

# Energy sensors



## 1.2 Energy Sensors

### Introduction

Pyroelectric sensors are for measuring repetitive pulse energies and average powers at pulse rates up to 25000 pulses per second and pulse widths up to 20ms. Note that single shot energy with pulse rates less than one pulse every 5s or so can be measured with thermal sensors described in the power sensor section.

### Pyroelectric Sensors

Pyroelectric type sensors are useful for measuring the energy of repetitively pulsed lasers at up to 25,000Hz and are sensitive to low energies.

They are less durable than thermal types and therefore should not be used whenever it is not necessary to measure the energy of each pulse and average power measurement is sufficient.

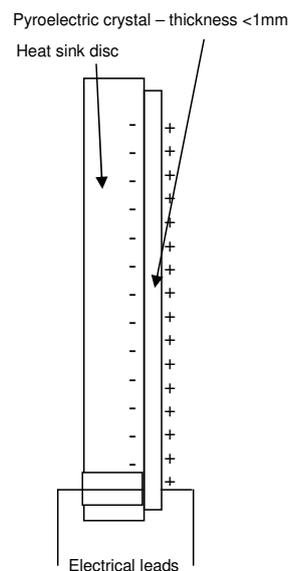
Pyroelectric sensors use a pyroelectric crystal that generates an electric charge proportional to the heat absorbed. Since the two surfaces of the crystal are metalized, the total charge generated is collected and therefore the response is not dependent on beam size or position. This charge then charges a capacitor in parallel with the crystal and the voltage difference thus generated is proportional to the pulse energy. After the energy is read by the electronic circuit, the charge on the crystal is discharged to be ready for the next pulse. The response time of the pyroelectric sensor depends on the time it takes for the heat to enter the crystal and heat it up. For metallic type pyro detectors, this time is tens of  $\mu\text{s}$  and thus the metallic type can run at a high repetition rate. For the BF and BB type, the response time is hundreds of  $\mu\text{s}$  with a correspondingly lower repetition rate.

Ophir pyroelectric detectors have unique and proprietary circuitry that allow them to measure long pulses as well as short pulses and work at a high duty cycle, i.e. where the pulse width is as much as 30% of the total cycle time.

Ophir came out with the compact C line of pyroelectric sensors that replaced previous models. The electronics and mechanics has been completely upgraded and the current sensors are superior in every way: more compact, wider dynamic range, have higher repetition rates and measure longer pulses. Through constant development, Ophir again brings you the best performance in the market.

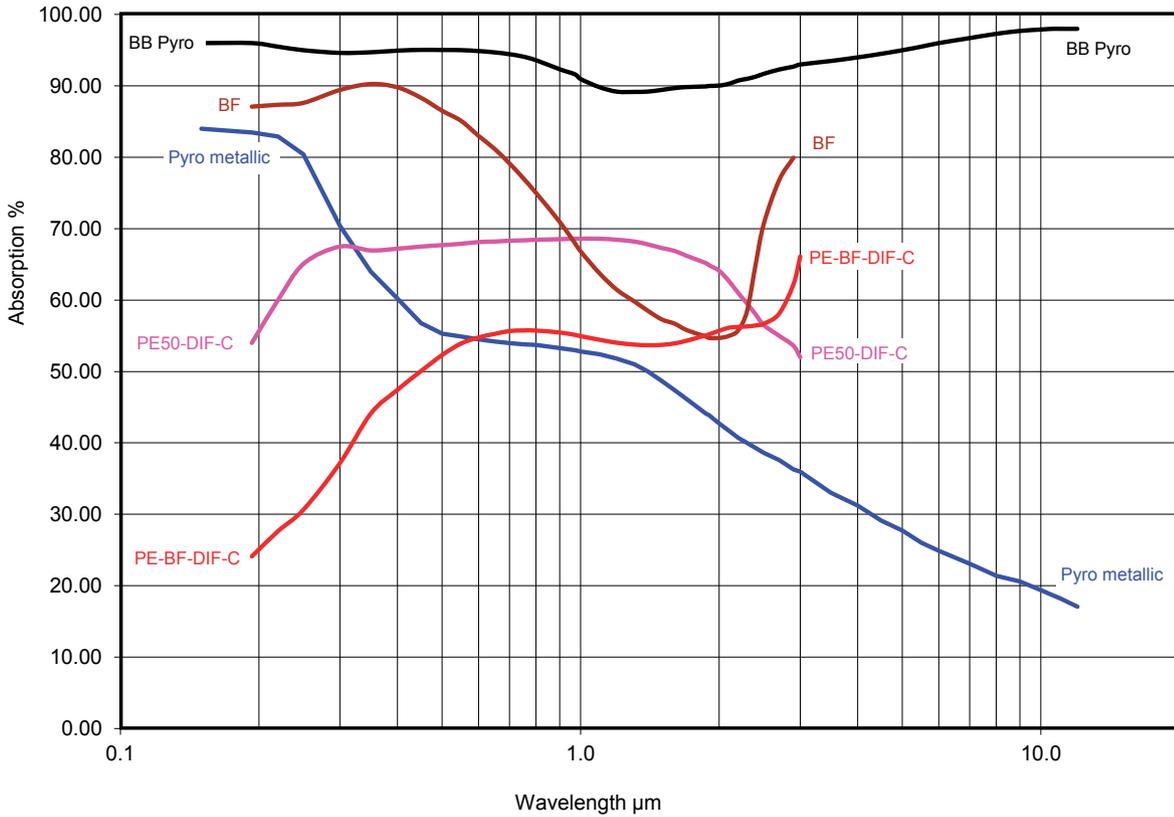
Note: Older line of Pyroelectric sensors is not supported by the StarBright and StarLite meters.

