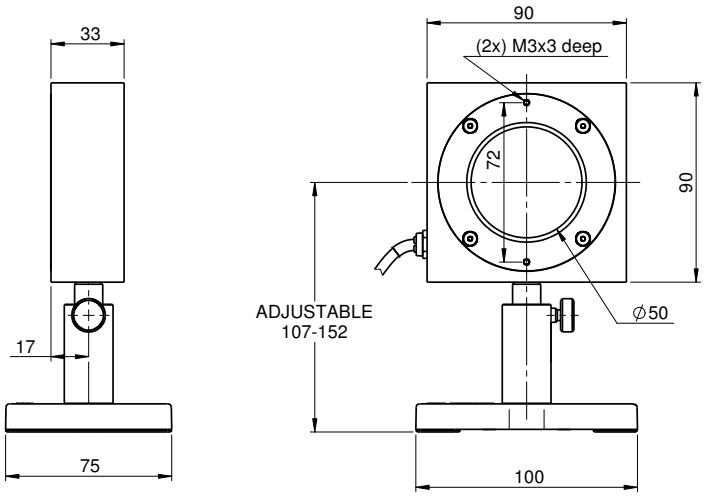
Notes: (f) ±4%. For wavelengths <240nm

* 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 1.1µm	~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/cm²	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 ±%	1.9	1.9	1.9	1.9
Power Accuracy ±%	3 [g]	3 [g]	3 [b]	4 [c]
Linearity with Power ±%	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/cm²				Single [d] 10-50Hz [d]
<100ns	0.3	0.3	0.1	3 [e] 1.5
1µs	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 118)	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 106

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

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

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

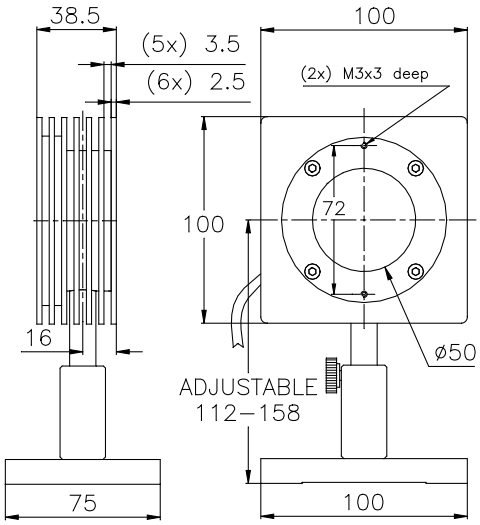
Note: (f) Recommended exposure times and 1/e² Gaussian beam diameters for very long pulses. Total energy for a series of measurements should not exceed 20kJ. Cooling down time before another 20kJ series, 10min. Recommended time between shots 12s.

Laser Power W	Recommended Exposure s	Number of shots before cooling down	Min 1/e² 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

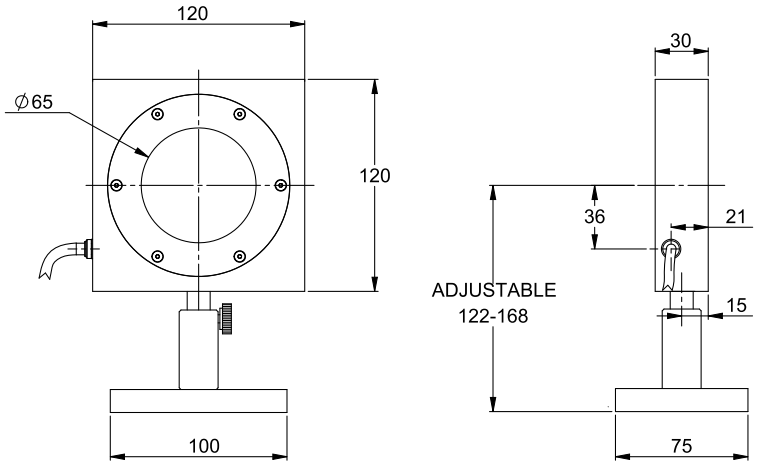
Note: (g) ±4%. For wavelengths <240nm

* 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 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

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 1.1µm
Aperture mm	Ø65mm	22x22mm [b]	Ø65mm
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 ±%	1.9	NA	1.9
Power Accuracy ±%	6 for most gel or air coupled IPL sources	NA	3 [e]
Linearity with Power ±%	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
1µs	0.9	9	0.9
0.5ms	50	500	50
2ms	130	1300	130
10ms	400	2000	400
Energy Accuracy ±%	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**

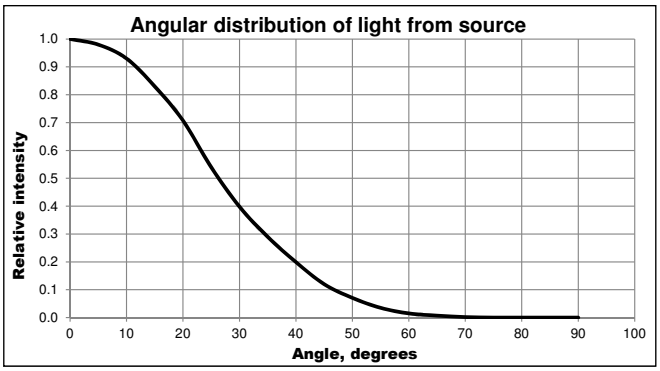
Note: (a) Sensor has a window for gel coupled IPL sources where IPL source is coupled to window with gel or water for measurement. Can also measure air coupled IPLs.

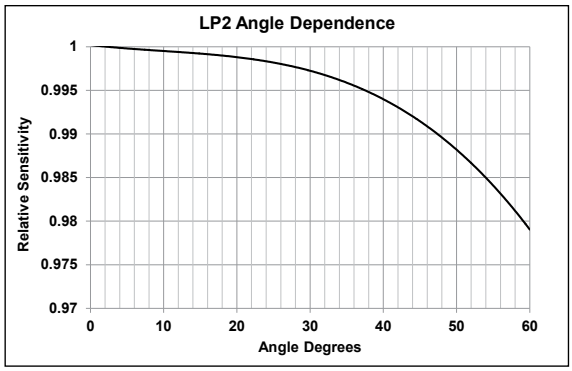
Note: (b) If the source is longer than the aperture, it can overfill and the output can be calculated proportionately.

Note: (d) Accurate measurement of air coupled sources due to low angular dependence of LP2 coating. See graph on page 71.
Note: (e) Above 1.1µm there is an additional calibration uncertainty of up to 2%.

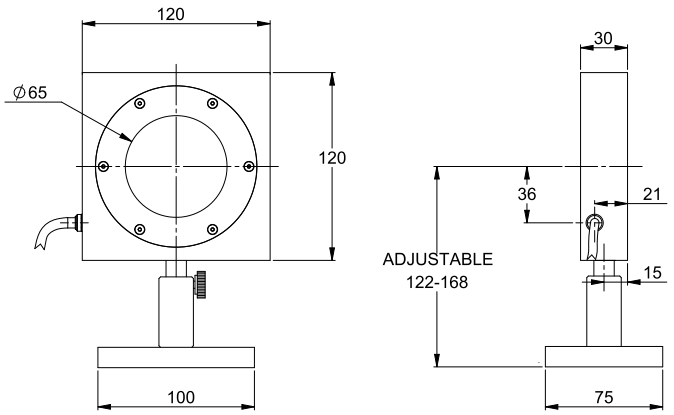
Note: (c) The assumed angular distribution of the IPL light is given below. The angle dependence of the LP2 coating is shown on page 71.

* For drawings and graphs please see page 71

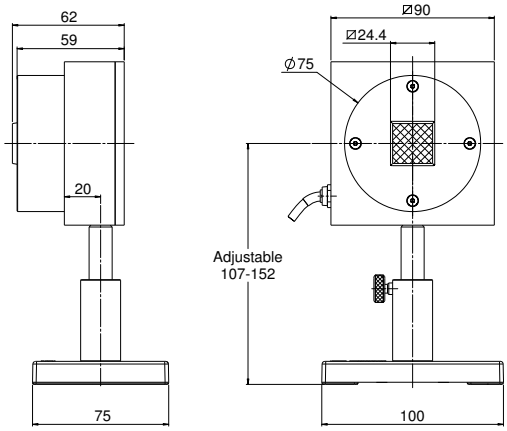




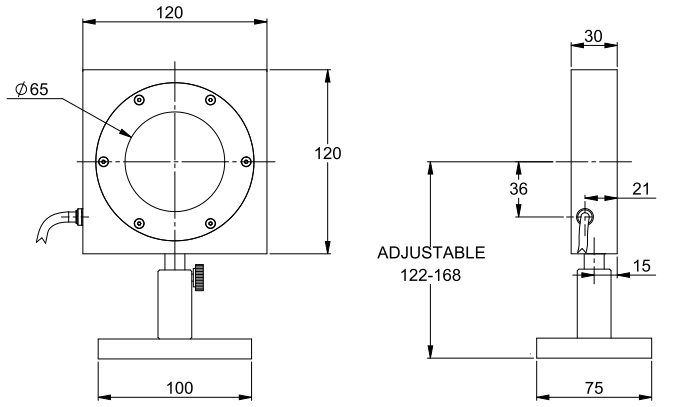
L50(300)A-IPL



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 [d]	3mW [d]
Maximum Average Power Density kW/cm²	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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3 [e]	5 [c]	3 [e]
Linearity with Power ±%	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/cm²			
<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 118)	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:

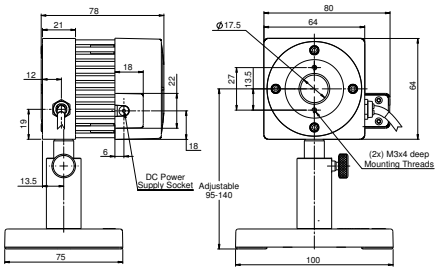
1064nm	not derated	355nm	60% of stated value
532nm	80% of stated value	266nm	40% of stated value
		193nm	NA

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

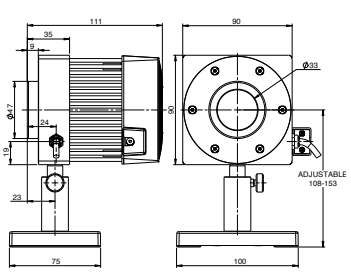
Notes: (d) For lower powers up to 30W it is recommended to work with the fan off and then the noise level is ~3 times lower. It is also recommended to measure energy with the fan off.

Notes: (e) ±4%. For wavelengths <240nm

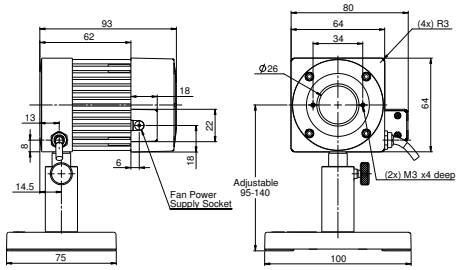
F50A-BB-18



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

FL250A-BB-35

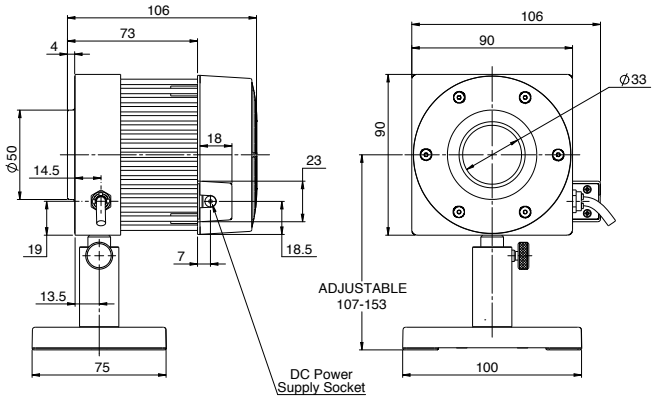
FL250A-LP2-35

FL250A-LP2-DIF-33

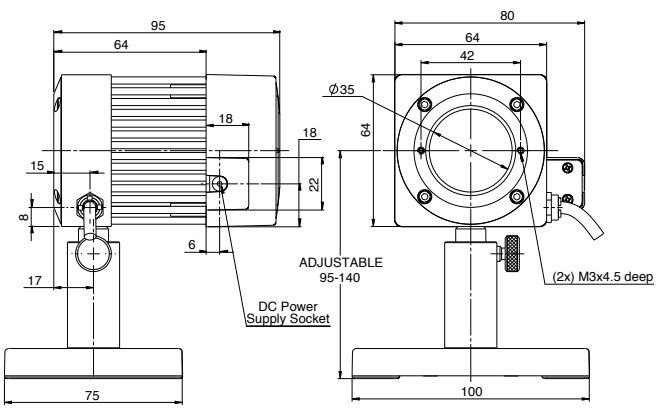
Model	FL250A-BB-35	FL250A-LP2-35	FL250A-LP2-DIF-33
Use	**General purpose**	**High power density and long pulse lasers**	**Diffuser for highest energy densities**
Absorber Type	Broadband	LP2	LP2 + diffuser
Spectral Range µm	0.19 - 20	0.25 - 2.2	0.4 - 3
Absorption	~88%	>94% from 0.25 to 1.1µm	20%
Aperture 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/cm²	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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3	3 [b]	3 [a]
Linearity with Power ±%	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 [c]	50	50	400
Maximum Energy Density J/cm²			
<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 118)	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 1.1µm 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

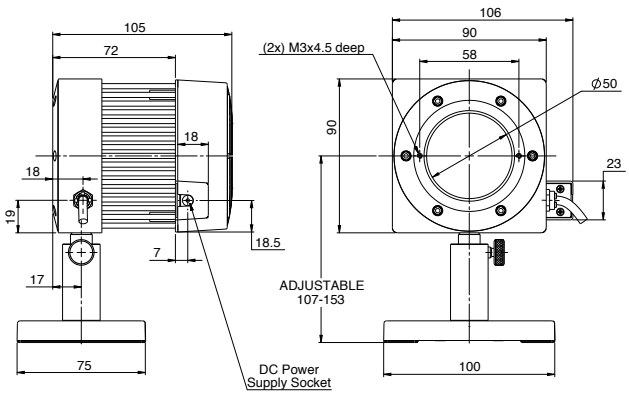
FL250A-BB-50 / FL400A-BB-50

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 1.1µm, 75% for 10.6µm
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/cm²	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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3 [c]	3	3 [b]
Linearity with Power ±%	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/cm²			
<100ns	0.3	0.3	0.07
1µs	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 118)	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 0.35-1.1µm and 10.6µm. For other wavelengths in the spectral range 1100 – 2200nm there is an additional calibration uncertainty of up to 1%.
Notes: (c) ±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

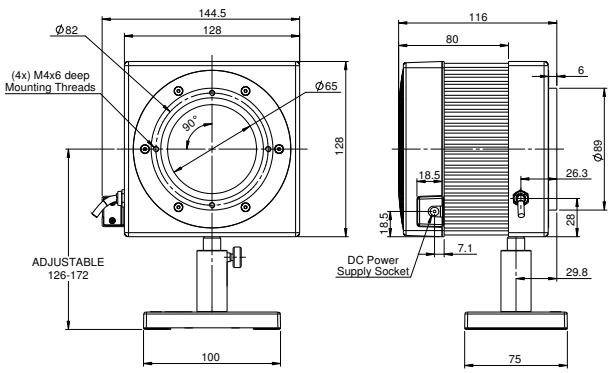
FL600A-BB-65 / FL1100A-BB-65

FL600A-LP2-65 / FL1100A-LP2-65

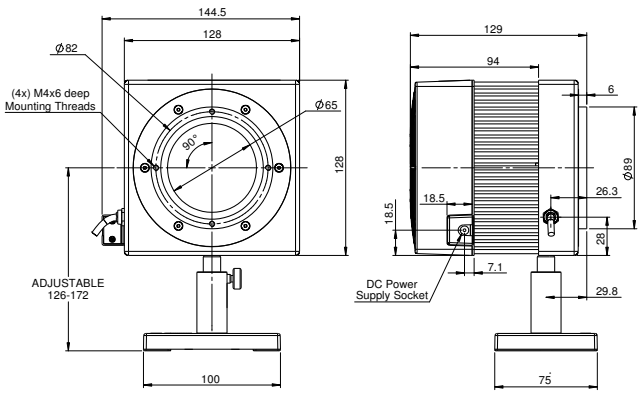
Model	FL600A-BB-65	FL600A-LP2-65	FL1100A-BB-65	FL1100A-LP2-65
Use	**General purpose**	**Long pulses**	**Highest power fan cooled**	**Long pulses**
Absorber Type	Broadband	LP2	Broadband	LP2
Spectral Range µm	0.19 - 11	0.35 – 2.2	0.19 - 11	0.35 – 2.2
Absorption	~88%	>94% from 0.35 to 1.1µm	~88%	>94% from 0.35 to 1.1µm
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/cm²	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 ±%	1.9	1.9	1.9	1.9
Power Accuracy ±%	3	3 [b]	3	3 [b]
Linearity with Power ±%	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/cm²				
<100ns	0.3	0.1	0.3	0.1
1µs	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 1.1µm 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 109-111)

- 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	Ø50mm	Ø34mm
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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	3	3 [f]
Linearity with Power ±%	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/cm²		
<100ns	0.3	0.3
1µs	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]	±5% for centered beam	NA
Size Range mm (4σ beam diameter)	Ø5-35	NA
Min Power Density for Size Measurement	3W/cm²	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 118)	ST, FC, SMA, SC	Consult Ophir representative
Accessories for High Power Sensors	NA	See pages 97-100
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 ±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 (TEM_{00}) 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.

