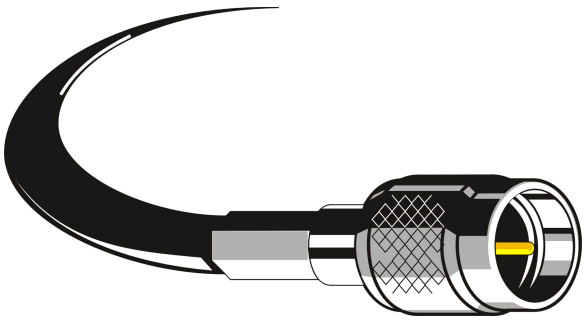
Polytec

User Manual

Fiber-optic Vibrometer Sensor Head

OFV-511/512



Warranty and Service

The warranty for this equipment complies with the regulations in our general terms and conditions in their respective valid version.

This is conditional on the equipment being used as it is intended and as described in this manual.

The warranty does not apply to damage caused by incorrect usage, external mechanical influences or by not keeping to the operating conditions. The warranty also is invalidated in the case of the equipment being tampered with or modified without authorization.

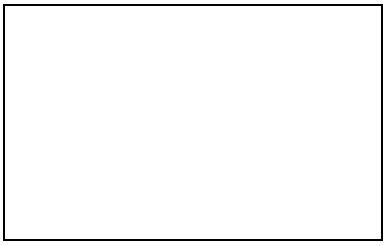
To return the equipment always use the original packaging. Otherwise we reserve the right to check the equipment for transport damage. Please mark the package as fragile and sensitive to frost. Include an explanation of the reason for returning it as well as an exact description of the fault. You can find advice on fault diagnosis in chapter 5.

Trademarks

Brand and product names mentioned in this manual could be trademarks or registered trademarks of their respective companies or organizations.

Identification Labels

Sensor Head



Contents

1 Safety Information

1.1 Laser Safety

The light source of the vibrometer is a helium neon laser. It is important to understand that laser light has different properties than ordinary light sources. Laser radiation is generally extremely intense due to the beam's low divergence and great care should be taken when handling laser instruments that the direct or reflected beam does not enter the eye. To ensure this, the following precautions have been taken:

- In general, Polytec equipment complies with the standards **EN 60825-1** (DIN VDE 0837) and **CFR 1040.10** (US).
- The optical output of the laser is less than 1 mW for the sensor head **OFV-511** providing the equipment is used in the manner for which it was intended. This means that the vibrometer conforms with **laser class II** and is generally very safe. Even when optimally focused, the laser radiation is not intense enough to harm the skin.
- The optical output of the laser is less than 5 mW (< 1 mW per fibre) for the sensor head **OFV-512** providing the equipment is used in the manner for which it was intended. This means that the vibrometer conforms with **laser class 3R (IIIa)** and is generally very safe. Even when optimally focused, the laser radiation is not intense enough to harm the skin.
- The sensor head has been equipped with a **beam shutter** which can be used to block the laser beam during the warm-up phase or when the vibrometer is not in use, although switched on.
- The **emission indicator** on the sensor head indicates the activity of the laser and thus potential harm caused by emitted laser beams.
- The beam shutter is always **less then 2 m away** from the aperture of the laser beam. Special editions of the fiber optical sensor heads with fiber lengths of 3 m are fitted with an additional emission indicator which is integrated in the fibers.
- The laser is switched on via a **key switch** on the controller. The key can only be removed when the controller is switched off.
- It is **not necessary to open** the housing of the sensor head when using the vibrometer as intended. Opening the housing will invalidate the warranty.

Please pay attention to the following **safety precautions** when using the vibrometer:

- Never look directly into the laser beam with the naked eye or with the aid of mirrors or optical instruments!
- Only open the beam shutter when you are making measurements!
- To position the sensor head, switch the beam shutter to the OFF position. Only when the sensor head is roughly in place and has been fixed in a stable position, open the beam shutter.
- Do not use any reflective tools, watches etc. when you are working in the path of the laser beam!

1.2 Laser Warning Labels

1.2.1 EC Countries

Warning labels

The laser warning labels for the sensor heads in EC countries are shown in figure 1.1. Label **2**, **3** and **4** are affixed or enclosed in the language of the customer's country.