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

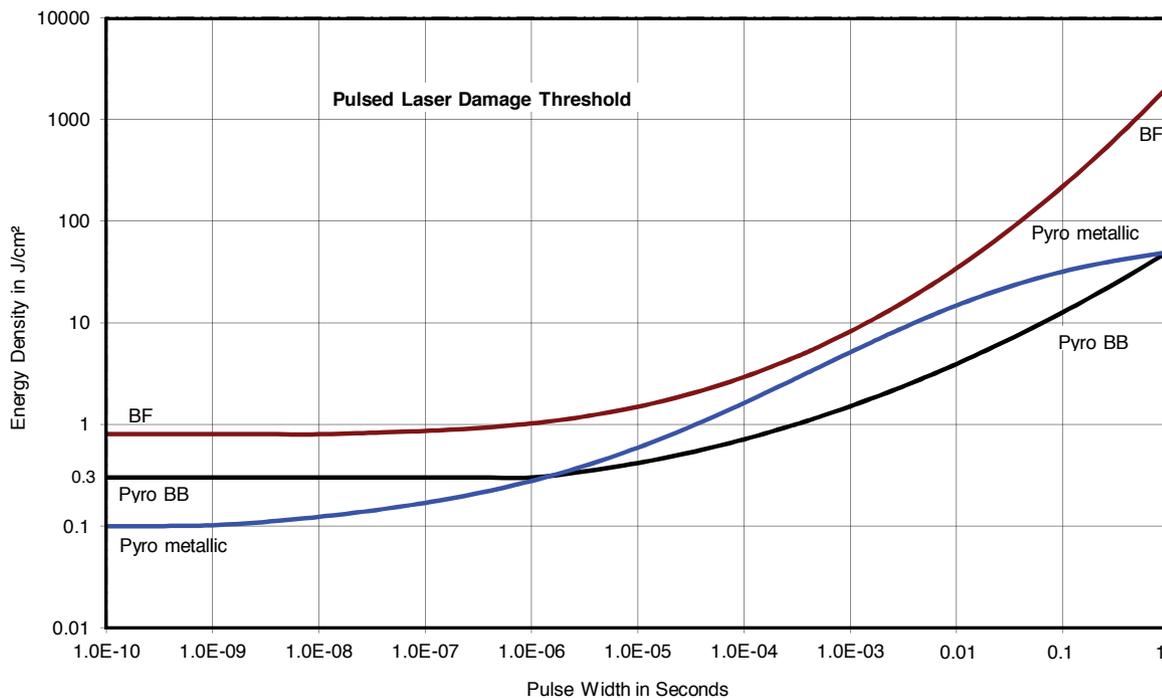


# Absorption and Damage Graphs for Pyroelectric Sensors

## Absorption vs. Wavelength

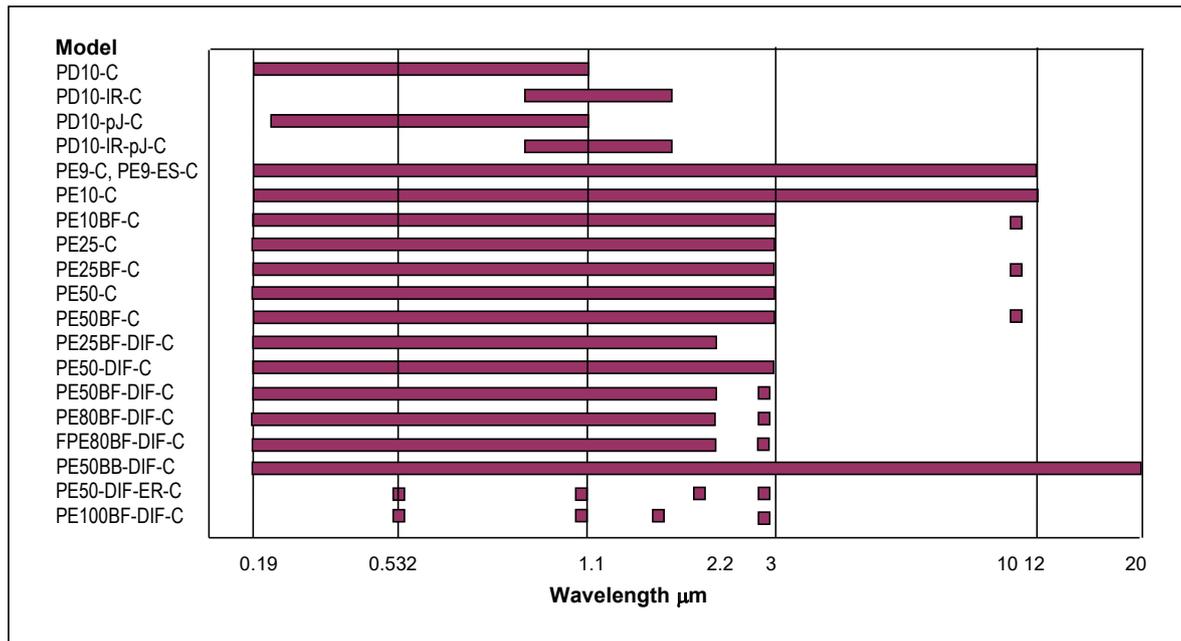


## Damage Threshold vs. Pulse Width

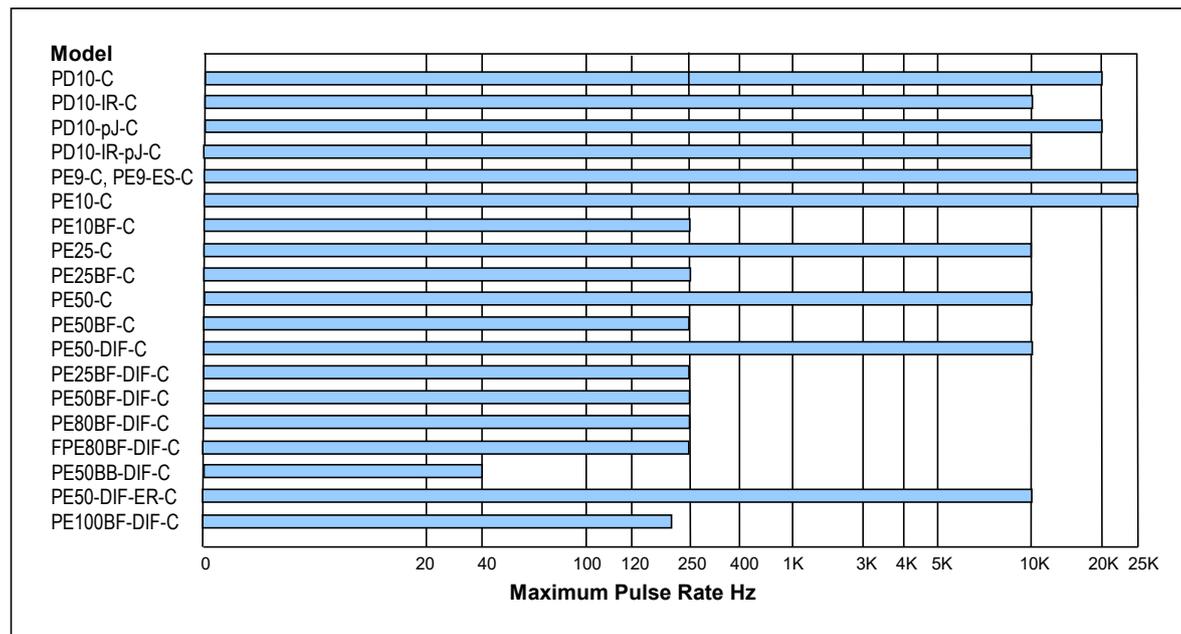


# Wavelength Range and Repetition Rate for Energy Sensors

## Wavelength Range



## Repetition Rate Range



# 1.2.1 Photodiode Energy Sensors

## 10pJ to 15μJ

PD10-C / PD10-IR-C / PD10-pJ-C / PD10-IR-pJ-C

### Features

- Silicon and Germanium detectors
- Very sensitive - down to 10pJ
- Repetition rates to 20kHz
- Wide spectral range