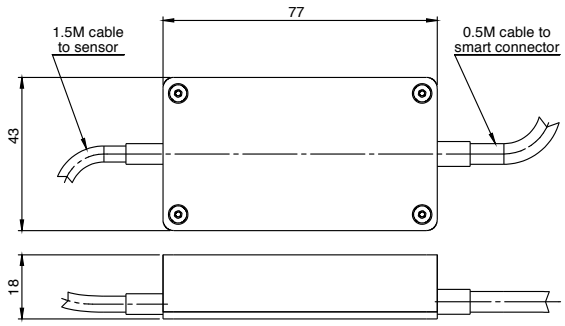
Note: (f) Calibrated for ~0.8µm, 1.064µm and 10.6µm

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

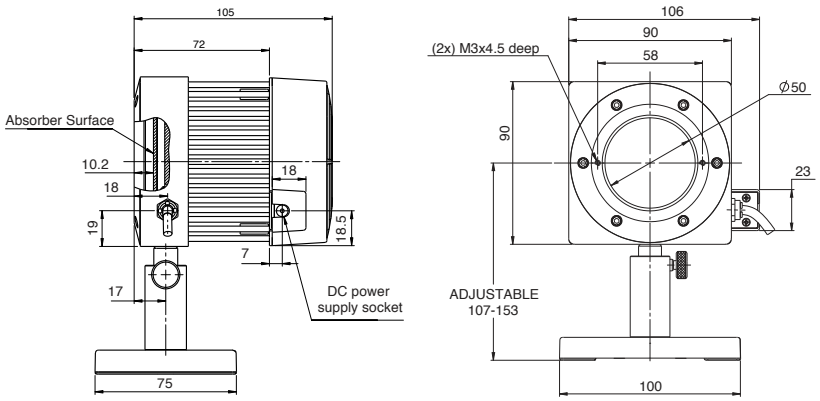
Note: (h) Position accuracy for the central 10 mm of the aperture as limited by beam position resolution. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

* For drawings please see page 77

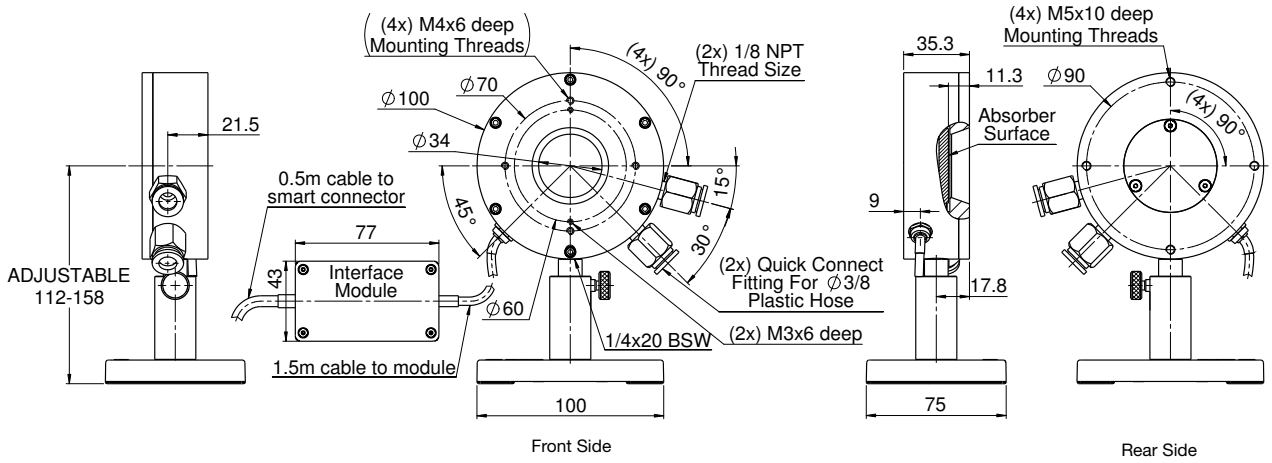
Interface Module on cable



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 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 as very 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.

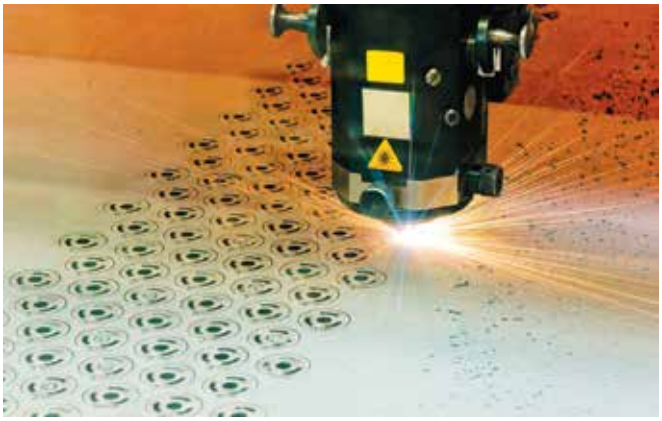
Calibration Method and Estimated Accuracy for Ophir High Power Sensors

Ophir high-power sensors (models 5000W, 10K-W, IPM-10KW, 15K-W, Comet 10K, 30K-W, and 120K-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 ±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 10µV/W (a typical value) and there is a zero offset of only 1µV, 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 High Power Water Cooled Thermal Sensors

0.5W to 300W

Features

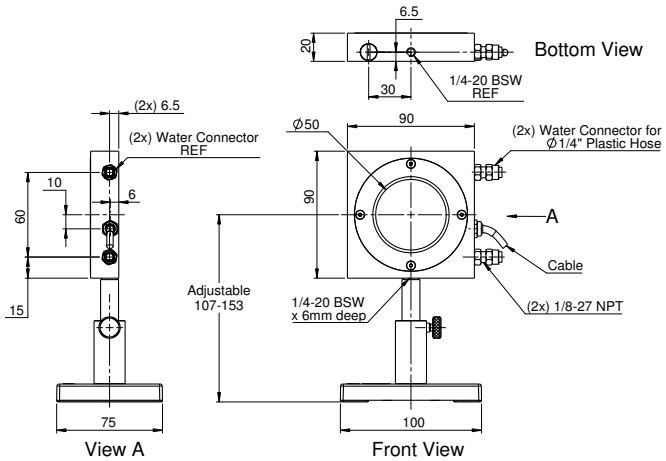
- High powers
- Water cooled
- Up to 300W
- Ø50mm aperture

L250W-BB-50

L300W-LP2-50

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 1.1µm, 75% for 10.6µm
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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	3 [c]	3 [a]
Linearity with Power ±%	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/cm²		
<100ns	0.3	0.07
1µs	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 97-100	See pages 97-100
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 - 1.1µm and 10.6µm. 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

1.1.2.7.2 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

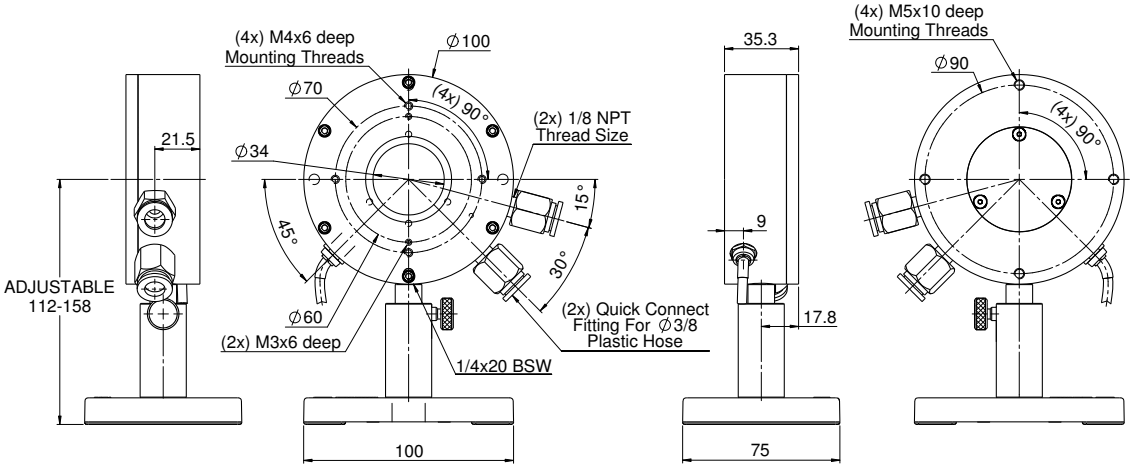
1000WP-BB-34

1000W-LP2-34

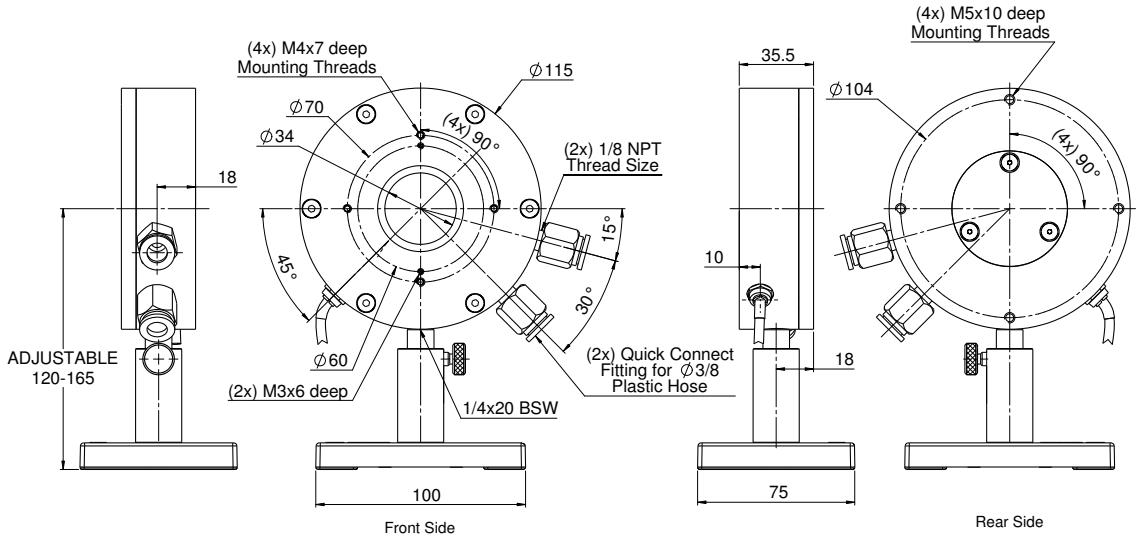
Model	1000W-BB-34 / 1000WP-BB-34	1000W-LP2-34
Use	**General purpose and CO_2 laser / Controlled materials in contact with water flow** [c]	**High power densities and long pulses**
Absorber Type	Broadband	LP2
Spectral Range µm	0.19 - 20	0.35 – 2.2
Absorption	~88%	>94% from 0.35 to 1.1µm
Aperture mm	Ø34mm	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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	3 [a]	3 [a]
Linearity with Power ±%	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/cm²		
<100ns	0.3	0.1
1µs	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 97-100	See pages 97-100
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 ~0.8µm, 1.064µm and 10.6µm	For spectral range 0.35 to 1.1µm
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

1000W-BB-34 / 1000W-LP2-34



1000WP-BB-34



1.1.2.7 High Power Thermal Sensors

1.1.2.7.2 High Power Water Cooled Thermal Sensor

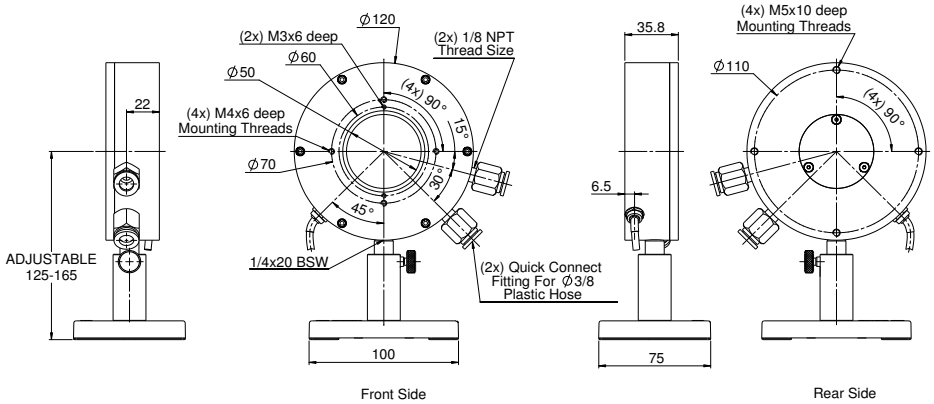
15W to 1500W

Features

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

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 1.1µm
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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	4 [a]	4 [a]
Linearity with Power ±%	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/cm²		
<100ns	0.3	0.1
1µs	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 97)	QBH-Fiber Adapter (see page 97)
Accessories for High Power Sensors	See pages 97-100	See pages 97-100
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 ~0.8µm, 1.064µm and 10.6µm	For spectral range 0.35 to 1.1µm
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

1.1.2.7.2 High Power Water / Air / Conduction Cooled Thermal Sensors

1W to 2000W

Features

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

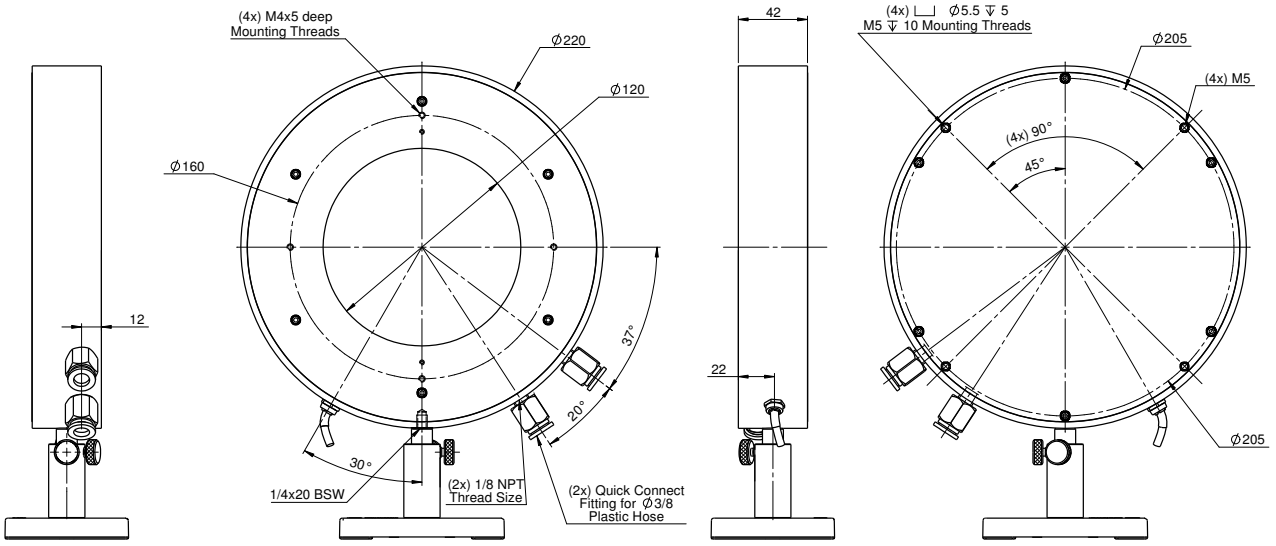
L2000W-BB-120 / L2000W-PF-120

L100(500)A-PF-120

Model	L2000W-BB-120	L2000W-PF-120	L100(500)A-PF-120
Use	**Very large beams**	**Very large beams, short pulses, high average power**	**High peak power, high energy measurements**
Absorber Type	Broadband	PF volume absorber	PF volume absorber
Spectral Range µm	0.19 – 20	0.3 – 2.2	0.15 – 20
Aperture mm	Ø120mm	Ø120mm	Ø120mm
Power Mode			
Power Range	1W – 2000W	1W – 2000W	1W – 500W
Maximum Intermittent Power	NA	NA	500W for 2min, 100W continuous, 500W continuous if heat sinked on rear
Power Scales	2000W / 200W	2000W / 200W	500W / 50W
Power Noise Level	50mW	50mW	50mW
Maximum Average Power Density W/cm²	700 at 1000W, 150 at 1500W, 60 at 2000W	600	2000
Response Time with Meter (0-95%) typ. s	7	7	7
Calibration Uncertainty ±%	1.9	1.9	1.9
Power Accuracy ±%	3 [a]	3 [a]	4 [a]
Linearity with Power ±%	2	2	2
Energy Mode			
Energy Range	6J – 6000J	6J – 6000J	6J – 6000J
Energy Scales	6kJ / 600J / 60J	6kJ / 600J / 60J	6kJ / 600J / 60J
Minimum Energy	6J	6J	6J
Maximum Energy Density J/cm²		Single 10 – 50Hz [c]	Single 10-50Hz [c]
<100ns	0.3	3 [d] 1.5	3 [d] 1.5
1µs	0.4	3 [d] 1.5	3 [d] 1.5
0.5ms	5	7 7	7 7
2ms	10	15 15	15 15
10ms	30	40 40	40 40
1s	4000	3000 NA	3000 NA
Cooling	water	water	convection or conduction
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]	NA
Fiber Adapters	Consult Ophir representative	Consult Ophir representative	Consult Ophir representative
Accessories for High Power Sensors	See pages 97-100	See pages 97-100	See pages 97-100
Weight kg	4.5	4.5	4.4
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version			
Part number	**7Z02751**	**7Z02792**	**7Z02765**
Notes: (a)	Calibrated for ~0.8µm, 1.064µm and 10.6µm	Calibrated for 1.07µm. Max additional error at other wavelengths not specified above: ±1%	Calibrated for 0.25 – 2µm
Notes: (b)	Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.06MPa.	Water temperature range 18-30°C. Water temperature rate of change <1°C/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	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 1.5J/cm² for wavelengths <500nm	Damage threshold 1.5J/cm² for wavelengths <500nm