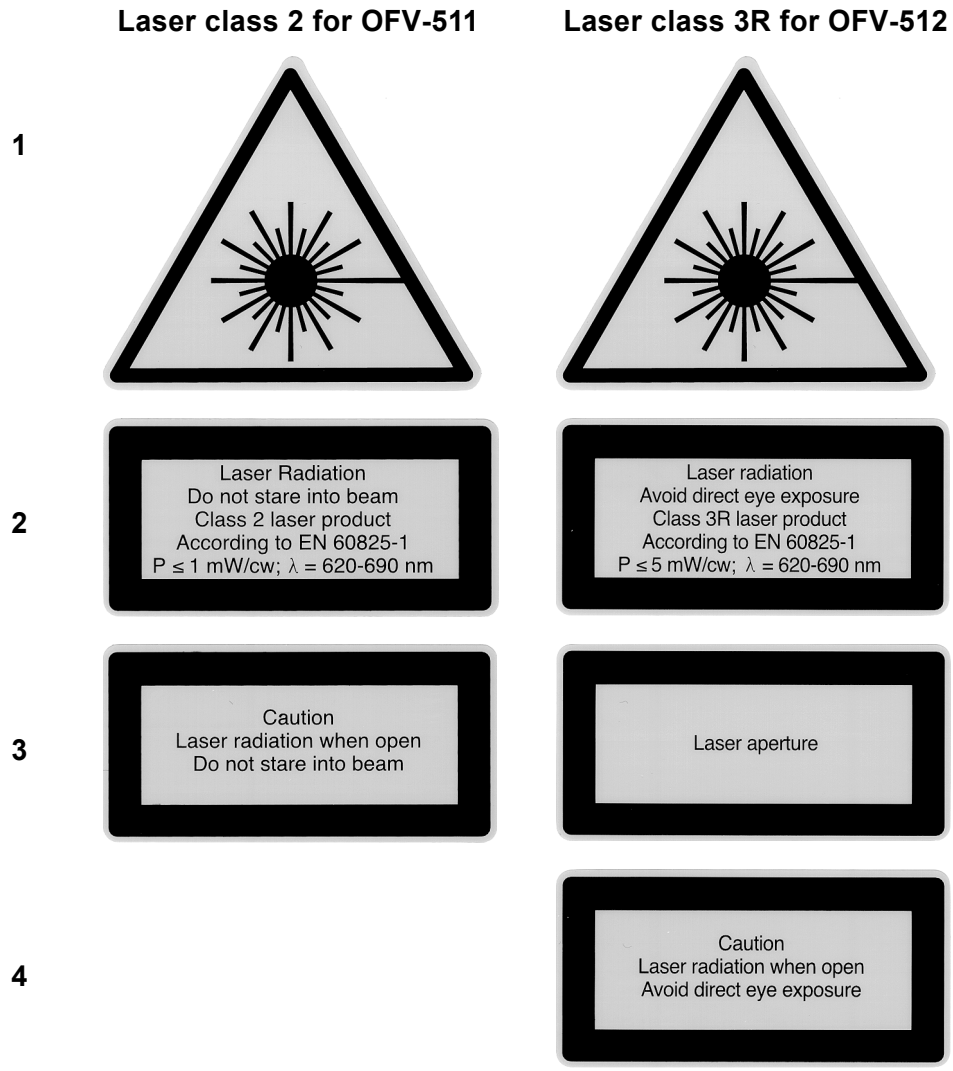


Figure 1.1: Laser warning labels for the sensor heads in EC countries

Position

The position of the laser warning labels in EC countries on the sensor head is shown in figure 1.2.

For the sensor head OFV-511, label **3** is affixed inside.

For the sensor head OFV-512, label **4** is affixed inside. Label **3** is enclosed with the sensor head as it is not possible to affix it on the mini sensor due to its size. Please affix this label clearly visible near the mounted mini sensor or fiber head.