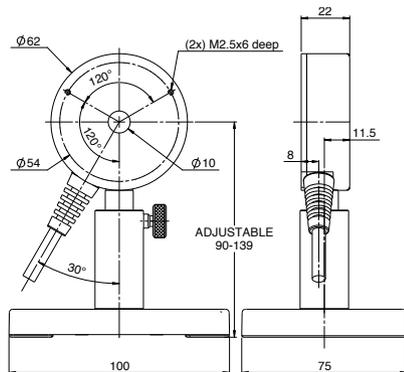
Model	PD10-C		PD10-IR-C		PD10-pJ-C		PD10-IR-pJ-C	
Use	Low energies		Infrared		Lowest energies		Infrared, lowest energies	
Aperture mm	Ø10		Ø5		Ø10		Ø5	
Absorber Type	Si photodiode		Ge photodiode		Si photodiode		Ge photodiode	
Spectral Range μm <sup>(a)</sup>	0.19 - 1.1		0.7 - 1.8		0.2 - 1.1		0.7 - 1.8	
Surface Reflectivity % approx.	50		30		30		30	
Calibration Accuracy +/--% <sup>(a)</sup>	5		5		5		5	
Energy Scales	20μJ to 20nJ		600nJ to 6nJ		200nJ to 200pJ		20nJ to 200pJ	
Lowest Measurable Energy nJ <sup>(b)</sup>	1 at 900nm		1 at 1550nm		0.01 at 900nm		0.03 at 1550nm	
Max Pulse Width ms	0.005		0.005		0.005		0.005	
Maximum Pulse Rate pps	20kHz		10kHz		20kHz		10kHz	
Noise on Lowest Range nJ	0.05		0.1		0.001		0.01	
Additional Error with Frequency %	±1% to 20kHz <sup>(c)</sup>		±1.5% to 10kHz		±1% to 20kHz <sup>(d)</sup>		±1.5% to 10kHz	
Linearity with Energy for > 10% of full scale <sup>(b)</sup>	±1.5%		±1.5%		±1.5%		±1.5%	
Damage Threshold J/cm <sup>2</sup>	0.1		0.1		0.1		0.1	
Maximum Average Power mW	50 at 800nm		6		0.5		0.2	
Maximum Average Power Density W/cm <sup>2</sup>	50		50		5		5	
Maximum Energy vs. Wavelength	Wavelength	Max Energy	Wavelength	Max Energy	Wavelength	Max Energy	Wavelength	Max Energy
	<300nm	15μJ	800 - 900nm	600nJ	<300nm	150nJ	800 - 900nm	20nJ
	350 - 550nm	8μJ	1000 - 1300nm	200nJ	350 - 550nm	75nJ	1000 - 1300nm	8nJ
	>800nm	5μJ	1300 - 1400nm	170nJ	>800nm	50nJ	1300 - 1400nm	7nJ
			1480 - 1560nm	150nJ			1480 - 1560nm	6nJ
			>1650nm	600nJ			>1650nm	20nJ
Fiber Adapters Available (see page 102)	ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC		ST, FC, SMA, SC	
Weight kg	0.25		0.25		0.25		0.25	
Compliance	CE, China RoHS		CE, China RoHS		CE, China RoHS		CE, China RoHS	
Version								
<b>Part number</b>	<b>7Z02944</b>		<b>7Z02955</b>		<b>7Z02945</b>		<b>7Z02946</b>	
Note: (a) This is basic calibration accuracy. In certain wavelength regions calibration there is additional error as tabulated here.	<250nm	add ±3%	<900nm	add ±2%	<250nm	add ±2%	<900nm	add ±2%
	>950nm	add ±2%	>1700nm	add ±2%	>950nm	add ±2%	>1700nm	add ±2%

Note: (b) With the "user threshold" setting set to minimum. For other settings, the spec is for >10% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USB1 and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PD-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.

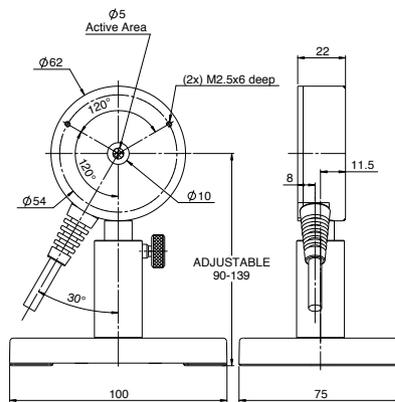
Note: (c) Additional Error with Frequency of ±1% on ly for energies up to 2μJ. For higher energies ±1% up to 10kHz, -4% at 20kHz.

Note: (d) Additional Error with Frequency of ±1% only for energies up to 20nJ. For higher energies ±2% up to 10kHz, -5% at 20kHz.

PD10-C / PD10-pJ-C



PD10-IR-C / PD10-IR-pJ-C



## 1.2.2 Pyroelectric Energy Sensors

### 0.1μJ to 1mJ

#### Features

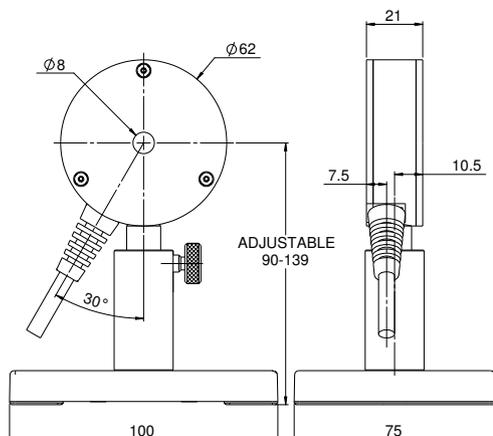
- Ø8mm aperture
- Repetition rates up to 20,000Hz
- High sensitivity sensors
- Pulse widths up to 20μs

PE9-C / PE9-ES-C



Model	PE9-C			PE9-ES-C		
Use	Very Sensitive			Most Sensitive		
Aperture mm	Ø8			Ø8		
Absorber Type	metallic			metallic		
Spectral Range μm <sup>(a)</sup>	0.15 - 12			0.15 - 12		
Surface Reflectivity % approx.	50			50		
Calibration Accuracy +/-% <sup>(a)</sup>	3			3		
Max Pulse Width Setting <sup>(c)</sup>	1μs	2μs	20μs	1μs	2μs	20μs
Energy Scales	1mJ to 2μJ	1mJ to 2μJ	1mJ to 20μJ	200μJ to 200nJ	200μJ to 200nJ	200μJ to 2μJ
Lowest Measurable Energy μJ <sup>(b)</sup>	0.5	<0.2	0.5	0.1	<0.1	0.1
Max Pulse Width μs	1	2	20	1	2	20
Maximum Pulse Rate pps	25kHz	15kHz	10kHz	20kHz	15kHz	10kHz
Noise on Lowest Range μJ	0.04	0.05	0.1	0.01	0.01	0.02
Additional Error with Frequency %	±1% to 15kHz, ±6% to 25kHz	±1% to 15kHz	±1% to 10kHz	±1.5% to 20kHz	±1.5% to 15kHz	±1.5% to 10kHz
Damage Threshold J/cm <sup>2</sup>						
<100ns	0.1			0.1		
1μs	0.2			0.2		
300μs	3			3		
Linearity with Energy <sup>(b)</sup>	±1%			±1.5%		
Maximum Average Power W	2			2		
Maximum Average Power Density W/cm <sup>2</sup>	30			30		
Fiber Adapters Available (see page 102)	ST, FC, SMA, SC			ST, FC, SMA, SC		
Weight kg	0.25			0.25		
Compliance	CE, China RoHS			CE, China RoHS		
Version						
<b>Part Number</b>	<b>7Z02933</b>			<b>7Z02949</b>		
Note: (a) Calibrated curve is checked and adjusted at the following wavelengths (μm)	0.193, 0.355, 1.064, 1.48-1.6			0.355, 1.064, 1.48-1.6		
For other wavelengths in the curve there is additional calibration error as stated.	240-800nm add ±4%, 2-3μm add ±8%, 10.6μm add ±15%.			240-800nm add ±4%, 2-3μm add ±8%, 10.6μm add ±15%. <240nm not calibrated		
Note: (b) For >7% (>10% for PE9-ES-C) of full scale, with the "user threshold" setting set to minimum. For other settings, the spec is for >7%/>10% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.						
Note: (c) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter, only 2 out of 3 pulse widths settings are available; the 1μs (displayed as "10μs") and the 2μs (displayed as "20μs").						