* For drawings please see page 84

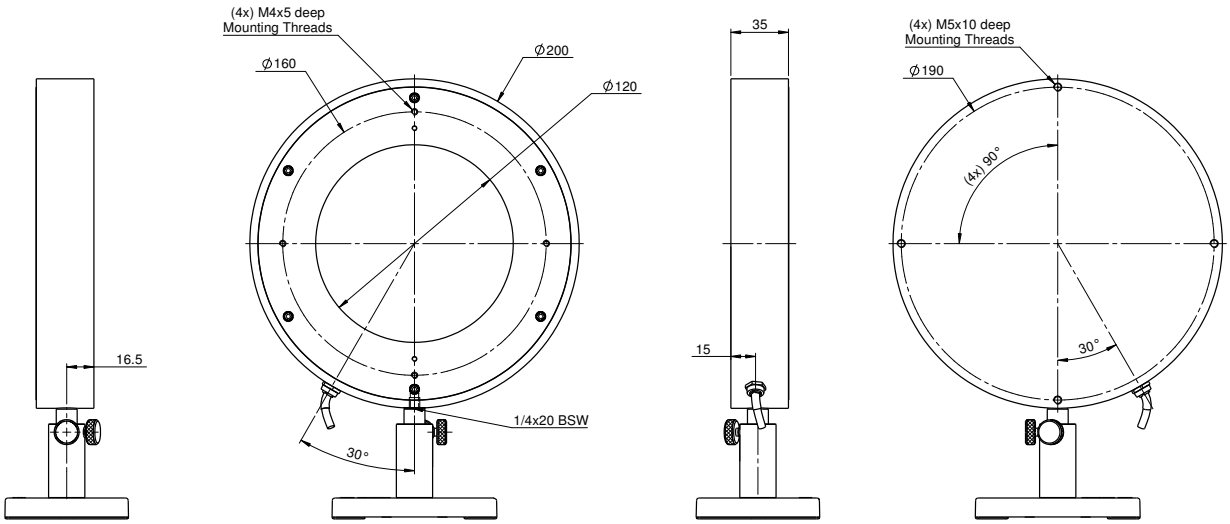
L2000W-BB-120 / L2000W-PF-120



Front Side

Back Side

L100(500)A-PF-120



Front Side

Back Side

1.1.2.7 High Power Thermal Sensors

1.1.2.7.2 High Power Water Cooled Thermal Sensors

20W to 5000W

Features

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

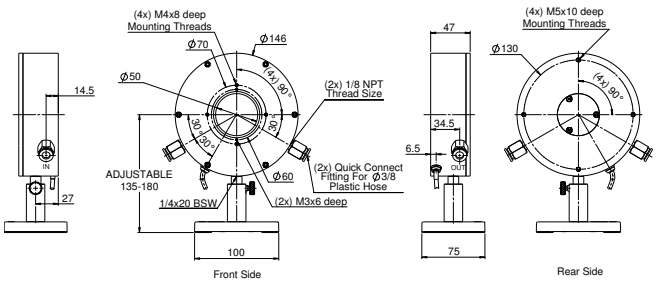
5000W-BB-50

5000W-LP2-50

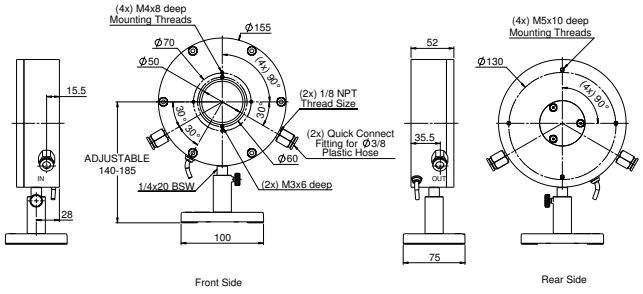
5000WP-LP2-50

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 1.1µm
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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	4 [a]	4 [a]
Linearity with Power ±%	2	2
Energy Mode		
Energy Range	NA	NA
Energy Scales	NA	NA
Minimum Energy mJ	NA	NA
Maximum Energy Density J/cm²		
<100ns	0.3	0.1
1µs	0.4	0.9
0.5ms	5	50
2ms	10	130
10ms	30	400
Cooling	water	water
Fiber Adapters	QBH-Fiber Adapter (see page 97)	For 5000W-LP2-50: QBH-Fiber Adapter (see page 97)
Accessories for High Power Sensors	See pages 97-100	See pages 97-100
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	**7Z07111**	**7Z07135 / 7Z02788**
Notes: (a)	Calibrated for ~0.8µm, 1.064µm and 10.6µm	For spectral range 0.35 to 1.1µm
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 Calorimetric Power Meter

200W to 6000W

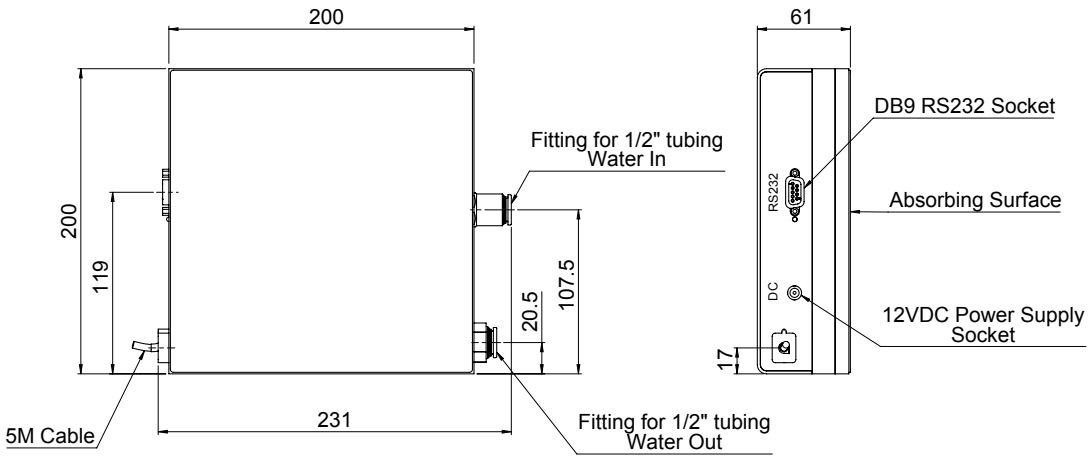
Features

- 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 x198mm
Power Mode	
Power Range	200W – 6000W
Power Scales	6kW / 1kW
Power Noise Level	5W
Maximum Average Power Density kW/cm²	1.5 at 1000W 0.4 at 6000W
Response Time with Meter (0-95%) typ. s	50
Calibration Uncertainty ±%	1.9
Power Accuracy ±%	4 [a] [b]
Linearity with Power ±%	2 [b]
Maximum Energy Density J/cm²	
<100ns	0.3
1µs	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 ~0.8µm and 1.08µm at flow rate of 6 liters/min. Calibration for 10.6µm 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 ±2% for flow rates between 4 and 8 liters/min. Water temperature range 15-25°C. Water temperature rate of change <1°C/min, at max power, proportionately less at lower power. Pressure drop across sensor 0.05MPa. Water should be filtered with a <50µm filter.

6K-W-BB-200 x 200



1.1.2.7 High Power Thermal Sensors

1.1.2.7.4 Very High Power Water Cooled Thermal Sensors

100W to 11kW

Features

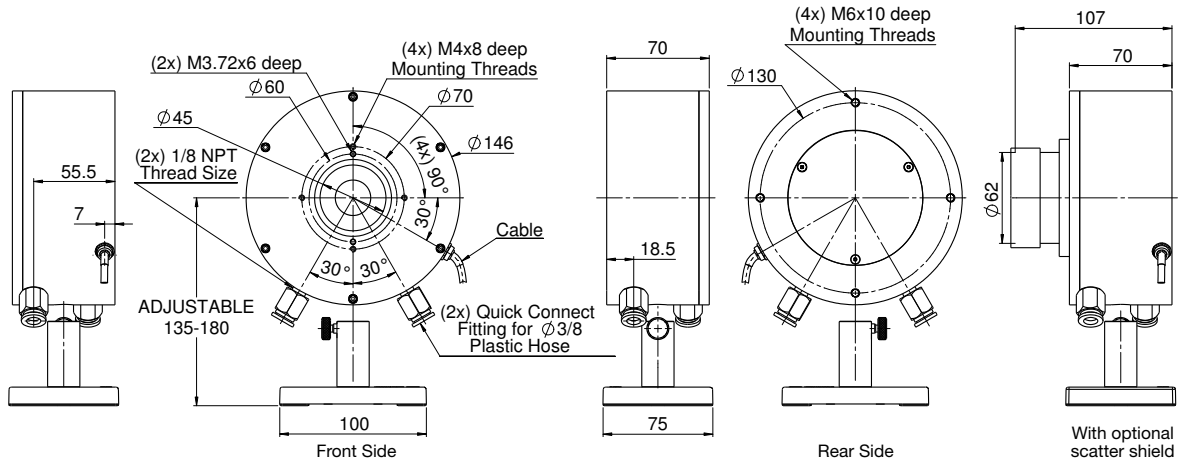
- Very high powers
- Water cooled
- Up to 11kW
- Up to Ø45mm apertures

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, e]	~3.5% without Scatter Shield, ~1% with Scatter Shield				
Maximum Average Power Density kW/cm²	See note [c] and table [1] below				
Response Time with Meter (0-95%) typ. s	2.7				
Calibration Uncertainty ±%	1.9				
Power Accuracy ±%	5 [a]				
Linearity with Power ±%	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 92				
Note: (a)	Calibrated at 1.07µm and 10.6µm. For other wavelengths in the ranges of 0.8 - 0.95µm & 1.1 - 2µm add up to ±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 ¼ 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 97-100.				
Table: (1)	Beam diameter	Max power density	Max energy density		
			1ms pulse width	3ms pulse width	10ms pulse width
	<15mm	10kW/cm²	30J/cm²	60J/cm²	150J/cm²
	15 - 20mm	7kW/cm²	20J/cm²	40J/cm²	100J/cm²
	20 - 40mm	5kW/cm²	15J/cm²	30J/cm²	70J/cm²
	40 - 45mm	4kW/cm²	12J/cm²	25J/cm²	60J/cm²

10K-W-BB-45



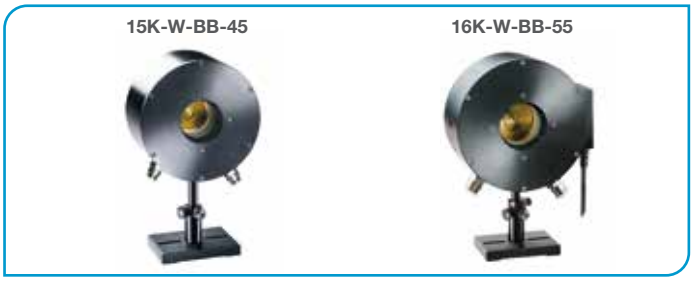
1.1.2.7 High Power Thermal Sensors

1.1.2.7.4 Very High Power Water Cooled Thermal Sensor

100W to 16kW

Features

- Very high powers
- Water cooled
- Up to 16kW
- Up to Ø55mm apertures
- Over temperature alarm and interlock



Model	15K-W-BB-45	16K-W-BB-55
Use	**High power up to 15kW**	**High power up to 16kW, larger aperture, over temperature alarm and interlock**
Absorber Type	Beam deflector + broadband absorber	Beam deflector + broadband absorber
Spectral Range µm [a]	0.8 - 2, 10.6	0.8 – 2, 10.6
Aperture mm	Ø45mm	Ø55mm
Power Range	100W – 15kW	100W – 16kW
Power Scales	15kW / 4kW / 400W	16kW / 4kW / 400W
Power Noise Level	1W	1W
Backscattered Power [b, e]	~3.5% without Scatter Shield, ~1% with Scatter Shield	~3.5% without Scatter Shield, ~1% with Scatter Shield
Maximum Average Power Density kW/cm²	See note [c] and table [1] below	See note [c] and table [1] below
Response Time with Meter (0-95%) typ. s	3.5	3.5
Calibration Uncertainty ±%	1.9	1.9
Power Accuracy ±%	5 [a]	5 [a]
Linearity with Power ±%	2	2
Variation with Beam Size	±1.7% from 15 to 30mm	±1% from 10 to 35mm
Cooling	water [d]	water [d]
Minimum Water Flow Rate	12 liter/min at full power [d]	12 liter/min at full power [d]
Water Pressure Requirements at Max Flow Rate	Pressure drop across sensor ~0.2MPa	Pressure drop across sensor at full flow rate <0.1MPa
Water Connectors [e]	Quick connector for 3/8" OD nylon tubing	Quick connector for 1/2" OD nylon tubing
Over Temperature Warning / Interlock	N.A.	Module on sensor near output cable with over temperature LED, loud audible signal and M8 3 connector interlock
Cable Length and Connections	5 meters terminated in Ophir DB15 smart connector	Signal: 5 meters terminated in DB15 Interlock: M8 connector with 1.5 meter cable terminated in flying leads: Brown - common, Black - N.C., Blue - N.O. 3 blue, 4 black, 1 brown
Optional Scatter Shield Accessory [e]	10K-W / 15K-W Scatter Shield (P/N 7Z08295)	16K-W Scatter Shield (P/N 7Z08355)
Weight kg	6	8
Compliance	CE, UKCA, China RoHS	CE, UKCA, China RoHS
Version	V2	V2
Part number	**7Z07133**	**7Z07131**

Note: (a) Calibrated at 1.07µm and 10.6µm.
For other wavelengths in the ranges of 0.8 - 0.95µm & 1.1 - 2µm, the calibration error may be up to ±2% more.

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 ¼ of beam diameter. IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR.
Maximum tilt angle ±5 degrees. For rectangular beam please consult Ophir representative.

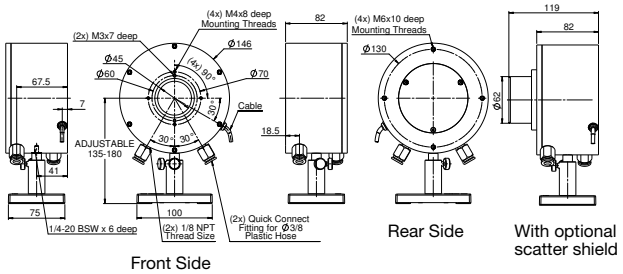
Note: (d) Water temperature range 18-30°C. Water temperature rate of change <1°C/min. The recommended flow rate can be lowered proportionately at lower than full power but should not be below 3 liter/min. The response time will be optimum at near 12 liter/min flow rate. For solutions for prolonged usage with untreated water (tap water, non DI water), please contact Ophir.