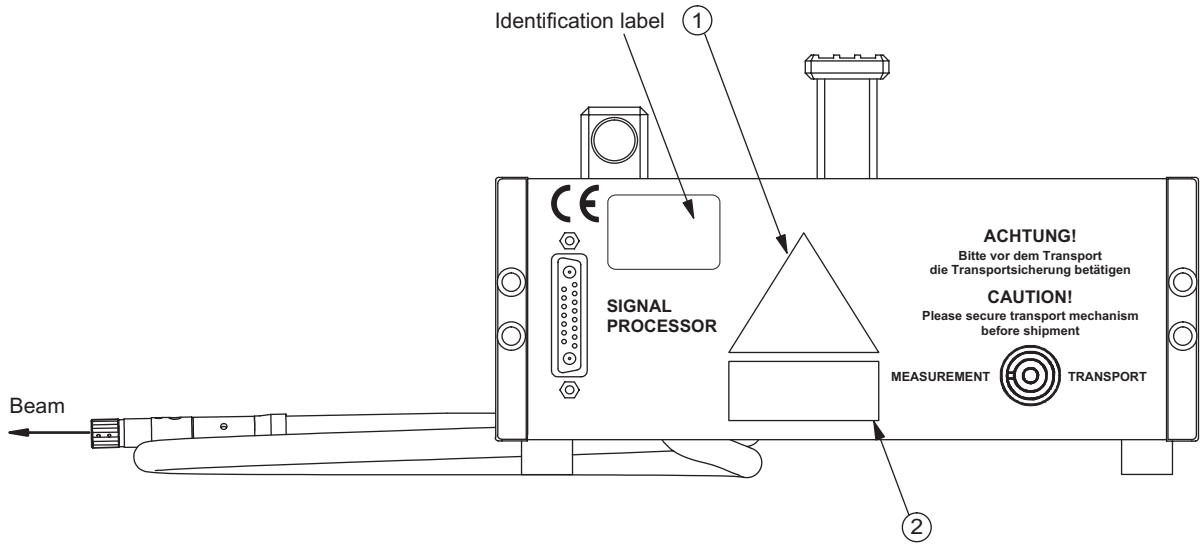


Figure 1.2: Position of the laser warning labels on the sensor head in EC countries

1.2.2 Non-EC Countries

Warning labels

The laser warning labels for the sensor heads in non-EC countries are shown in figure 1.3.

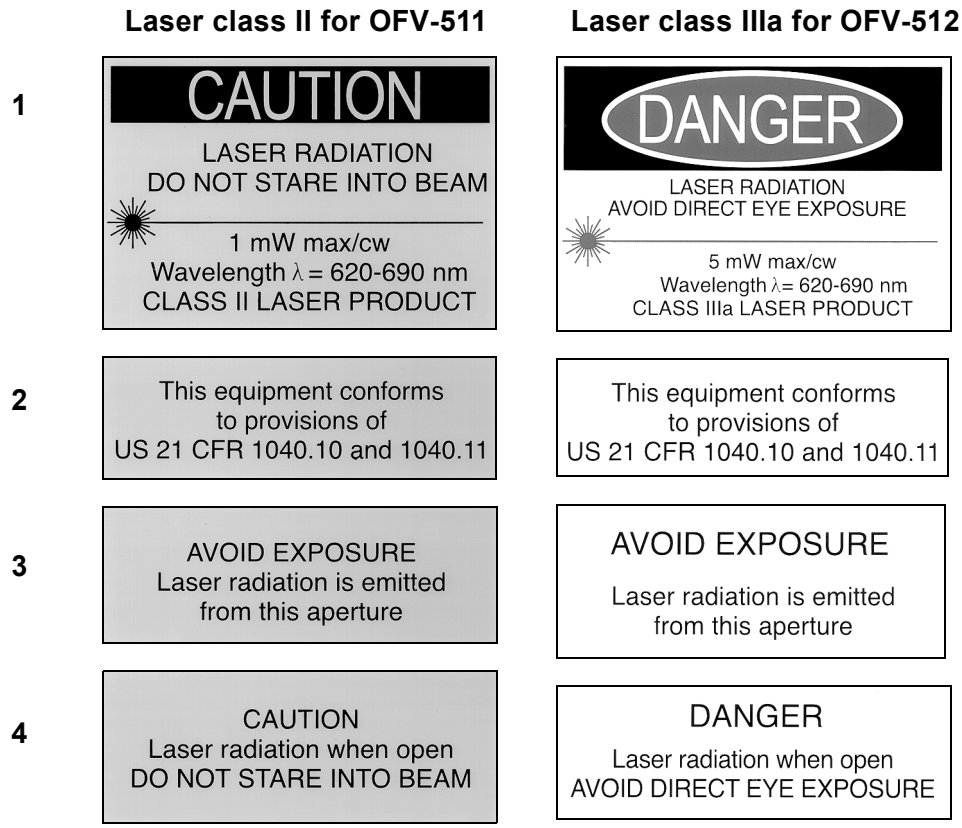


Figure 1.3: Laser warning labels for the sensor heads in non-EC countries

Position

The position of the laser warning labels in non-EC countries on the sensor head is shown in figure 1.4.