PE9-C / PE9-ES-C



## 1.2.2 Pyroelectric Energy Sensors

### 1µJ to 10mJ

#### Features

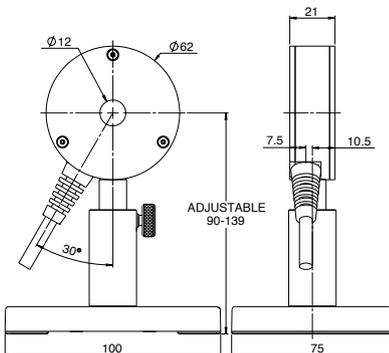
- Ø12mm apertures
- Repetition rates up to 25,000Hz
- High sensitivity sensors
- Pulse widths up to 5ms

PE10-C / PE10BF-C



Model	PE10-C	PE10BF-C
<b>Use</b>	<b>Sensitive</b>	<b>High damage threshold</b>
Aperture mm	Ø12	Ø12
Absorber Type	metallic	BF
Spectral Range µm <sup>(a)</sup>	0.15 - 12	0.15 - 3, 10.6 <sup>(d)</sup>
Surface Reflectivity % approx.	50	20
Calibration Accuracy +/--% <sup>(a)</sup>	4	3
Max Pulse Width Setting <sup>(e)</sup>	1µs                      30µs	1ms                      5ms
Energy Scales	10mJ to 2µJ                      10mJ to 20µJ	10mJ to 20µJ                      10mJ to 200µJ
Lowest Measurable Energy µJ <sup>(c)</sup>	1	7
Max Pulse Width µs	1	1000
Maximum Pulse Rate pps	25kHz	5kHz
Noise on Lowest Range µJ	0.1	0.15
Additional Error with Frequency %	±2% to 15kHz, ±3% to 25kHz	±1% to 5kHz
Damage Threshold J/cm <sup>2</sup>		
< 100ns	0.1	0.8 <sup>(b)</sup>
1µs	0.2	1 <sup>(b)</sup>
300µs	3	4 <sup>(b)</sup>
Linearity with Energy <sup>(c)</sup>	±1.5%	±2%
Maximum Average Power W	2	3
Maximum Average Power Density W/cm <sup>2</sup>	50	50
Fiber Adapters Available (see page 102)	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight kg	0.25	0.25
Compliance	CE, China RoHS	CE, China RoHS
Version		
<b>Part Number</b>	<b>7Z02932</b>	<b>7Z02938</b>
Note: (a) Calibrated curve is checked and adjusted at the following wavelengths (µm)	1.064, 0.355	0.193, 0.248, 0.355, 0.532, 1.064
For other wavelengths in the curve there is additional calibration error as stated.	240 - 800nm add ±4%, 2-3µm add ±8%, 10.6µm add ±15%. <240nm not calibrated	0.2-3µm ±2%, 10.6µm ±5%
Note: (b) For wavelengths below 600nm, derate damage threshold to 60% of given values. Below 300nm, derate to 40% of given values.		
Note: (c) For >7% of full scale, with the "user threshold" setting set to minimum. For other settings, the spec is for >7% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.		
Note: (d) The absorption at 675nm is approximately the same as at 10.6µm. Therefore, to measure a CO <sub>2</sub> laser, set to the 675nm setting. The additional error for measuring 10.6µm is ±5%.		
Note: (e) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter, for the PE10-C model the 1µs pulse width setting is displayed as "10µs".		

PE10-C / PE10BF-C



## 1.2.2 Pyroelectric Energy Sensors

### 8μJ to 10J

#### Features

- Ø24mm apertures
- Metallic coating for high rep rates
- BF coating for highest damage threshold
- Rep rates up to 10kHz
- Measure lasers with pulse widths up to 20ms



Model	PE25-C					PE25BF-C				
Use	High rep rate					High damage threshold				
Aperture mm	Ø24					Ø24				
Absorber Type	metallic					BF				
Spectral Range μm <sup>(a)</sup>	0.15 - 3					0.15 - 3, 10.6 <sup>(e)</sup>				
Surface Reflectivity % approx.	50					20				
Calibration Accuracy +/-% <sup>(a)</sup>	3					3				
Max Pulse Width Setting <sup>(d)</sup>	2μs	30μs	500μs	1ms	5ms	1ms	2ms	5ms	10ms	20ms
Energy Scales	10J to 200μJ	10J to 200μJ	10J to 2mJ	10J to 2mJ	10J to 2mJ	10J to 2mJ	10J to 2mJ	10J to 20mJ	10J to 20mJ	10J to 20mJ
Lowest Measurable Energy μJ <sup>(c)</sup>	8	10	60	80	100	60	100	400	400	400
Max Pulse Width ms	0.002	0.03	0.5	1	5	1	2	5	10	20
Maximum Pulse Rate pps	10kHz	5kHz	900Hz	450Hz	100Hz	100Hz	250Hz	100Hz	50Hz	40Hz
Noise on Lowest Range μJ	0.5	1	6	10	20	10	20	40	40	50
Additional Error with Frequency %	±2% to 5kHz ±4% to 10kHz		±1.5%	±2% to 750Hz	±1.5% to 400Hz	±1.5% to 80Hz	±1%	±1%	±1%	±1%
Linearity with Energy for >7% of full scale <sup>(c)</sup>	±1.5%					±2%				
Damage Threshold J/cm <sup>2</sup> <sup>(b)</sup>	<100ns					0.8				
	1μs					1				
	300μs					2				
	2ms					4				
Maximum Average Power W	6					10				
Maximum Average Power Density W/cm <sup>2</sup>	15, 25 with optional heat sink					15, 25 with optional heat sink				
Uniformity over surface	20					20				
Fiber Adapters Available (see page 102)	±2% over central 50% of aperture					±2% over central 50% of aperture				
Weight kg	ST, FC, SMA, SC					ST, FC, SMA, SC				
Compliance	0.25					0.25				
Version	CE, China RoHS					CE, China RoHS				
<b>Part Number</b>	<b>7Z02937</b>					<b>7Z02935</b>				
Note: (a) Calibration curve is verified and adjusted at specified wavelengths.	Specified wavelengths: 248-266nm, 355nm, 1064nm and 2940nm.					Specified wavelengths: 193nm, 248 266nm, 355nm, 532nm and 1064nm.				
At other wavelengths, there may be an additional error up to the value given.	Max additional error at other wavelengths: ±2%. <240nm not calibrated					Max additional error at 2940nm ±3%. Max additional error at other wavelengths: ±2%.				
Note: (b)						For wavelengths below 600nm, derate damage threshold to 60% of given values. Below 300nm, derate to 40% of given values.				
Note: (c) With the "user threshold" setting set to minimum. For other settings, the spec is for >7% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.										
Note: (d) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter, only 2 out of 5 pulse widths settings are available; for the PE25-C model the 2μs (displayed as "10μs") and 1ms settings, and for the PE25BF-C model the 1ms and 10ms settings.										
Note: (e) If the sensor is set to the 1064nm wavelength, then when measuring 10.6μm pulses, the reading will be approximately 1.19X the correct reading. If you use the attenuate function and set the attenuation to read 0.84, then you will have the correct reading at 10.6μm. The additional error at 10.6μm is +/-5%.										