Note: (e) For further information and other options see **Accessories for High Power Sensors** on pages 97-100.

Table: (1)

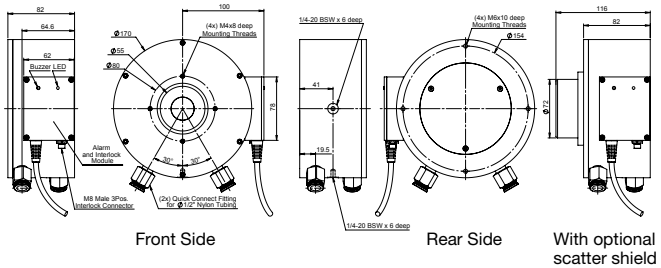
Beam diameter	Max power density	Max energy density		
		1ms pulse width	3ms pulse width	10ms pulse width
<15mm	10kW/cm²	30J/cm²	60J/cm²	150J/cm²
15 - 20mm	7kW/cm²	20J/cm²	40J/cm²	100J/cm²
20 - 40mm	5kW/cm²	15J/cm²	30J/cm²	70J/cm²
40 - 45mm	4kW/cm²	12J/cm²	25J/cm²	60J/cm²

15K-W-BB-45



Front Side | Rear Side | With optional scatter shield

16K-W-BB-55



Front Side | Rear Side | With optional scatter shield

1.1.2.7 High Power Thermal Sensors

1.1.2.7.4 Very High Power Water Cooled Thermal Sensors

100W to 30kW

Features

- Highest 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/cm²	10kW/cm² 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 ±%	1.9
Power Accuracy ±%	5 [a]
Linearity with Power ±%	2
Variation with Beam Size ±%	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°C/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 1.07µm. For other wavelengths in the ranges of 0.8 - 0.95µm & 1.1 – 2µm add up to ± 2% to the calibration error

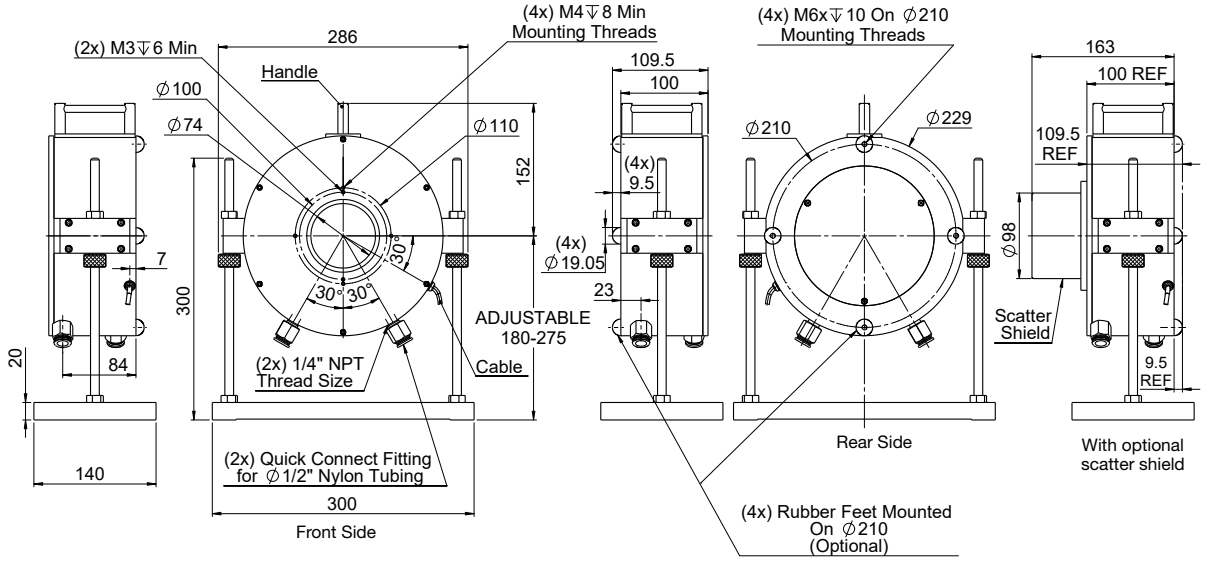
Note: (b) When scatter shield is installed, use the 107S laser setting to compensate for the slightly higher reading. When not installed, use the 107 setting

Note: (c) For further information and options see **Accessories for High Power Sensors** on pages 97-100

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

* For drawings please see page 90

30K-W-BB-74


(2x) M3↧6 Min
286
(4x) M4↧8 Min
Mounting Threads
(4x) M6x↧10 On ∅210
Mounting Threads
163
Handle
∅100
∅74
∅110
109.5
100
100 REF
∅210
∅229
109.5
REF
152
(4x)
9.5
7
30°
30°
30°
(4x)
∅19.05
∅98
300
ADJUSTABLE
180-275
23
Scatter
Shield
20
84
(2x) 1/4" NPT
Thread Size
Cable
9.5
REF
140
(2x) Quick Connect Fitting
for ∅1/2" Nylon Tubing
300
Front Side
Rear Side
With optional
scatter shield
(4x) Rubber Feet Mounted
On ∅210
(Optional)

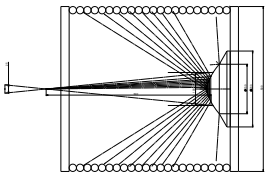
1.1.2.7 High Power Thermal Sensors

1.1.2.7.5 Very High Power Water Cooled Calorimetric Sensors

100W to 120kW

Features

- Highest powers
- Calorimetric
- Up to 120kW
- Ø200mm aperture



Laser Beam Path

120K-W

Model	120K-W
Use	**Measuring Highest powers to 120kW**
Measurement Type	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]
Aperture mm	Ø200
Power Range for Calibrated Reading	10kW – 120kW
Power Noise Level	±20W with stable water temperature
Backscattered Power	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).
Beam Centering Requirements IMPROPERLY CENTERED BEAM CAN CAUSE DAMAGE TO SENSOR	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
Calibration Uncertainty ±%	1.9
Power Accuracy ±%	5 [a]
Linearity with Power ±%	2
Variation with Beam Size ±%	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 Pressure Drop across Beam Absorber	0.4MPa at 60 liter/min flow rate
Water Connections	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.
Dimensions	See drawing on next page
Weight kg	Beam Absorber 50kg. Power measuring unit 10kg
Compliance	CE, UKCA, China RoHS
Version	
Part number	**7Z02691**

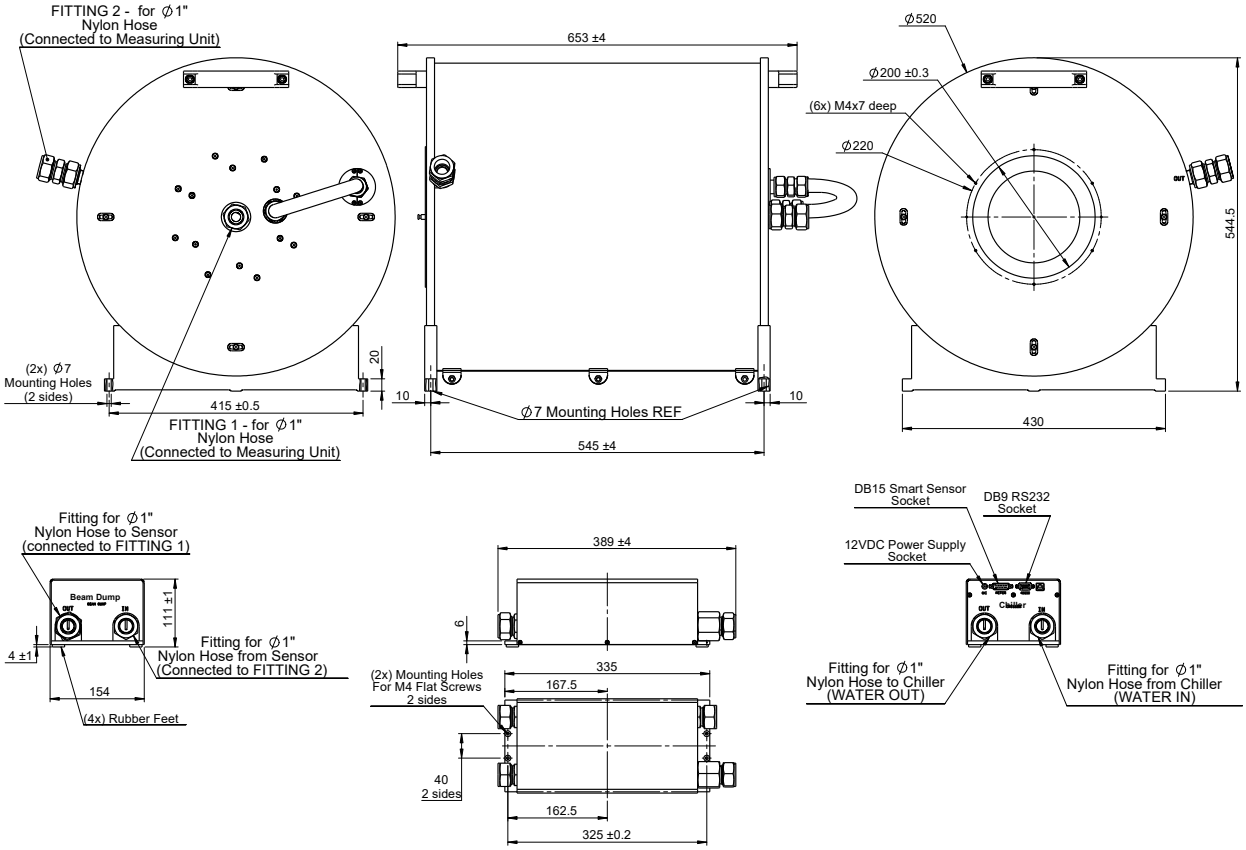
Note: (a) Calibrated for 1.07 µm

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 90B

120K-W


FITTING 2 - for ∅1"
Nylon Hose
(Connected to Measuring Unit)
653 ±4
∅520
∅200 ±0.3
(6x) M4x7 deep
∅220
544.5
(2x) ∅7
Mounting Holes
(2 sides)
20
415 ±0.5
FITTING 1 - for ∅1"
Nylon Hose
(Connected to Measuring Unit)
10
∅7 Mounting Holes REF
10
545 ±4
430
Fitting for ∅1"
Nylon Hose to Sensor
(connected to FITTING 1)
Beam Dump
OUT
IN
111 ±1
4 ±1
154
(4x) Rubber Feet
Fitting for ∅1"
Nylon Hose from Sensor
(Connected to FITTING 2)
389 ±4
6
(2x) Mounting Holes
For M4 Flat Screws
2 sides
335
167.5
40
2 sides
162.5
325 ±0.2
DB15 Smart Sensor
Socket
DB9 RS232
Socket
12VDC Power Supply
Socket
Chiller
OUT
IN
Fitting for ∅1"
Nylon Hose to Chiller
(WATER OUT)
Fitting for ∅1"
Nylon Hose from Chiller
(WATER IN)

1.1.2.8 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

1.1.2.8 IPM Industrial High Power Sensor

1.1.2.8.1 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	Ø45mm
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 Sheild, ~1% [b] Without IPM-SHUTTER10 or 10K-W/15K-W Scatter Sheild 3.5 [b]
Maximum Average Power Density kW/cm²	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 ±%	1.9
Power Accuracy ±%	5 [a]
Repeatability ±%	0.4
Linearity with Power ±% (0-100% range)	2
Linearity with Power ±% (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/cm²	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 100)
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	P/N
IPM-SHUTTER10	Combined protective shutter with built in scatter shield, IP62 rated	7Z08409
IPM-SHUTTER10 Window replacement kit	Replacement anti reflective coated window	7Z08411
10K-W / 15K-W Scatter Shield	Scatter Shield for mounting on front flange	7Z08295
IPM-COM-Profinet	Profinet communications adapter with AIDA connectors	7Z08404
IPM-COM-EtherNet/IP-M	EtherNet/IP communications adapter with circular connectors (M12 & 7/8)	7Z08405

Compliance	CE, UKCA, China RoHS
Part number	**7Z07106**

Note: (a) Calibrated at 1.07µm and 10.6µm. When working at 10.6µm (CO2), if using the SHUTTER10 unit, the window should be removed.

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 ±5 degrees.
For rectangular beam please consult Ophir representative.

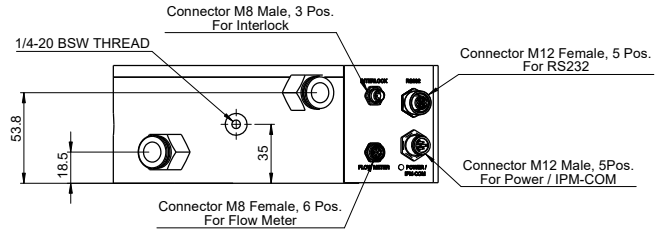
Note: (d) Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across sensor 0.1MPa. The recommended flow rate can be lowered proportionately at lower than full power but should not be below 3 liter/min. The response time will be optimal with the recommended flow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

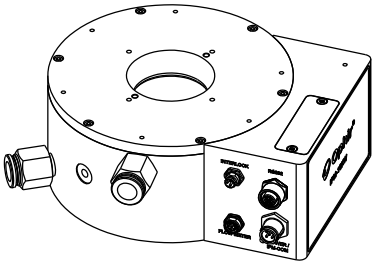
Note: (e) See IPM User Manual for details of connectors and cables

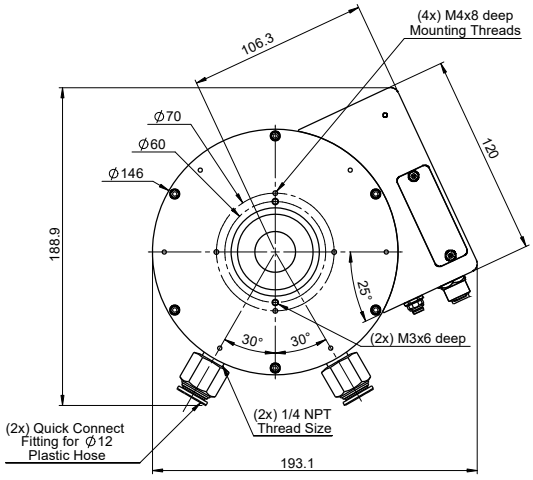
Table (1)	Beam diameter	Max power density	Max energy density – by pulse width			
			1ms PW	3ms PW	10ms PW	100ms PW
	<15mm	10kW/cm²	30J/cm²	60J/cm²	150J/cm²	1350 J/cm²
	15 – 20mm	7kW/cm²	20J/cm²	40J/cm²	100J/cm²	900 J/cm²
	20 – 40mm	5kW/cm²	15J/cm²	30J/cm²	70J/cm²	600 J/cm²
	40 – 45mm	4kW/cm²	12J/cm²	25J/cm²	60J/cm²	500 J/cm²

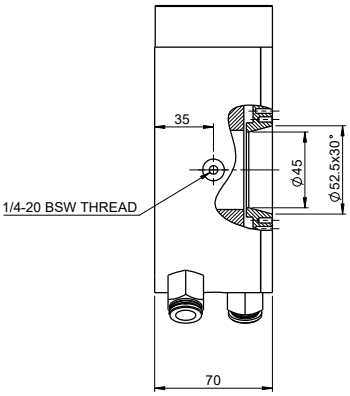
* For drawings please see page 93

IPM-10KW


Connector M8 Male, 3 Pos.
For Interlock
1/4-20 BSW THREAD
Connector M12 Female, 5 Pos.
For RS232
53.8
18.5
35
Connector M12 Male, 5Pos.
For Power / IPM-COM
Connector M8 Female, 6 Pos.
For Flow Meter




106.3
(4x) M4x8 deep
Mounting Threads
Ø70
Ø60
Ø146
120
188.9
25°
30°
30°
(2x) M3x6 deep
(2x) 1/4 NPT
Thread Size
(2x) Quick Connect
Fitting for Ø12
Plastic Hose
193.1


35
Ø45
Ø52.5x30°
1/4-20 BSW THREAD
70

1.1.2.8 IPM Industrial High Power Sensor

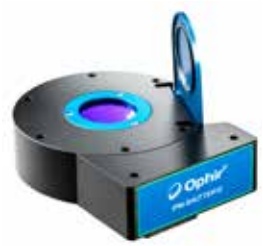
1.1.2.8.2 IPM-SHUTTER10 Shutter Assembly for IPM-10KW

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

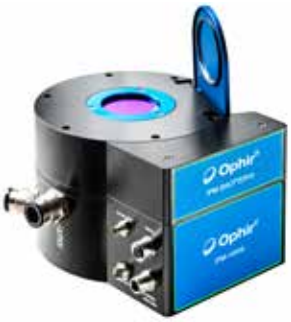
- Built-in scatter shield
- Antireflective coated window [(a)]
- Motorized dust-resistant shutter
- IP62 rated