Label **4** is affixed inside. Label **3** is enclosed with the sensor head as it is not possible to affix it on the mini sensor due to its size. Please affix this label clearly visible near the mounted mini sensor or fiber head.

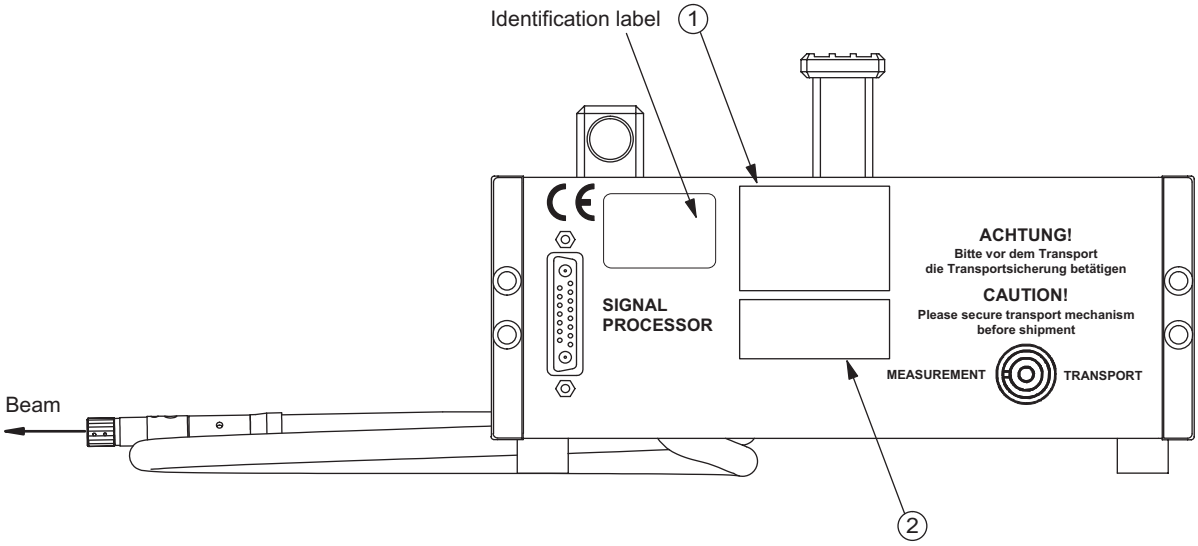


Figure 1.4: Position of the labels on the sensor head in non-EC countries

2 First Steps

2.1 Unpacking and Inspection

Unpacking

The vibrometer consists of the following components:

- sensor head OFV-511/-512
- reference head OFV-151 (only for OFV-512)
- connecting cable from the controller to the sensor head (length 5 m)
- controller

> **Note!**
>
> The controller is described in a separate user manual!

Optional:

- reference head OFV-153
- side exit heads OFV-C-102 and OFV-C-110
- fiber heads OFV-102, OFV-130-3 and OFV-130-5
- flexible arm OFV-039

> **Caution!**
>
> Protect the unpacked sensor head from hard jolts as these can lead to misalignment of the interferometer!

> **Caution!**
>
> Handle the front lens of the sensor head with great care! Dirt may only be removed very carefully with a soft, dry cloth, an optics brush and bellows!

Inspection

Please pay attention to the following steps when unpacking:

1. Check the packaging for signs of unsuitable handling during transport.
2. After unpacking, check all components for external damage (scratches, loose screws, damaged lens etc.).
3. In the case of a wrong delivery, damage or missing parts, inform your local Polytec representative immediately and give them the serial number of the sensor head. The identification label can be found on the back of the sensor head and also on the inside cover of this manual.
4. Carefully retain the original packaging in case you have to return the instrument.

Install the sensor head as described in section 2.4 and carry out a first functional test as described in the user manual of the controller.

2.2 Operating and Maintenance Requirements

Operating environment

The sensor head can be operated in dry rooms under normal climate conditions (refer to specifications in chapter 6). In particular the optical components in the sensor head are sensitive to moisture, high temperatures, jolting and dirt.

When the vibrometer is taken into operation after being stored somewhere cool, a sufficient acclimatization period should be allowed for before switching it on. Avoid condensation on the optical components caused by a rapid change in temperature.

Warming-up

After switching on, the helium neon laser in the sensor head requires a certain period of time to reach optimum stability. The vibrometer should thus be switched on 20 minutes before the first measurements are made to ensure that it is in thermal equilibrium with the surroundings.