\* For drawings please see page 99

## 1.2.2 Pyroelectric Energy Sensors

### 10μJ to 10J

#### Features

- Ø46mm apertures
- Metallic coating for high rep rates
- BF coating for highest damage threshold
- Rep rates up to 10kHz
- Measure lasers with pulse widths up to 20ms



Model	PE50-C	PE50BF-C
<b>Use</b>	<b>High rep rate</b>	<b>High damage threshold</b>
Aperture mm	Ø46	Ø46
Absorber Type	metallic	BF
Spectral Range μm <sup>(a)</sup>	0.15 - 3	0.15 - 3, 10.6 <sup>(e)</sup>
Surface Reflectivity % approx.	50	20
Calibration Accuracy +/- % <sup>(a)</sup>	3	3
Max Pulse Width Setting <sup>(d)</sup>	2μs    30μs    500μs    1ms    5ms	1ms    2ms    5ms    10ms    20ms
Energy Scales	10J to 200μJ    10J to 200μJ    10J to 2mJ    10J to 2mJ    10J to 2mJ	10J to 2mJ    10J to 2mJ    10J to 20mJ    10J to 20mJ    10J to 20mJ
Lowest Measurable Energy μJ <sup>(c)</sup>	10    10    60    80    100	120    300    600    600    600
Max Pulse Width ms	0.002    0.03    0.5    1    5	1    2    5    10    20
Maximum Pulse Rate pps	10kHz    5kHz    900Hz    450Hz    100Hz	250Hz    100Hz    50Hz    40Hz    20Hz
Noise on Lowest Range μJ	0.5    1    6    10    20	30    60    100    100    100
Additional Error with Frequency %	±2% to 2kHz ±4.5% to 5kHz	±2%
Linearity with Energy for >7% of full scale <sup>(c)</sup>	±1.5%	±2%
Damage Threshold J/cm <sup>2</sup> <sup>(b)</sup>		
<100ns	0.1	0.8
1μs	0.2	1
300μs	2	4
2ms	6	10
Maximum Average Power W	15, 25 with optional heat sink	15, 25 with optional heat sink
Maximum Average Power Density W/cm <sup>2</sup>	20	20
Uniformity over surface	±2% over central 50% of aperture	±2% over central 50% of aperture
Fiber Adapters Available (see page 102)	ST, FC, SMA, SC	ST, FC, SMA, SC
Weight kg	0.25	0.25
Compliance	CE, China RoHS	CE, China RoHS
Version		
<b>Part Number</b>	<b>7Z02936</b>	<b>7Z02934</b>
Note: (a) Calibration curve is verified and adjusted at specified wavelengths.	Specified wavelengths: 248-266nm, 355nm and 1064nm.	Specified wavelengths: 193nm, 248-266nm, 355nm, 532nm and 1064nm.
At other wavelengths, there may be an additional error up to the value given.	Max additional error at 2940nm ±3%. Max additional error at other wavelengths: ±2%. <240nm not calibrated	Max additional error at 2940nm ±3%. Max additional error at other wavelengths: ±2%.
Note: (b)		For wavelengths below 600nm, derate damage threshold to 60% of given values. Below 300nm, derate to 40% of given values.
Note: (c) With the "user threshold" setting set to minimum. For other settings, the spec is for >7% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.		
Note: (d) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter, only 2 out of 5 pulse widths settings are available; for the PE50-C model the 2μs (displayed as "10μs") and 1ms settings, and for the PE50BF-C model the 1ms and 10ms settings.		
Note: (e) If the sensor is set to the 1064nm wavelength, then when measuring 10.6μm pulses, the reading will be approximately 1.19X the correct reading. If you use the attenuate function and set the attenuation to read 0.84, then you will have the correct reading at 10.6μm. The additional error at 10.6μm is +/-5%.		

\* For drawings please see page 99

## 1.2.3 High Energy Pyroelectric Sensors

### 20μJ to 10J

#### Features

- Sensors with diffuser for high energies and high energy densities
- Metallic coating for high rep rates
- BF coating for highest damage threshold
- Wide spectral range. Measure YAG and harmonics and many more.
- Rep rates up to 10kHz
- Measure lasers with pulse widths up to 20ms

PE50-DIF-C



PE25BF-DIF-C



Model	PE50-DIF-C					PE25BF-DIF-C				
Use	High rep rate. Complete calibration curve					Complete calibration curve. High damage threshold				
Aperture mm	Ø35					Ø20				
Absorber Type	Metallic with diffuser					BF with diffuser				
Spectral Range μm <sup>(a)</sup>	0.19 - 2.2, 2,94					0.24 - 2.2				
Surface Reflectivity % approx.	25					25				
Calibration Accuracy +/- % <sup>(a)</sup>	3					3				
Max Pulse Width Setting <sup>(d)</sup>	2μs	30μs	500μs	1ms	5ms	1ms	2ms	5ms	10ms	20ms
Energy Scales	10J to 200μJ	10J to 200μJ	10J to 2mJ	10J to 2mJ	10J to 20mJ	10J to 2mJ	10J to 2mJ	10J to 20mJ	10J to 20mJ	10J to 20mJ
Lowest Measurable Energy μJ <sup>(c)</sup>	20	20	100	120	200	100	150	200	200	300
Max Pulse Width ms	0.002	0.03	0.5	1	5	1	2	5	10	20
Maximum Pulse Rate pps	10kHz	5kHz	900Hz	450Hz	100Hz	250Hz	100Hz	50Hz	40Hz	20Hz
Noise on Lowest Range μJ	1	2	20	20	40	15	30	40	40	60
Additional Error with Frequency %	±2% to 2kHz	±2%	±1% to 750Hz	±2% to 400Hz	±1% to 80Hz	±1%	±1%	±1%	±1%	±2%
Linearity with Energy for >7% of full scale <sup>(c)</sup>	±1.5%					±2%				
Damage Threshold J/cm <sup>2</sup> <sup>(b)</sup>										
<100ns	1					4				
1μs	2					5				
300μs	20					20				
2ms	40					60				
Maximum Average Power W	25, 40 with optional heat sink					20, 30 with optional heat sink				
Maximum Average Power Density W/cm <sup>2</sup>	100					120				
Uniformity over surface	±2.5% over central 20mm					±2.5% over central 10mm				
Weight kg	0.25					0.25				
Compliance	CE, China RoHS					CE, China RoHS				
Version										
<b>Part Number</b>	<b>7Z02939</b>					<b>7Z02941</b>				
Notes: (a) Calibration curve is verified and adjusted at specified wavelengths.	Specified wavelengths: 193nm, 248-266nm, 532nm, 1064nm and 2100nm. Max additional error at 193nm ±4%. Max additional error at other wavelengths not specified above: ±2%. 193nm reading may need 1min irradiation to stabilize.					Specified wavelengths: 248-266nm, 355nm, 532nm, 1064nm and 2100nm. Max additional error at other wavelengths not specified above: ±2%.				
Notes: (b)	For wavelengths >2.1μm, derate to 40% of above values. For beam size <=5mm. For 10mm beam, derate to 40% of above value.					For wavelengths below 600nm, derate to 60% of given values. For wavelengths below 240nm, derate to 1J/cm <sup>2</sup> . For beam size <=4mm. For 8mm beam, derate to 50% of above values.				
Notes: (c) With the "user threshold" setting set to minimum. For other settings, the spec is for >7% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.										
Notes: (d) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter, only 2 out of 5 pulse widths settings are available; for the PE50-DIF-C model the 2μs (displayed as "30μs") and 1ms settings, and for the PE25BF-DIF-C model the 1ms and 10ms settings.										