IPM-Shutter10



IPM-10KW with IPM-Shutter10

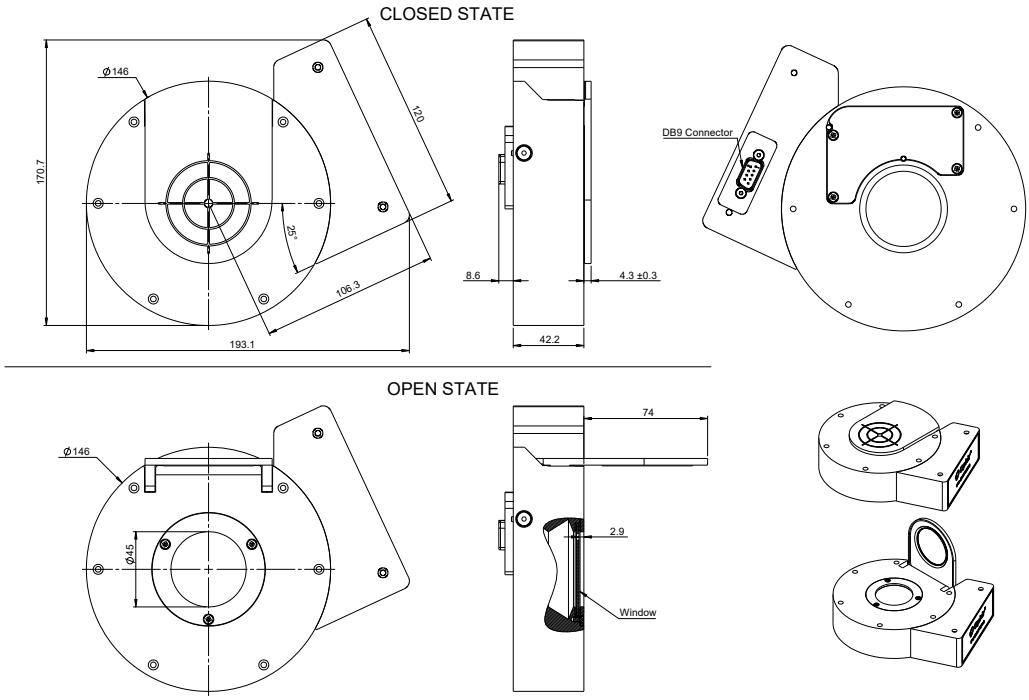
With shutter open



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 10.6um (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



1.1.2.8 IPM Industrial High Power Sensor

1.1.2.8.3 IPM-COM – IPM adapter for industrial protocols

Modern automation systems integrate equipment from multiple vendors into a common Ethernet infrastructure. The IPM-COM is an industrial communication module enabling the integration of the IPM industrial sensor into Profinet or EtherNet/IP automation systems. For additional protocols please approach your local Ophir sales representative.

Features

- Connects to the IPM sensor to provide industrial communication protocols
- Supports communication and power daisy chaining
- Supports Profinet, EtherNet/IP
- Industrial ruggedized housing and connectors
- Two connector options: M12 & Mini 7/8", or AIDA

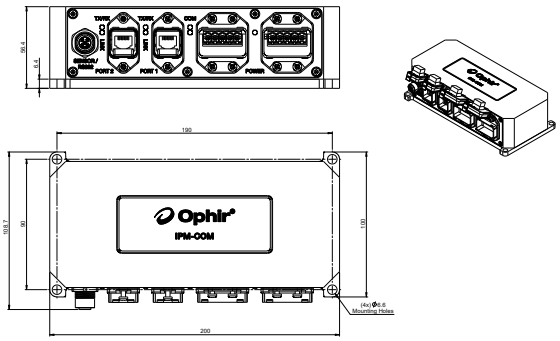
IPM-COM-Profinet

IPM-COM-EtherNet/IP-M

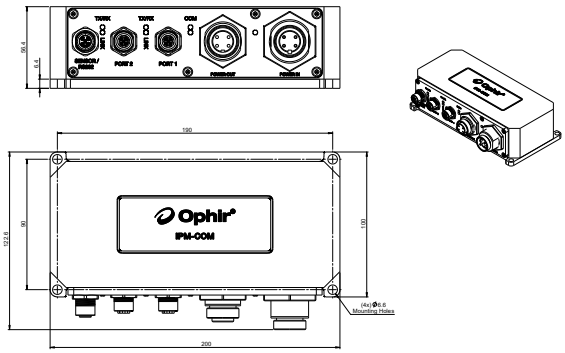
Model	IPM-COM				
Use	**Support industrial communication protocols for IPM sensor**				
Connectors	2x Industrial Ethernet connectors, 2x 24V power connectors, 1x M12 interconnection with the IPM sensor				
Cables	Cable to IPM sensor, M12 male to M12 female, 5-pin, 1.5m (P/N 7E01540, supplied)				
Weight kg	2				
Part Numbers	**Name**	**Protocol** [a]	**Data Connector** [b]	**Power Connector**	**P/N**
	IPM-COM-Profinet	Profinet	AIDA RJ45	AIDA Power	**7Z08404**
	IPM-COM-EtherNet/IP-M	EtherNet/IP	M12	Mini 7/8"	**7Z08405**
Related Products	**Name**				**P/N**
	IPM-10KW sensor				**7Z07106**
	Combined protective shutter and scatter shield IPM-SHUTTER10				**7Z08409**
	IPM-SHUTTER10 window replacement kit				**7Z08411**
Optional Accessories	**Name**				**P/N**
	Power Cable, Mini 7/8" female, 4-pin, to flying leads, 2m (not supplied)				**7E01535**
	Power Cable, AIDA female, 4-pin, to flying leads, 5m (not supplied)				**7Z10458A**
	Profinet Cable, RJ45 AIDA to RJ45, 5m (not supplied)				**7E01298**
	EtherNet/IP Cable, M12-D to RJ45, 3m (not supplied)				**7E11211**

Notes: (a) Other protocols (EtherCAT, CC-link) can be supported, contact Ophir for more information
Notes: (b) Other combinations of protocol and connector types are possible, contact Ophir for more information

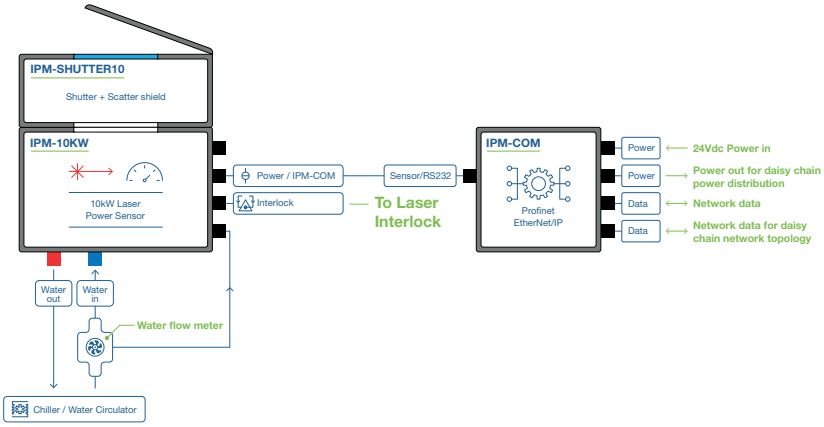
IPM-COM-Profinet (AIDA)



IPM-COM-EtherNet/IP-M (M12, Mini 7/8")



1.1.2.8.4 Full IPM System Setup



1.1.2.9 Beam Dumps

Up to 11kW

Features

- Up to 11kW CW
- Water or Fan cooled
- High Power Density
- Ø45-65mm apertures

BDFL500A-BB-50

BDFL1500A-BB-65

BD5000W-BB-50

BD10K-W

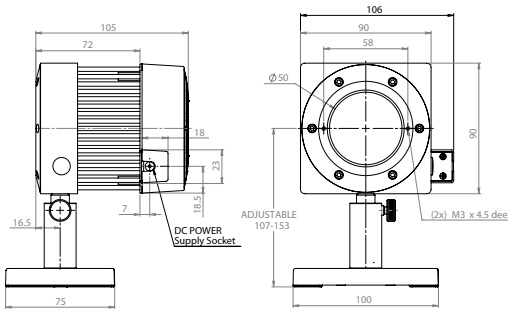
Model	BDFL500A-BB-50	BDFL1500A-BB-65	BD5000W-BB-50	BD10K-W
Use	**General purpose High power beam dump**			
Absorber Type	Broadband	Broadband	Broadband	Beam Deflector + Broadband
Spectral Range µm	0.19 - 20	0.19 - 20	0.19 - 20	0.8 - 20
Typical Absorption	86% for 600 to 2500nm, 82% for 10.6µm			
Aperture mm	Ø50mm	Ø65mm	Ø50mm	Ø45mm
Maximum Incident Power	500W	1500W	5000W	11,000W
Maximum Average Power Density	7kW/cm²	6kW/cm² at 1000W 1.5kW/cm² at 1500W	6kW/cm² at 1000W 3kW/cm² at 5000W	See note [b] below
Maximum Energy Density J/cm²				See note [b] below
<100ns	0.3	0.3	0.3	
1µs	0.4	0.4	0.4	
0.5ms	5	5	5	
2ms	10	10	10	
10ms	30	30	30	
Cooling	fan	fan	water	water
Minimum Water Flow Rate at Full Power	N/A	N/A	5 liter/min [a]	8 liter/min [a]
Accessories for High Power Sensors	See pages 97-100	See pages 97-100	See pages 97-100	See pages 97-100
Weight kg	0.9	2.4	2.8	4.5
Compliance	RoHS, China RoHS	RoHS, China RoHS	RoHS, China RoHS	RoHS, China RoHS
Version			V2	V1
Part number	**7Z17200**	**7Z17203**	**7Z17206**	**7Z17205**

Note: (a) Water temperature range 18-30°C. Water temperature rate of change <1°C/min. Pressure drop across BD5000W-BB-50 beam dump 0.06MPa. Pressure drop across BD10K-W beam dump 0.1MPa.

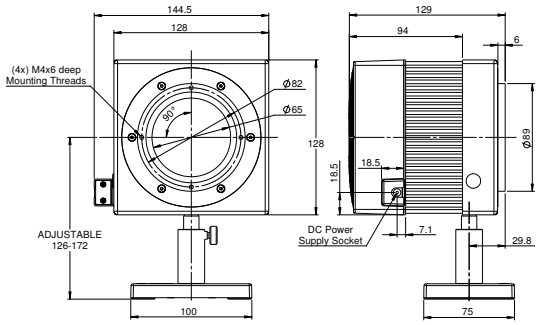
Note: (b) Max power and energy density

Beam diameter	Max power density	Max energy density		
		1ms pulse width	3ms pulse width	10ms pulse width
<15mm	10kW/cm²	30J/cm²	60J/cm²	150J/cm²
15 - 20mm	7kW/cm²	20J/cm²	40J/cm²	100J/cm²
20 - 40mm	5kW/cm²	15J/cm²	30J/cm²	70J/cm²
40 - 45mm	4kW/cm²	12J/cm²	25J/cm²	60J/cm²

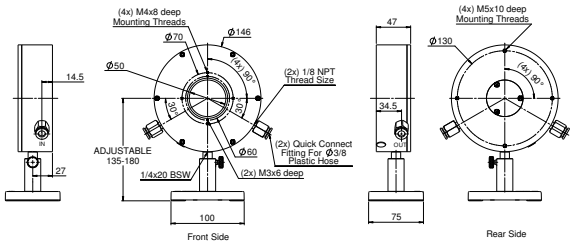
BDFL500A-BB-50



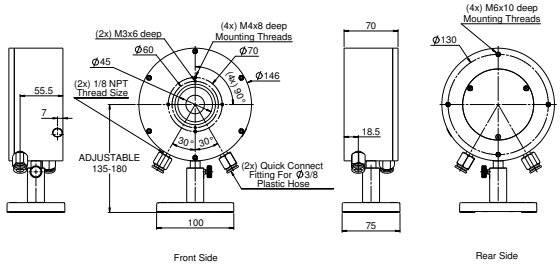
BDFL1500A-BB-65



BD5000W-BB-50



BD10K-W



1.1.2.10 Accessories for High Power Water Cooled Sensors

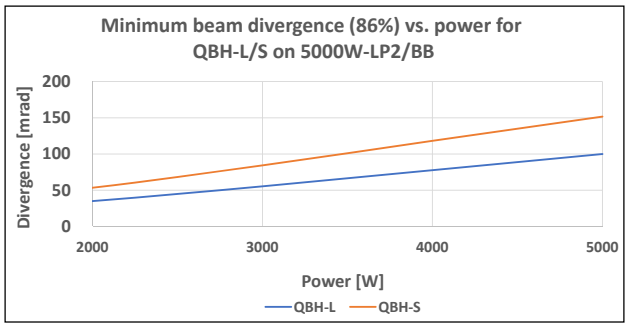
1.1.2.10.1 Fiber Adapter for Ophir High Power Sensors

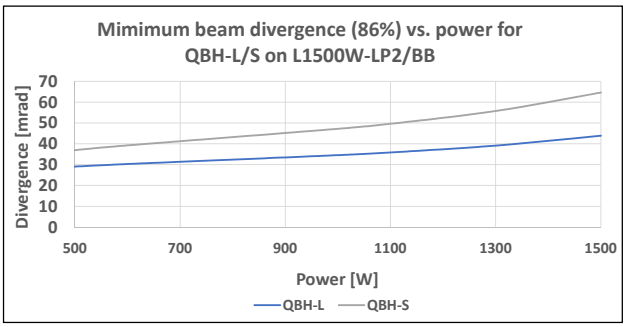
Adapters for high power fiber connectors are available for Ophir sensors L1500W and 5000W for use in industrial environments.
The fiber adapters allow mounting of QBH fiber terminators to Ophir sensors. When using an adapter, the fiber output is centered on the sensor surface and is isolated from surrounding 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**

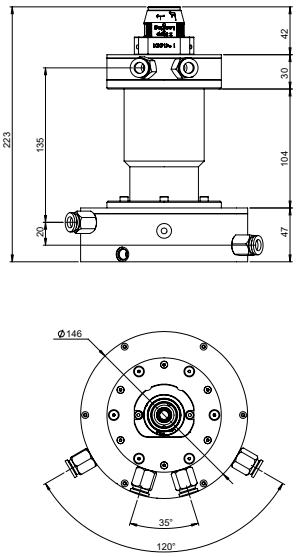
Note: (a) Please note that older versions of the above sensors do not have the requisite 4 threads on Ø70mm circle on their front flange and cannot be used with the QBH adapter.
Note: (b) When using BB type coatings temperature may reach 80°C at midpoint of adapter.
Note: (c) The water flow requirements 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 100.
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:

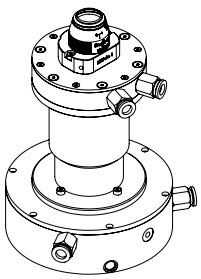




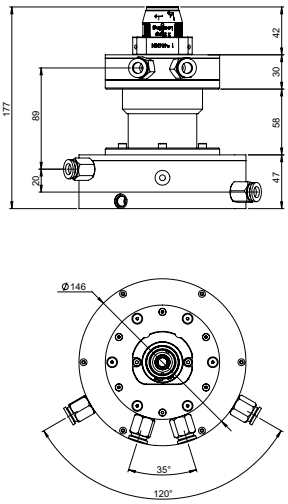
High Power QBH-Fiber Adapter Mounted on a 5000W-LP2-50 Sensor

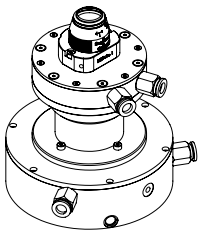
QBH-L-Fiber Adapter





QBH-S-Fiber Adapter



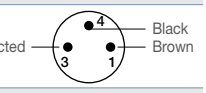


1.1.2.10 Accessories for High Power Water Cooled Sensors

1.1.2.10.2 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)].