\* For drawings please see page 99

## 1.2.3 High Energy Pyroelectric Sensors

### 100µJ to 40J

#### Features

- Sensors with diffuser for high energies and high energy densities
- BF coating for highest damage threshold
- BB coating for spectral flatness
- Wide spectral range. Measure YAG and harmonics and many more.
- Rep rates up to 250Hz
- Measure lasers with pulse widths up to 20ms
- PE50BF-DIFH-C sensor - highest damage threshold

PE50BF-DIF-C / PE50BF-DIFH-C



PE50BB-DIF-C

DIFFUSER IN

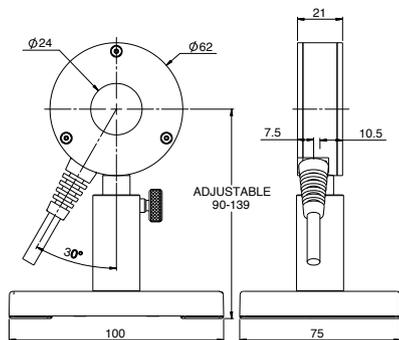
DIFFUSER OUT



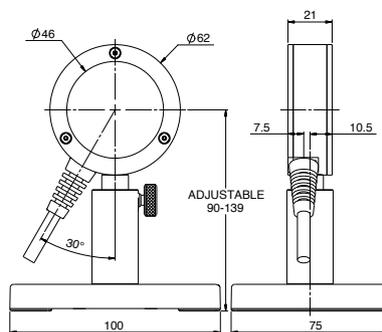
Model	PE50BF-DIF-C / PE50BF-DIFH-C					PE50BB-DIF-C					
Use	Complete calibration curve. Highest damage threshold					Removable diffuser. Spectrally flat					
Diffuser	Fixed					Diffuser out					Diffuser in
Aperture mm	Ø35					Ø46					Ø33
Absorber Type	BF with diffuser					BB					BB with diffuser
Spectral Range µm <sup>(a)</sup>	0.19 – 2.2, 2.94					0.19 – 20					0.4 – 2.5
Surface Reflectivity % approx.	25					5					15
Calibration Accuracy +/--% <sup>(a)</sup>	3					3					3
Max Pulse Width Setting <sup>(d)</sup>	1 ms	2ms	5ms	10ms	20ms	3ms	10ms	20ms	3ms	10ms	20ms
Energy Scales	10J to 2mJ	10J to 2mJ	10J to 20mJ	10J to 20mJ	10J to 20mJ	10J to 2mJ	10J to 20mJ	10J to 20mJ	40J to 8mJ	40J to 8mJ	40J to 8mJ
Lowest Measurable Energy mJ <sup>(c)</sup>	0.2	0.4	0.8	0.8	0.8	0.1	0.1	0.2	0.5	5	5
Max Pulse Width ms	1	2	5	10	20	3	10	20	3	10	20
Maximum Pulse Rate pps	250Hz	100Hz	50Hz	40Hz	20Hz	40Hz	10Hz	5Hz	40Hz	10Hz	5Hz
Noise on Lowest Range µJ	40	80	200	200	200	15	15	20	40	60	80
Additional Error with Frequency %	±1%	±1%	±1%	±2%	±2%	±1%	±1%	±1%	±1%	±1%	±1%
Linearity with Energy for >7% of full scale <sup>(c)</sup>	±2%					±2%					±2%
Damage Threshold J/cm <sup>2</sup> <sup>(b)</sup>	PE50BF-DIF-C		PE50BF-DIFH-C			Diffuser out			Diffuser in		
<100ns	4		6			0.3			3		
1 µs	5		8			0.3			3		
300µs	20		30			1			10		
2ms	60		90			2			20		
Maximum Average Power W	25, 40 with optional heat sink					10, 15 with optional heat sink			30, 50 with optional heat sink		
Maximum Average Power Density W/cm <sup>2</sup>	200					10			500		
Uniformity over surface	±2.5% over central 20mm					±2% over 70% of diameter			±2.5% over central 20mm		
Weight kg	0.25					0.25					
Compliance	CE, China RoHS		CE, China RoHS			CE, China RoHS					
Version											
<b>Part Number</b>	<b>7Z02940</b>		<b>7Z02943</b>			<b>7Z02947</b>					
Notes: (a) Calibration accuracy at various wavelengths as specified here.	Specified wavelengths: 355nm, 532nm, 1064nm and 2100nm.		Specified wavelengths: 193nm, 248-266nm, 355nm, 532nm, 1064nm and 2100nm.			Calibrated at 1064nm			Calibrated at 1064nm, 532nm and 2100nm only. Calibration accuracy at 2100nm, ±5%.		
At other wavelengths, there may be an additional error up to the value given.	Max additional error at other wavelengths not specified above: ±2%. <250nm not calibrated		Max additional error at 193nm ±4%. Max additional error at other wavelengths not specified above: ±2%.			Max additional error at other wavelengths is ±2%					
Notes: (b)	For wavelengths >2.1µm, derate to 10% of above values. For wavelengths below 600nm, derate to 60% of given values (for DIFH 50% of given values). For wavelengths below 240nm, derate to 1J/cm <sup>2</sup> . For beam size ≤5mm. For 10mm beam, derate DIF to 80% and DIFH to 70% of above.										
Notes: (c) With the "user threshold" setting set to minimum. For other settings, the spec is for >7% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.											
Notes: (d) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter only 2 of the pulse width settings are available. For the PE-BF models the 1ms and 10ms settings and for the PE-BB model the 3ms and 10ms settings. Furthermore, with the diffuser mounted, the sensor may saturate at lower than the maximum energy in some cases. Therefore it is recommended to use these sensors with the newer meters/PC interfaces.											

\* For drawings please see page 99

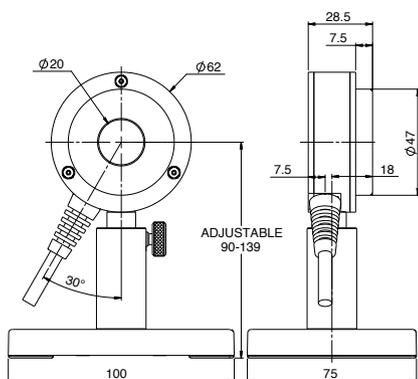
PE25-C / PE25BF-C



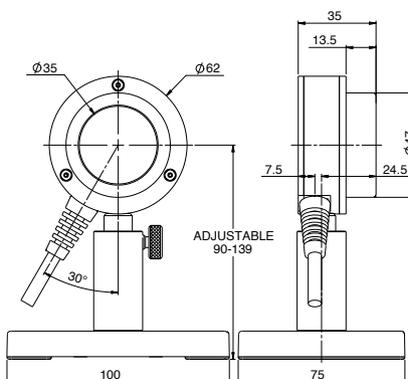
PE50-C / PE50BF-C



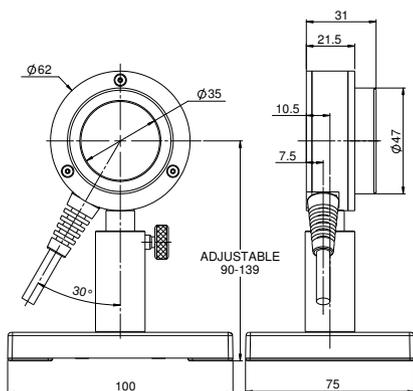
PE25BF-DIF-C



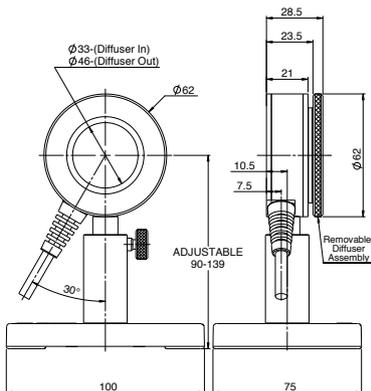
PE50BF-DIF-C / PE50-DIF-C



PE50BF-DIFH-C



PE50BB-DIF-C



## 1.2.3 High Energy Pyroelectric Sensors

### 10μJ to 40J

#### Features

- Removable diffusers
- PE50-DIF-ER-C mainly for NIR lasers
- PE100BF-DIF-C for very large beams
- Rep rates up to 10kHz
- Measure lasers with pulse widths up to 20ms