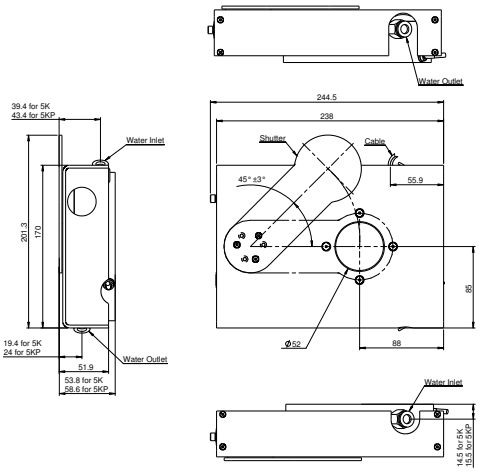
Protective Housing for 5000W / 10K-W / 15K-W
Mounted on Sensor (shutter open)
Rear view (cables and water connector)

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	
Dimensions	See drawing below	
Housing Material	Sheet aluminum	
Version	V1	
Part number	**7Z08344**	

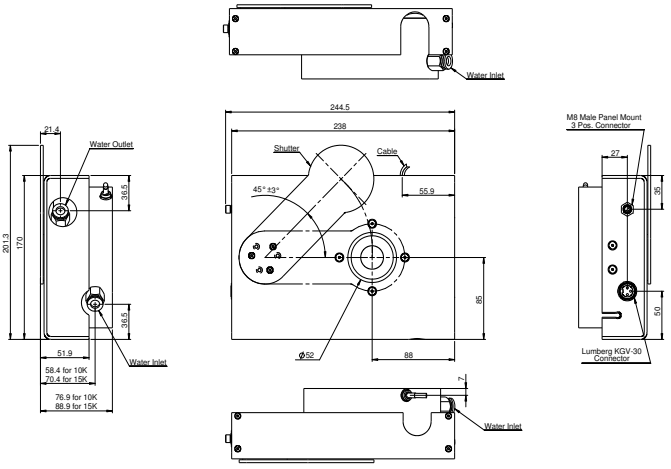
Note: (a) When fitting the housing to previous versions of the above sensors not having the requisite threads on their front flange, it will be necessary to exchange the front flange of the sensor with a new one having the requisite mounting threads. For details, consult Ophir representative.

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

As mounted on 5000W



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



1.1.2.10 Accessories for High Power Water Cooled Sensors

1.1.2.10.3 Scatter Shield

Scatter Shield for mounting on front flange of 10K-W / 15K-W, 16K-W and 30K-W to reduce backscattered power.

3 to 4% of the light impinging on the 10K-W, 15K-W, 16K-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.

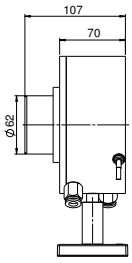
Since some of the light is reabsorbed, the power reading is 1-1.5% higher than without the shield, so an additional laser setting is given for use when the shield is mounted to adjust for this difference.

The scatter shield comes with a protective cover with target pattern for alignment that also can be purchased separately, (see page 100).

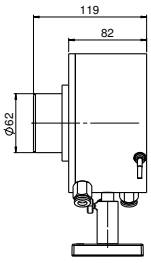
Scatter Shield with protective cover

Scatter Shield without protective cover

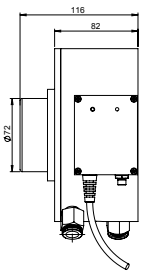
10K-W with Scatter Shield



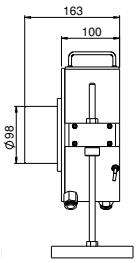
15K-W with Scatter Shield



16K-W with Scatter Shield



30K-W with Scatter Shield

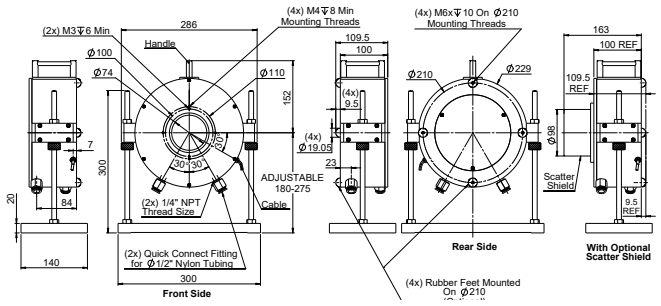


Model	10K-W / 15K-W Scatter Shield	16K-W Scatter Shield	30K-W Scatter Shield
Wavelength range of use	0.8 – 2µm	0.8 – 2µm	0.8 – 2µm
Laser setting with and without shield	with NIRS, without NIR	with NIRS, without NIR	with 107S, without 107
Backscatter with and without shield	with 1%, without 3.5%	with 1%, without 3.2%	with 1.4%, without 4.3%
Part number	**7Z08295**	**7Z08355**	**7Z08293**

1.1.2.10.4 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

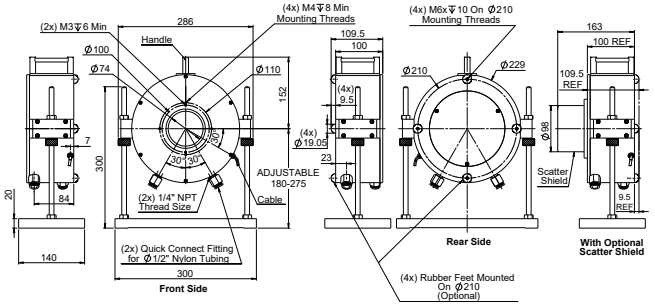


Heavy Duty Stand for 10K-W and 15K-W (Shown with a 15K-W sensor)

1.1.2.10.5 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



1.1.2.10 Accessories for High Power Water Cooled Sensors

1.1.2.10.6 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	16K-W & 30K-W	7Z08352
1/8" NPT to 10mm O.D. tubing	All other water cooled sensors & QBH Adapters	7Z08353

7Z08352 1/4" - 12mm

7Z08353 1/8" - 10mm

1.1.2.10.7 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 16K-W sensor is supplied with the 16K-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), 16K-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 99.

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

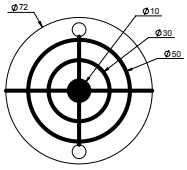
Sensor with 10K-W Protective Cover

Sensor with 30K-W Protective Cover

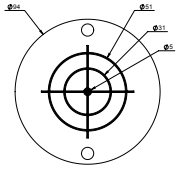
Protective Cover on Scatter Shield

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
16K-W Protective Cover	16K-W without Scatter Shield	1G02813
30K-W Protective Cover	30K-W without Scatter Shield	1G02406
30K-W Scatter Shield Cover	30K-W with Scatter Shield	7Z08346

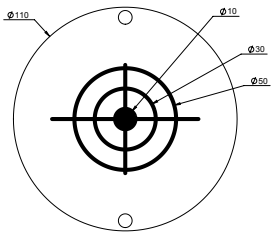
10K-W Protective Cover



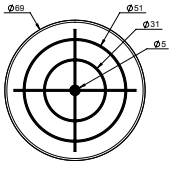
16K-W Protective Cover



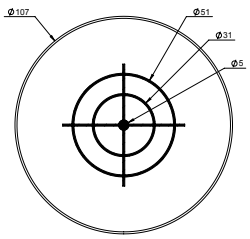
30K-W Protective Cover



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



30K-W Scatter Shield Cover



1.1.2.11 Short Exposure High Power Sensors

1.1.2.11.1 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 102 and for drawings see page 103

Specifications of Helios Pro (following the Model Table on page 101)

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 ø50mm With Diffuser ø35 mm
Max Beam Diameter	Without Diffuser 35mm With Diffuser 20mm
Calibration Uncertainty	±1.9%
Accuracy [b]	Without Diffuser: ±3% (900 - 1100nm), 532nm; ±3.5% (450 - 550nm) With Diffuser: ±3% (940 - 1100nm); ±4% (450 - 550nm)
Linearity with Energy	±1.5% [c]
Reproducibility	±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 ±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

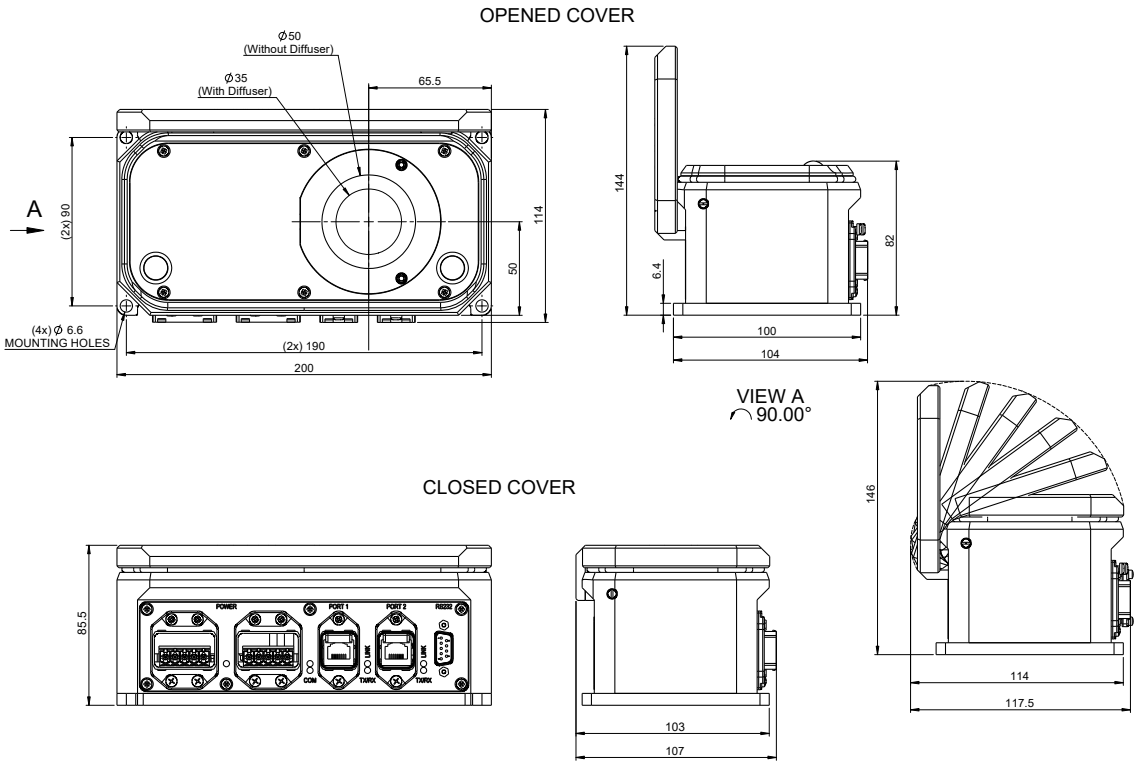
Cover	Motor driven cover opens sideways
Accessories Supplied with Helios Pro	Model: Profinet, EtherNet/IP, EtherCAT - 1. Power Supply Cable, AIDA to flying leads termination 5m (P/N 7Z10458A) 2. Data Cable, Ethernet AIDA to RJ-45 5m (P/N 7E01299) Model: EtherNet/IP-M - 1. Power Supply Cable, 7/8" to flying leads termination 2m (P/N 7E01535) 2. D9F to D9M Shielded 3m RS232 Cable (P/N 7E11216A)
Optional Accessories	Model: EtherNet/IP-M - 1. Data Cable, Ethernet M12 to RJ-45 plug IP67 3m Cable (P/N 7E11211) For all Modes: - 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.

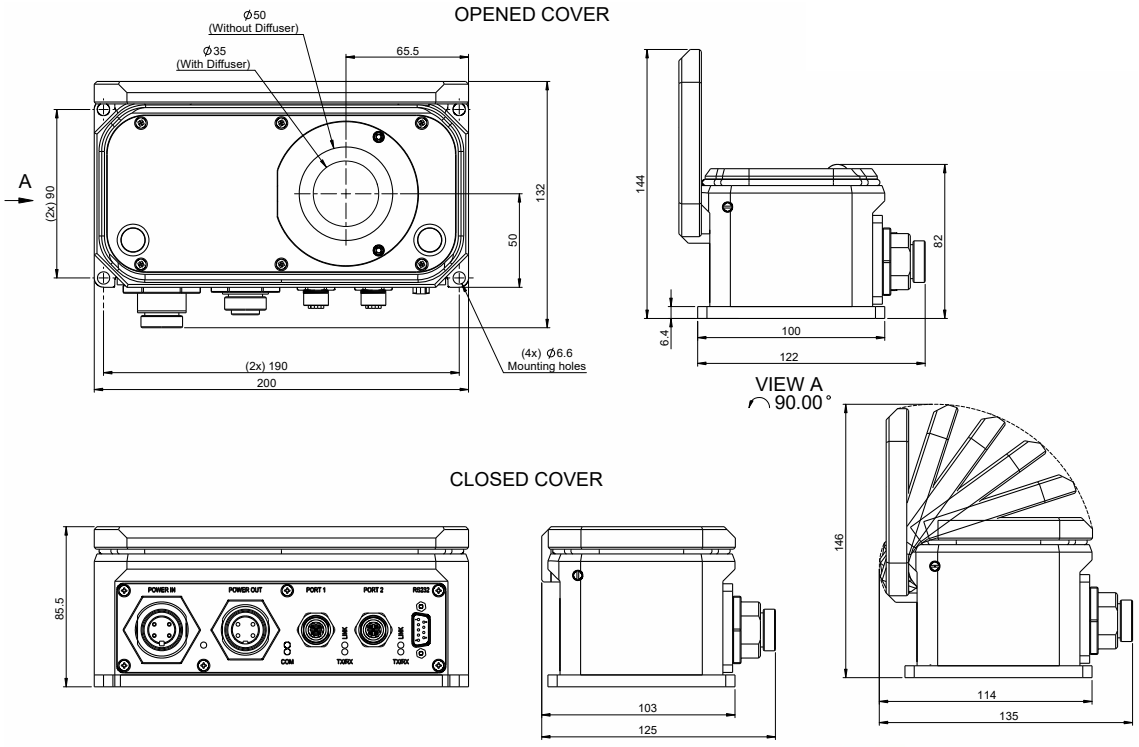
* For drawings please see page 103

Helios Pro Drawings

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



Helios Pro - EtherNet/IP-M



1.1.2.11 Short Exposure High Power Sensors

1.1.2.11.2 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

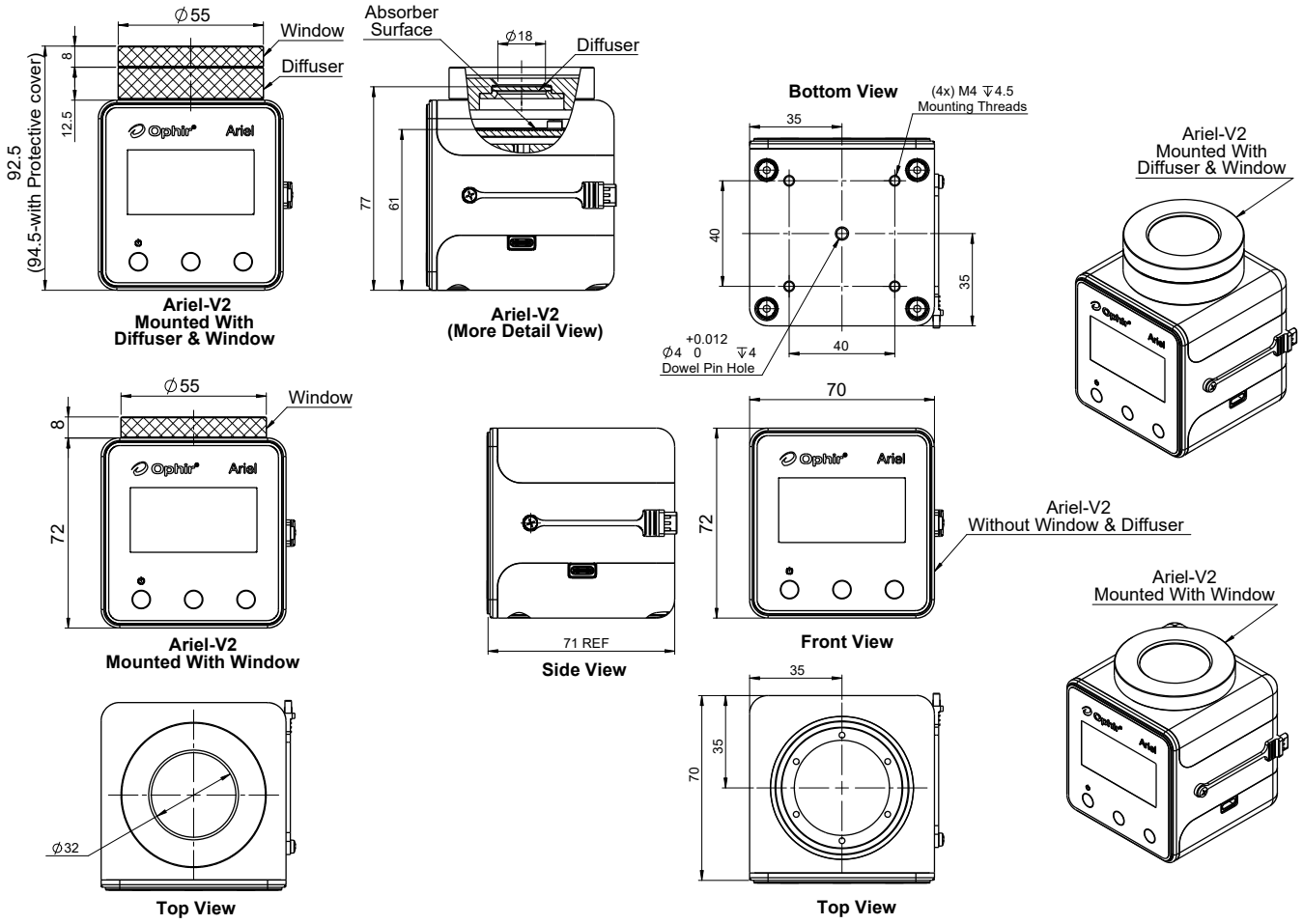
The Ariel measures high power industrial lasers of up to 8kW by measuring the energy of a short exposure to this power. The laser is set to deliver a pulse of from 0.05 to several seconds. It then measures the energy and duration of the laser pulse and calculates the power. Ariel can also measure continues 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/e² Gaussian Beam Diameters	Laser Power W	Recommended Exposure s	Min 1/e² beam dia. Without diffuser [mm]	Min 1/e² beam dia. With diffuser (max dia. is 10mm) [mm]
Continuous Power Measurement	30	Continuous [f]	1	0.3
	500	20 [f]	4	2
Power Measurement from Short Exposure	500	2	4	1
	1000	1	6	1
	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 105