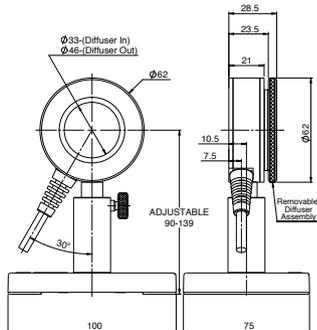
Model	PE50-DIF-ER-C										PE100BF-DIF-C									
Use	Mainly for 1064nm, 2.1μm and 2.94μm										Very large aperture									
Diffuser	Diffuser out					Diffuser in					Diffuser out					Diffuser in				
Aperture mm	Ø46					Ø33					Ø96					Ø85				
Absorber Type	Metallic					Metallic with diffuser					BF					BF with diffuser				
Spectral Range μm <sup>(a)</sup>	0.19 - 3					0.4 - 3					0.15 - 3					0.4 - 2.5				
Surface Reflectivity % approx.	50					50					20					50				
Calibration Accuracy +/--% <sup>(a)</sup>	3					4					3					4				
Max Pulse Width Setting <sup>(c)</sup>	2μs	30μs	500μs	1ms	5ms	2μs	30μs	500μs	1ms	5ms	1ms	2ms	5ms	10ms	20ms	1ms	2ms	5ms	10ms	20ms
Energy Scales	10J to 200μJ	10J to 200μJ	10J to 2mJ	10J to 2mJ	10J to 2mJ	30J to 600μJ	30J to 600μJ	30J to 6mJ	30J to 6mJ	30J to 6mJ	10J to 2mJ	10J to 20mJ	10J to 20mJ	10J to 20mJ	10J to 20mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ
Lowest Measurable Energy mJ <sup>(b)</sup>	0.01	0.01	0.06	0.08	0.1	0.05	0.05	0.3	0.4	0.5	0.4	0.7	1.5	1.5	1.5	2	3	5	5	5
Max Pulse Width ms	0.002	0.03	0.5	1	5	0.002	0.03	0.5	1	5	1	2	5	10	20	1	2	5	10	20
Maximum Pulse Rate pps	10kHz	5kHz	800Hz	400Hz	100Hz	10kHz	5kHz	800Hz	400Hz	100Hz	200	100	50	35	25	200	100	50	35	25
Noise on Lowest Range μJ	1	1	6	10	20	5	5	30	50	100	80	150	250	200	200	300	500	1000	600	600
Additional Error with Frequency %	±2% to 2kHz	±2% to 4.5kHz	±2%	±2%	±1% to 80Hz	±2% to 2kHz	±2% to 4.5kHz	±2%	±2%	±1% to 80Hz	±1%									
Linearity with Energy for > 10% of full scale <sup>(b)</sup>	±1.5%										±1%									
Damage Threshold J/cm <sup>2</sup>	<100ns					1.5					0.8					3				
	1μs					3					1					3				
	300μs					20					5					10				
	2ms					60					10					25				
Maximum Average Power W	15, 25 with optional heat sink					40, 60 with optional heat sink					25					50				
Maximum Average Power Density W/cm <sup>2</sup>	20					500					20					500				
Weight kg	0.3										1.2									
Compliance	CE, China RoHS										CE, China RoHS									

Part Number	7Z02948										7Z02942									
Notes: (a)	Calibrated at 532nm and 1064nm only					Calibrated at 1064nm, 2100nm and 2940nm					Calibrated at 532nm and 1064nm only					Calibrated at 532nm, 1064nm and 1550nm only				

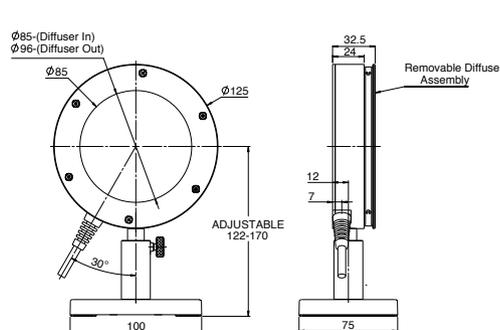
Notes: (b) With the "user threshold" setting set to minimum. For other settings, the spec is for >10% of full scale or greater than twice the "user threshold", whichever is greater. For use with Centauri, StarBright, StarLite, Nova II, Vega, Juno, Juno+ and EA-1. The sensors will operate with older Ophir meters and PC interfaces but do not support the threshold function and may give inaccurate readings with the diffuser in and therefore it is not recommended to use these sensors with older Ophir meters and PC interfaces. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.

Notes: (c) With the LaserStar, Pulsar, USBi, Quasar and Nova/Orion with adapter only 2 of the 5 pulse width settings are available. For the PE50-DIF-ER-C, the 30μs and 1ms settings and for the PE100BF-DIF-C, the 1ms and 10ms settings. Furthermore, with the diffuser mounted, the sensor may saturate at lower than the maximum energy in some cases. Therefore it is recommended to use these sensors with the newer meters/PC interfaces.

PE50-DIF-ER-C



PE100BF-DIF-C



## 1.2.3 High Energy Pyroelectric Sensors

### 1mJ to 40J

#### Features

- Fan or conduction cooled for high average power capability
- BF coating with diffuser for highest damage threshold
- Wide spectral range. Measure YAG and harmonics and many more
- Rep rates up to 250Hz
- Measure lasers with pulse widths up to 20ms

FPE80BF-DIF-C



PE80BF-DIF-C



Model	FPE80BF-DIF-C					PE80BF-DIF-C				
Use	High average power pulsed lasers					Large aperture pulsed lasers				
Diffuser	Fixed					Fixed				
Aperture mm	Ø53					Ø67				
Absorber Type	BF with diffuser					BF with diffuser				
Spectral Range $\mu\text{m}$ <sup>(a)</sup>	0.19 – 2.2, 2.94					0.19 – 2.2, 2.94				
Surface Reflectivity % approx.	25					25				
Calibration Accuracy +/- % <sup>(a)</sup>	3					3				
Max Pulse Width Setting <sup>(d)</sup>	1ms	2ms	5ms	10ms	20ms	1ms	2ms	5ms	10ms	20ms
Energy Scales	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ	40J to 40mJ
Lowest Measurable Energy mJ <sup>(c,f)</sup>	1	1	1	2	2	4	4	4	4	4
Max Pulse Width ms	1	2	5	10	20	1	2	5	10	20
Maximum Pulse Rate pps	250Hz	100Hz	50Hz	40Hz	20Hz	250Hz	100Hz	50Hz	40Hz	20Hz
Noise on Lowest Range $\mu\text{J}$	200	300	300	300	300	100	200	200	200	200
Additional Error with Frequency %	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$	$\pm 1.5\%$
Linearity with Energy for >10% of full scale <sup>(c)</sup>	$\pm 1.5\%$					$\pm 2\%$				
Damage Threshold $\text{J}/\text{cm}^2$ <sup>(b)</sup>										
<100ns	4					4				
1 $\mu\text{s}$	8					5				
300 $\mu\text{s}$	30					20				
2ms	50					60				
Maximum Average Power W	200					40				
Maximum Average Power Density at Maximum Power $\text{W}/\text{cm}^2$	120 <sup>(e)</sup>					200 <sup>(e)</sup>				
Uniformity over surface	$\pm 2\%$ over central 40mm					$\pm 2\%$ over central 60mm				
Cooling	fan (see page 103 for details)					conduction				
Weight kg	1.2					0.5				
Compliance	CE, China RoHS					CE, China RoHS				
Version										
Part Number	<b>7Z02950</b>					<b>7Z02954</b>				

Notes: (a) Calibration accuracy at various wavelengths as specified here. At other wavelengths, there may be an additional error up to the value given.

Notes: (b)

Specified wavelengths:

355nm, 532nm, 1064nm, 2100nm and 2940nm.