Ariel


∅55
Window
Diffuser
8
12.5
92.5
(94.5-with Protective cover)
Ariel-V2
Mounted With
Diffuser & Window
Absorber
Surface
∅18
Diffuser
77
61
Ariel-V2
(More Detail View)
Bottom View
(4x) M4 ↧4.5
Mounting Threads
35
40
35
40
+0.012
∅4 0 ↧4
Dowel Pin Hole
Ariel-V2
Mounted With
Diffuser & Window
∅55
Window
8
72
Ariel-V2
Mounted With Window
71 REF
Side View
70
72
Front View
Ariel-V2
Without Window & Diffuser
Ariel-V2
Mounted With Window
∅32
Top View
35
70
35
Top View


Window
With diffuser and protective window
Protective cover
Positioning hole
Heatsink
mounting
screw holes
USB rubber plug

1.1.2.11 Short Exposure High Power Sensors

1.1.2.11.3 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

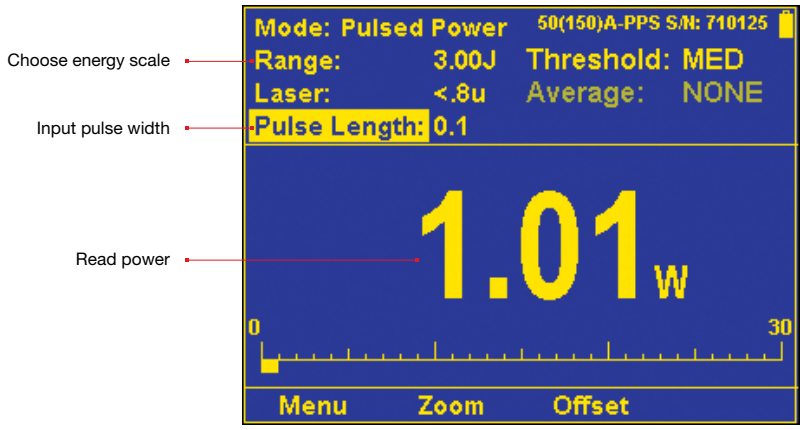
If the full features of the Helios Plus or Ariel including protective cover, Profinet interface and pulse width measurement are not needed, similar performance can be obtained with the L40(250)A-LP2-50 and L40(500)A-LP2-DIF-35. The L40(250)A-LP2-50 has the same sensor as the Helios Plus. It can measure 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 & 151.

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 sinked		
Maximum CW power density	20kW/cm² at 250W			>150kW/cm² at 500W			42kW/cm² 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/e² beam dia. mm	Laser Power W	Recommended Exposure s	Min 1/e² beam dia. mm	Laser Power W	Recommended Exposure s	Min 1/e² 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 151)		

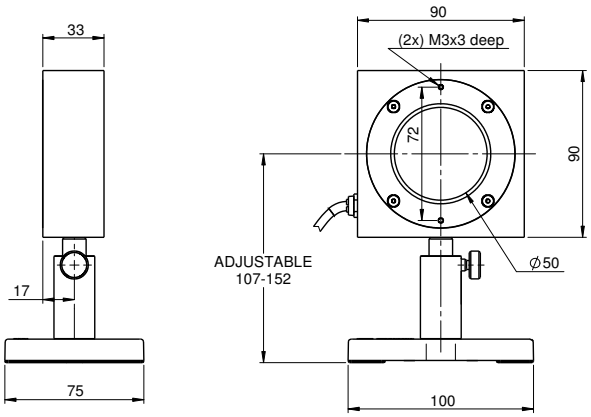
Notes: (a) Above 1100nm there is an additional 1% uncertainty
(b) Repetitive pulses can also be measured as long as the total exposure time is within this range
(c) The power is calculated by measuring the energy and exposure time. The laser pulse is assumed to be rectangular for this calculation
(d) 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 107

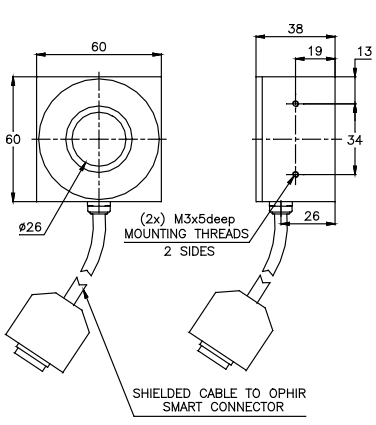
Pulsed Power Mode Screen:



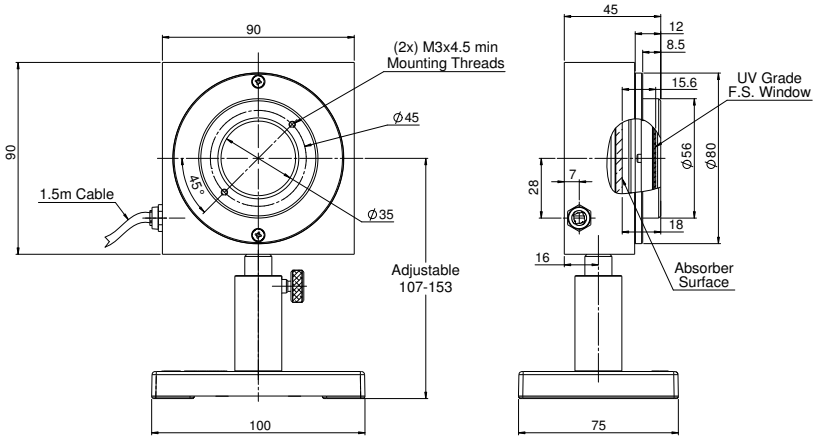
L40(250)A-LP2-50



L30C-LP2-26-SH



L40(500)A–LP2-DIF-35



1.1.2.11 Short Exposure High Power Sensors

1.1.2.11.4 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

Comet 1K

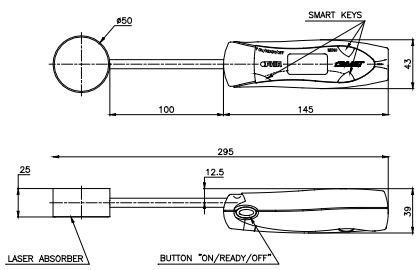
Comet 10K

Comet 10K-HD

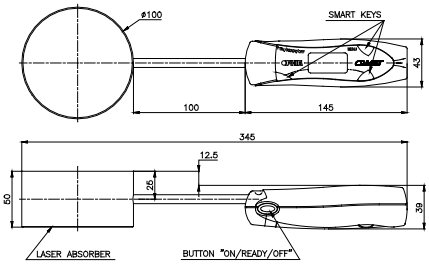
Model	Comet 1K [a]	Comet 10K [a]	Comet 10K-HD [a]
Use	**For powers to 1kW**	**For powers to 10kW**	**For high power density beams**
Absorber Type	Broadband	Broadband	Broadband with reflective cone beam spreader
Spectral Range µm	0.2 - 20	0.98-1.07 and 10.6	0.98-1.07 and 10.6
Aperture mm	Ø50mm	Ø100mm	Ø55mm
Power Mode			
Power Range	20W to 1kW	200W to 10kW	200W to 10kW
Repeatability	±1% for same initial temperature	±1% for same initial temperature	±1% for same initial temperature
Maximum Average Power Density kW/cm²	Power Damage Threshold	Power Damage Threshold	Power Damage Threshold
			Beam dia <40 Beam dia >40
	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 ±%	5	5	5
Linearity with Power ±%	±2% ±1W from 20W to 1kW	±2% from 1kW to 10kW	±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/cm²			
<100ns	0.3	0.3	1
10µs	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.

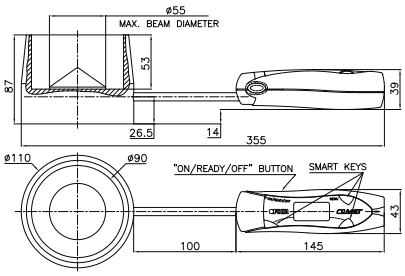
Comet 1K



Comet 10K



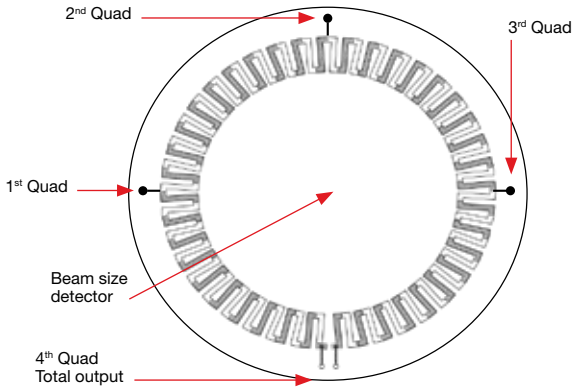
Comet 10K-HD



1.1.3 BeamTrack Power / Position / Size Sensors

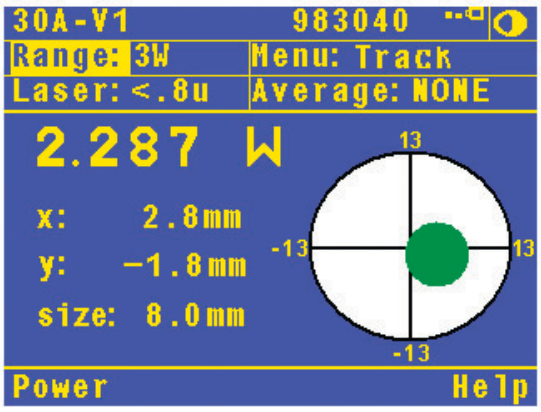
1.1.3.1 Introduction

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

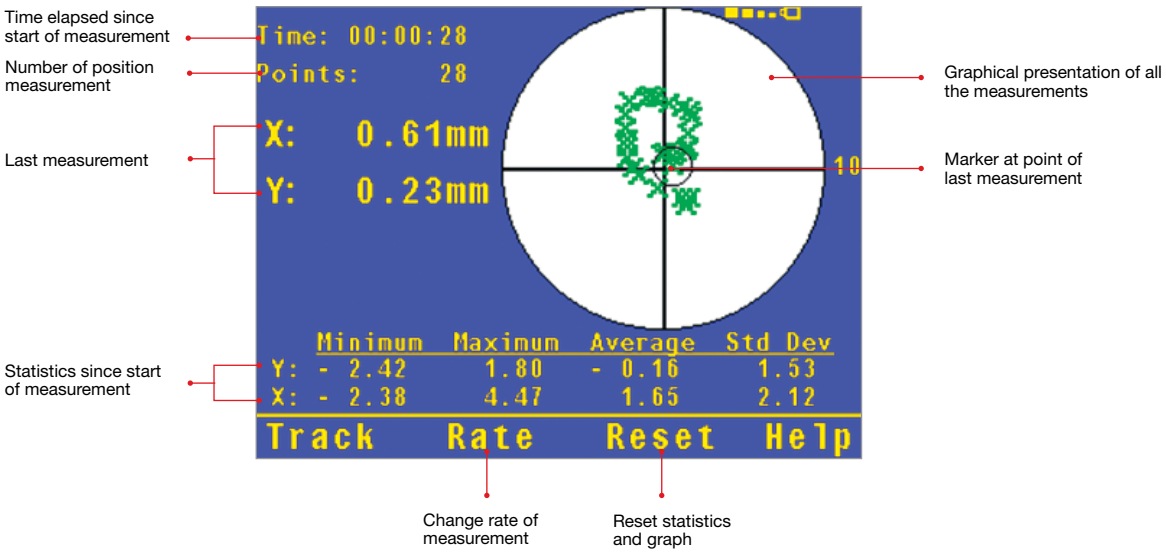
1.1.3.2 BeamTrack Device Software Support

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



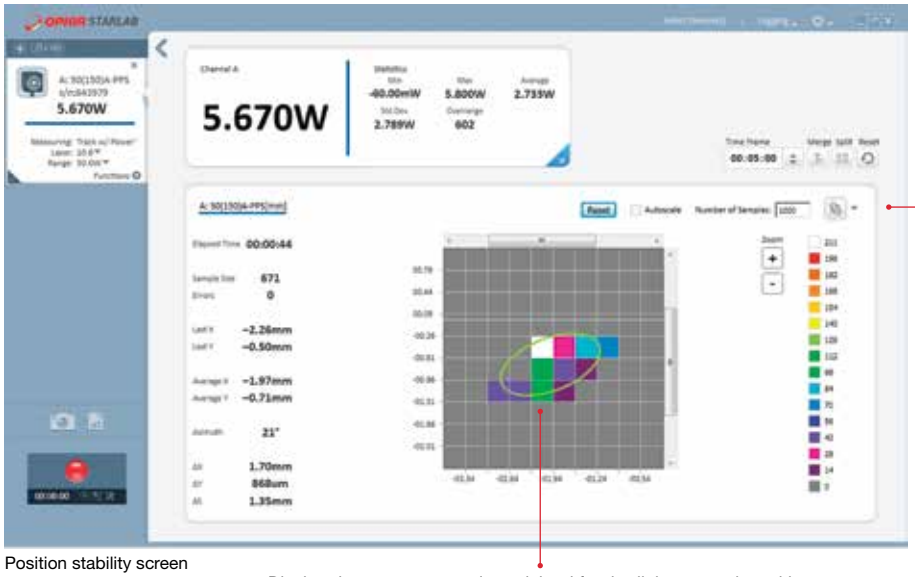
1.1.3.3 BeamTrack PC Software Support

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

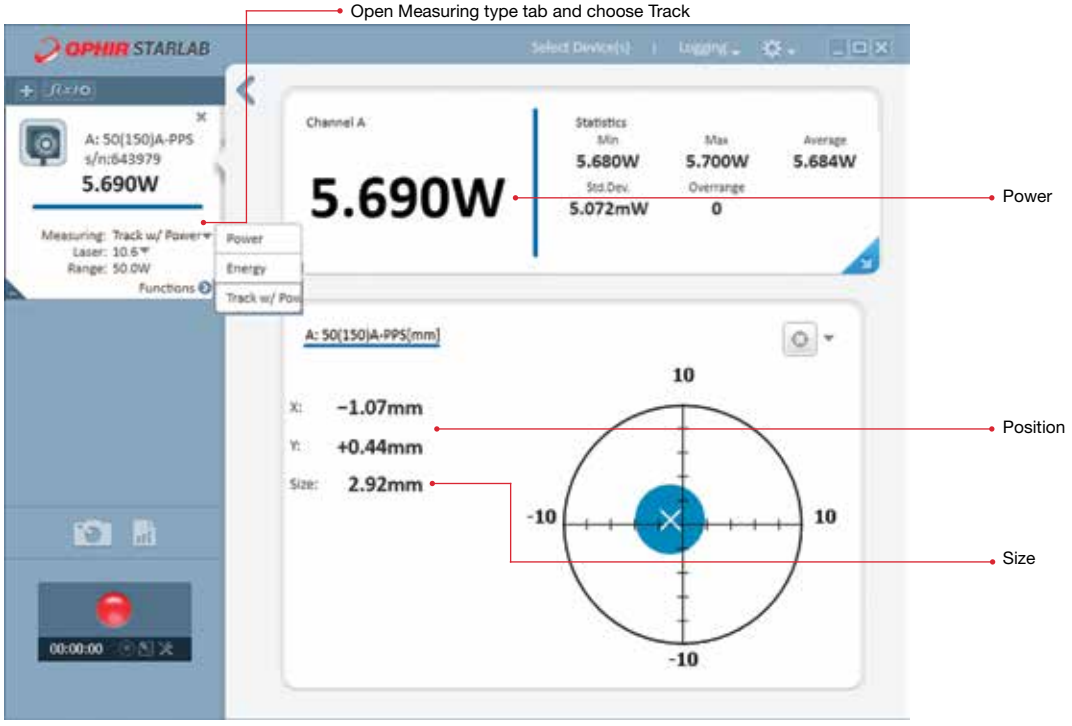
Stability Screen



Position stability screen

Displays beam center wander weighted for dwell time at each position

Position & Size Screen



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/cm²	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/cm²			
<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 118)	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 (TEM_{00}) 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:

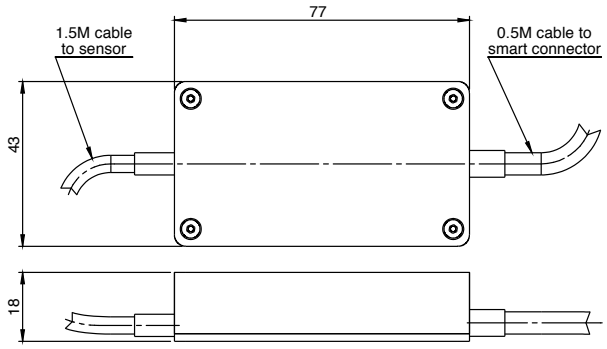
Wavelength	Derate to value
1064nm	not derated
532nm	not derated
355nm	40% of stated value
266nm	10% of stated value
193nm	10% of stated value

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, Orion 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.