Max additional error at other wavelengths not specified above:  $\pm 2\%$ . <250nm not calibrated.

For wavelengths >2.1 $\mu\text{m}$ , derate to 10% of above values. For wavelengths below 600nm, derate to 60% of given values. For wavelengths below 240nm, derate to 1J/cm<sup>2</sup>. For beam size  $\leq 16\text{mm}$ . For 32mm beam, derate to 50% of above values.

Notes: (c) With the "user threshold" setting set to minimum. For other settings, the spec is for >10% of full scale or greater than twice the "user threshold", whichever is greater. The user threshold is not available with LaserStar, Nova/Orion, Pulsar, USBI and Quasar. For these meters, the threshold is set to minimum and the linearity spec is >10% of full scale. The PE-C series will only operate with Nova or Orion meters with an additional adapter Ophir P/N 7Z08272 (see page 103). The adapter can introduce up to 1% additional measurement error. The user threshold feature allows adjustment of the internal threshold up to 25% of full scale if desired to avoid false triggering in noisy environments. For further information, see the FAQs on our Website.

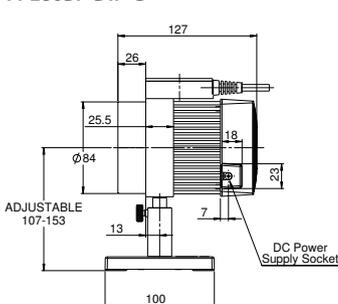
Notes: (d) With the LaserStar, Pulsar, USBI, Quasar and Nova/Orion with adapter only 2 of the pulse width settings are available, the 1ms and 10ms settings.

Notes: (e) For maximum power. For lower powers the damage threshold is correspondingly higher.

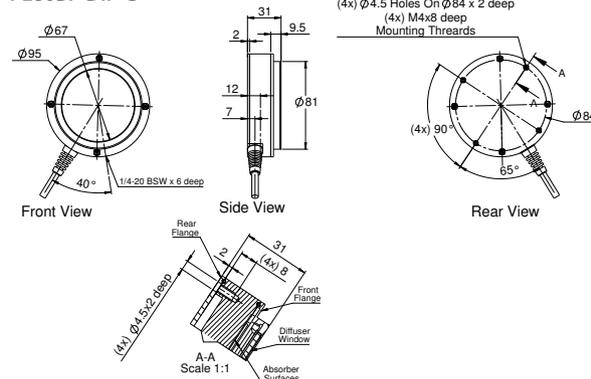
Notes: (f) For powers below 50W it is recommended to work with the fan off. If working with the fan on, the threshold must be set to 6% and the lowest measurable energies will be as follows:

Max Pulse Width Setting	1ms	2ms	5ms	10ms	20ms
Lowest Measurable Energy mJ	4mJ	4mJ	4mJ	4mJ	4mJ

FPE80BF-DIF-C



PE80BF-DIF-C



## 1.2.4 Energy Sensors Accessories

### 1.2.4.1 Accessories for Pyroelectric Sensors

**Fiberoptic Adapter for Pyroelectric Sensors**



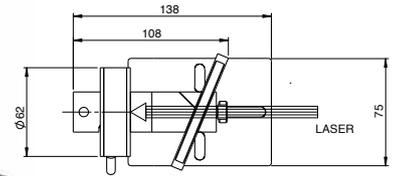
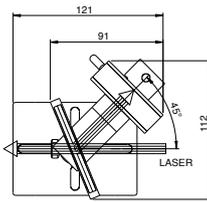
**Oscilloscope Adapter for Pyroelectric Sensors**



**Heat Sink for PE-C Series Sensors**



**Beam Splitter Assembly**



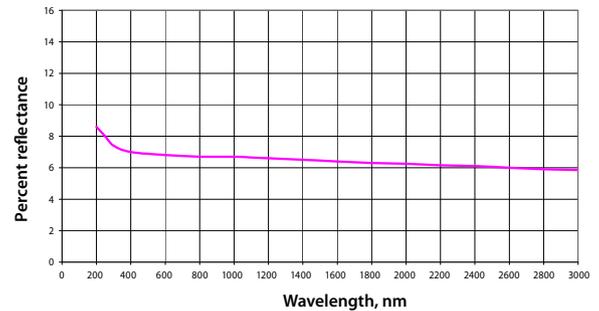
**Beam splitter installed – reflected beam on sensor**

**Beam Splitter removed – direct beam on sensor**

**Beam Splitter Specifications**

Material	UV grade fused silica	
Spectral range	0.19 - 2.2µm	
Aperture	Ø60mm	
Damage threshold for pulses	< 10ns PW	>300µs PW
	5J/cm <sup>2</sup>	>200J/cm <sup>2</sup>
Fraction split off	See graph	

**F.S. Beam Splitter, 2 sided reflection unpolarized light**



Accessory	Description	Part number			
Heat Sink	Heat sink that screws onto rear of PE25 and PE50 series sensors and allows working at over 50% higher average powers.	7Z08267			
Scope Adapter	Plugs in between the PE sensor and power meter. Provides BNC output to scope to see every pulse up to the maximum frequency of the sensor.	7Z11012			
Fiber Adapters	To mount fibers to sensors you need an adapter bracket and fiber adapter. All fiber adapters are compatible with the adapter bracket selected.				
Fiber Adapter Brackets	Mounting brackets to allow mounting fiber adapters to pyroelectric sensors.				
PE Sensor Family Type		Bracket P/N	Distance from fiber to detector		
PD10-C / PD10-IR-C / PD10-pj-C / PD10-IR-pj-C		7Z08275	10mm		
PE50-C / PE50BF-C		7Z08270	15mm		
PE9-C / PE9-ES-C / PE10-C / PE10BF-C / PE25-C / PE25BF-C		7Z08269	10mm		
Fiber Adapters	Fiber adapters for mounting to above brackets	SC type	ST type	FC type	SMA type
For all PE sensors above		7Z08227	7Z08226	7Z08229	1G01236A
Beam Splitter Assembly	Beam Splitter Assembly to measure pulsed laser sources too energetic for direct measurement. The reading with the Beam Splitter can be calibrated by setting the laser to a lower energy that will not damage the sensor and then taking a measurement with the beam splitter and without and taking the ratio.	7Z17001			

## 1.2.4.1 Accessories for Pyroelectric Sensors - Continued

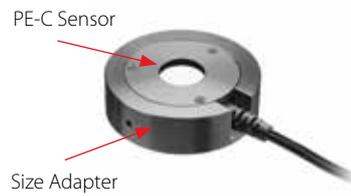
**Damage Threshold Test Plates**



**Nova PE-C Adapter**



**PE-C to PE Size Adapter**



**Negative Polarity Power Supply/Charger**



Accessory	Description	Part number			
		Metallic type	BF type	THz type	BB type
Damage Threshold Test Plates	Test plates with same absorber coating as the sensor. For testing that laser beam is not above damage threshold	7E06031A	7E06031D	7E06031F	7E06031C
Nova PE-C Adapter	The adapter plugs between the Nova D15 socket and the smart plug of the PE-C sensor to allow the Nova to operate with PE-C series sensors. See PE-C spec sheet for details.	7Z08272			
PE-C to PE Size Adapter	The newer PE-C series sensors have a Ø62mm diameter. The older PE series sensors have a Ø85mm diameter. This adapter allows using the PE-C type sensors in jigs and setups that were originally designed for PE sensors.	7Z08273			
N Polarity Power Supply/Charger AC/DC 12V 2A N-2.1x5.5	For FPE80BF-DIF-C sensor (1 unit supplied with the sensor)	7E05029			