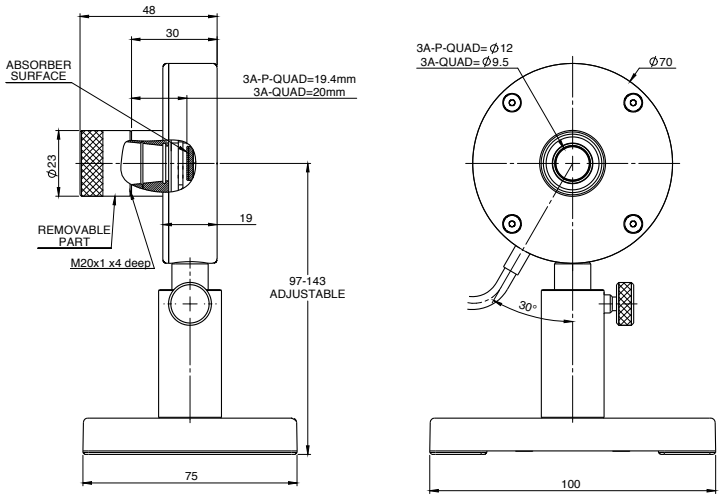
Note: (h) ±4%. For wavelengths <240nm

* For drawings please see page 113

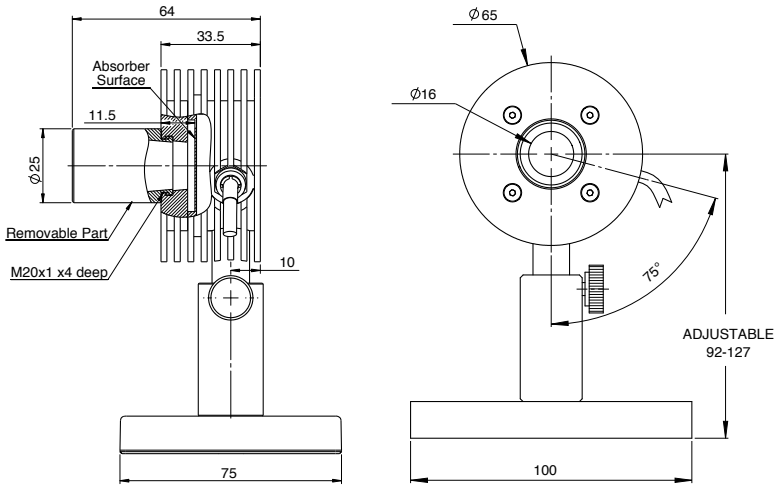
Interface Module on cable



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	Ø26mm	Ø26mm	Ø26mm
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/cm²	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 ±%	1.9	1.9	1.9
Power Accuracy ±%	3 [f]	3 [f]	3 [f]
Linearity with Power ±%	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/cm²			
<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.	±5% for centered beam	±5% for centered beam
Size Range mm (4σ beam diameter)	N.A.	Ø3 - 20	Ø3 - 20
Min Power Density for Size Measurement	N.A.	1 W/cm²	1 W/cm²
Cooling	Convection	Convection	Fan
Fiber Adapter Available (see page 118)	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 ±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.

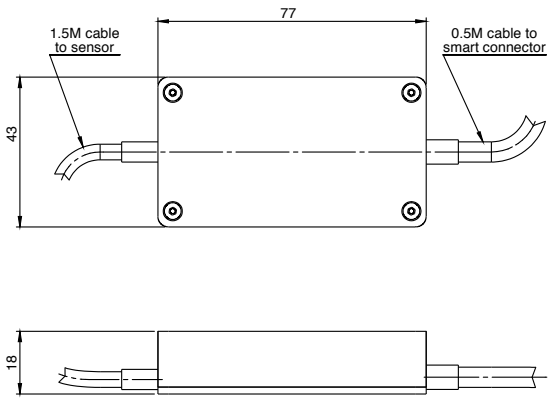
Note: (d) Assumes laser beam with Gaussian (TEM_{00}) distribution. For other modes, size measurement is relative.

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 ±10%.

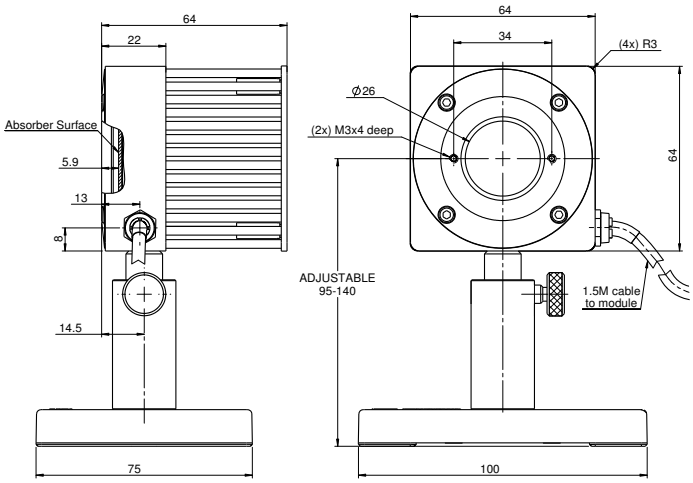
Note: (f) ±4%. For wavelengths <240nm

* For drawings please see page 115

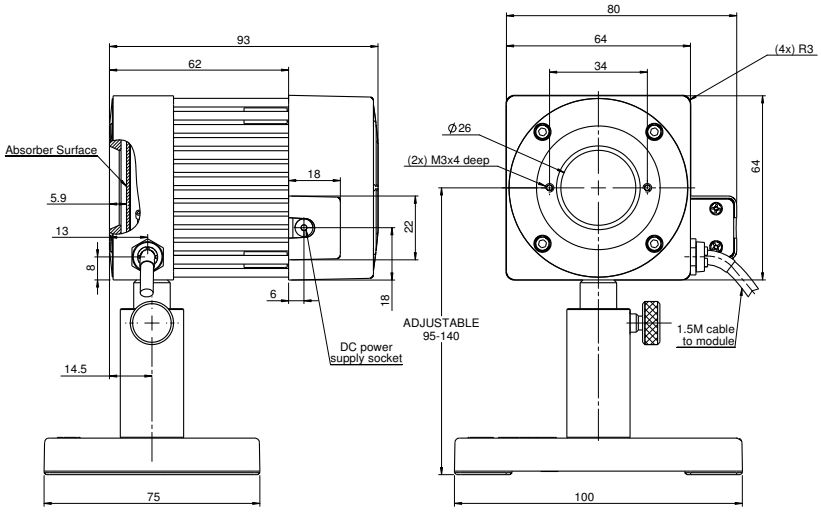
Interface Module on cable



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	Ø50mm	Ø34mm
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/cm²	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 ±%	1.9	1.9
Power Accuracy ±%	3	3 [f]
Linearity with Power ±%	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/cm²		
<100ns	0.3	0.3
1µs	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]	±5% for centered beam	NA
Size Range mm (4σ beam diameter)	Ø5-35	NA
Min Power Density for Size Measurement	3W/cm²	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 118)	ST, FC, SMA, SC	Consult Ophir representative
Accessories for High Power Sensors	NA	See pages 97-100
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 ±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 (TEM_{00}) 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.

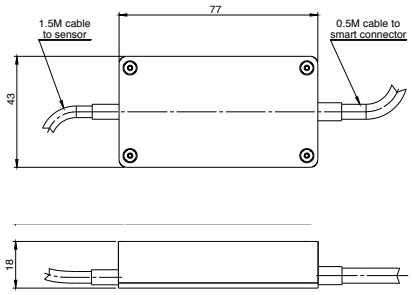
Note: (f) Calibrated for ~0.8µm, 1.064µm and 10.6µm

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

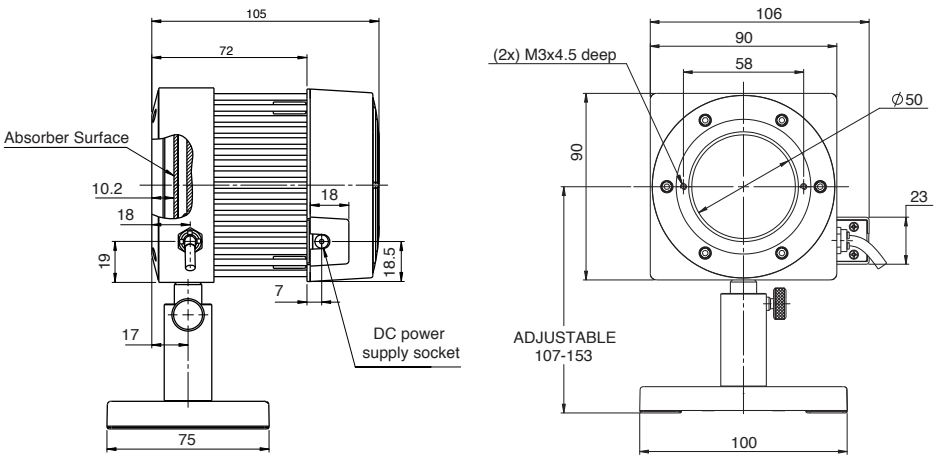
Note: (h) Position accuracy for the central 10 mm of the aperture as limited by beam position resolution. Position measuring center corresponds to geometrical center within <1mm. Position center can be software reset to geometric center or other desired position with Centauri, StarBright or StarLab.

* For drawings please see page 117

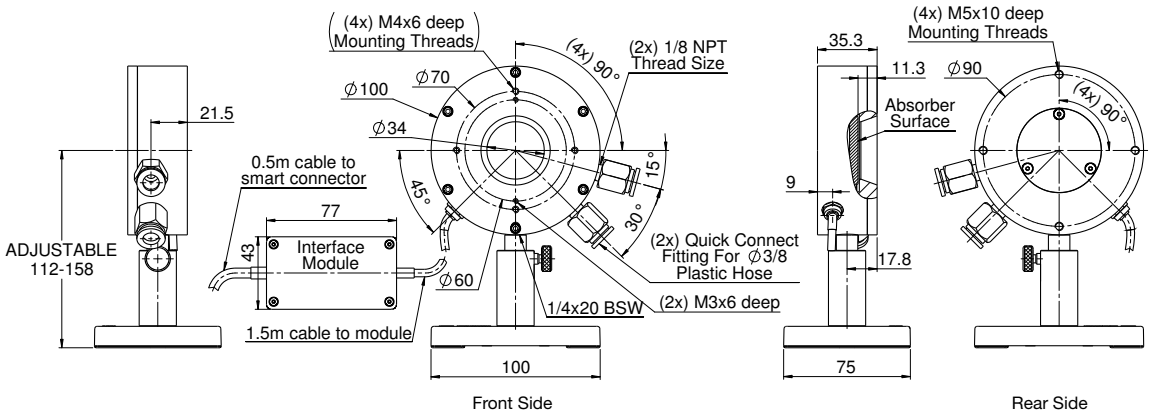
Interface Module on cable



FL250A-BB-50-PPS



1000W-BB-34-QUAD



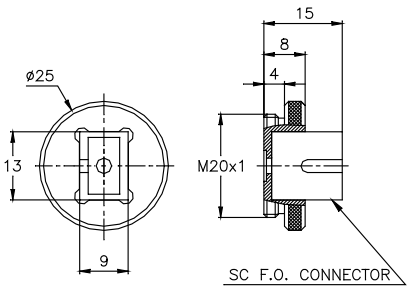
1.1.4 Accessories for Thermal Sensors

1.1.4.1 Fiberoptic Adapters

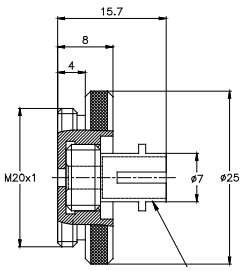
Sensor Series	Fiber adapter mounting bracket (1 bracket fits all fiber adapters)	SC fiber adapter	ST fiber adapter	FC, FC/APC fiber adapter	SMA fiber adapter
Thermal Sensors					
2A-BB-9 / 3A / 3A-QUAD / 3A-P / 3A-P-QUAD / 3A-PF-12 / 3A-FS / 3A-P-THz	not needed	7Z08227	7Z08226	7Z08229	1G01236A
10A / 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				
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

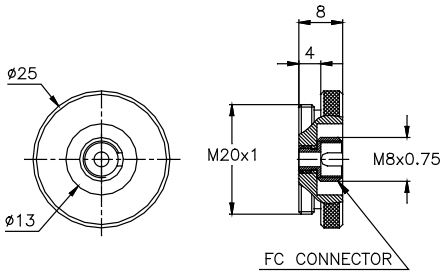
SC fiber adapter



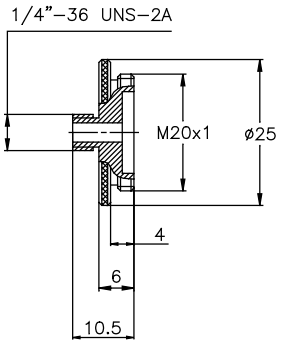
ST fiber adapter



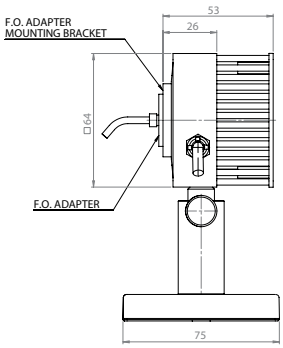
FC fiber adapter



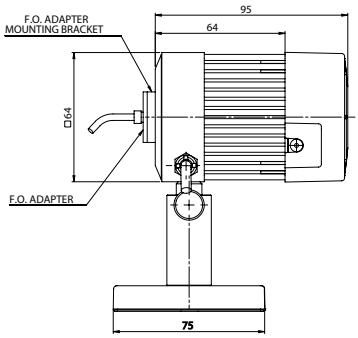
SMA fiber adapter



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 97
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 98
Scatter Shield for 10K-W, 15K-W, 16K-W and 30K-W Sensors	Scatter Shield to reduce backscattered power (including protective cover)	7Z08295 (for 10K-W / 15K-W) 7Z08355 (for 16K-W) 7Z08293 (for 30K-W)	See page 99
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 100
Protective Covers with Target Pattern for 1000W, L1500W, 5000W, 10K-W, 15K-W, 16K-W and 30K-W Sensors	Black anodized aluminum cover with a target pattern for directing the beam using a pointer	1G01332 (all except 16K-W & 30K-W) 1G02813 (for 16K-W) 1G02406 (for 30K-W)	See page 100
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 16K-W & 30K-W) 7Z08352 (for 16K-W & 30K-W)	See page 100
Heavy Duty Stand for 10K-W and 15K-W	For continuous use in vertical position, heavy duty stand is recommended	7Z08330	See page 99
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 99
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	**Application**	**P/N**	
N Polarity Power Supply/Charger 12V 2A N-2.1x5.5	For: Centauri, Vega, Nova II, Nova, EA-1, Pulsar, Quasar, LaserStar, 120K-W, 6K-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	

Protective Housing

30K-W Scatter Shield

Protective Cover on Scatter Shield

7Z08352 1/4” - 12mm

7Z08353 1/8” - 10mm

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