Transport

The sensor head is equipped with a transport safety mechanism which always has to be activated before moving the sensor head (refer to section 4.8).

Connecting cables

As a general rule the vibrometer must not be switched on until all cables are connected. Make sure that all jacks are connected properly and firmly. Protect the cables from mechanical damage and from high temperatures.

Cleaning

The housing surfaces of the instrument can be cleaned with mild detergent solutions. Organic solvents must not be used.

Optical components

Handle all optical components with great care. Dirt may only be removed very carefully with a soft, dry cloth, an optics brush and bellows.

Cooling

It is very important to ensure that there is sufficient air circulation to keep the sensor head cool. The air vents of the sensor head must never be covered up.

Opening up the equipment

Opening up of the equipment without authorization is not necessary for its operation and will invalidate the warranty.

2.3 Control Elements

2.3.1 Sensor Head OFV-511

Front panel The front panel of the sensor head OFV-511 is shown in figure 2.1.

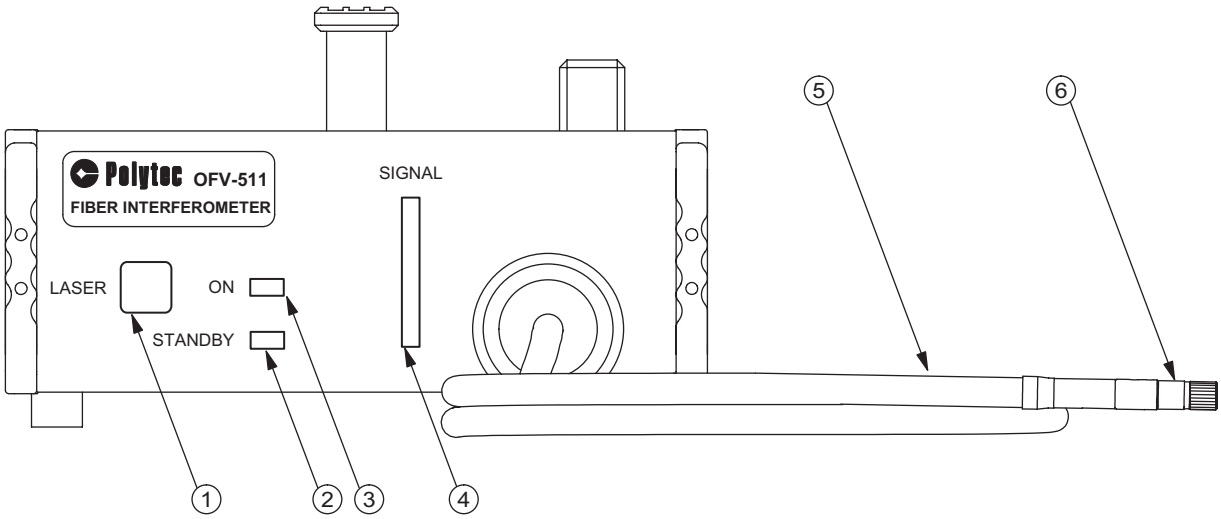


Figure 2.1: Front view of the sensor head OFV-511

1 **LASER** beam shutter key

Pressing this key the beam shutter is opened and pressing this key a second time the beam shutter is closed again (refer to section 4.2). The beam shutter is closed automatically when the controller is switched on (key switch on the controller in position I).

2 LASER **STANDBY** LED

The LED goes on when the controller is switched on. This then shows that the laser is operational. However, no laser beam is emitted yet as the beam shutter is still closed (LED ON is out). The LED goes out when the beam shutter key is pressed and thus the laser beam is emitted (LED ON is then on).

3 LASER **ON** LED

The LED goes on when the beam shutter key LASER is pressed and thus the laser beam is emitted. At the same time the LED STANDBY goes out. Pressing the beam shutter key LASER a second time the beam shutter is closed and the LED ON goes out and the LED STANDBY goes on again.

4 **Signal level display**

The length of the bar is a measure of the amount of light scattered back from the surface of the object.

5 **Fiber optic cable**

6 Mini sensor (diameter 10 mm)

The mini sensor contains a lens to focus the laser beam. Exchange of the mini sensor with a fiber head is described in section A.1.

Note!
Each mini sensor is exactly adjusted to its fiber. **Never** exchange the mini sensor with a mini sensor of another sensor head!

Back panel

The back panel of the sensor head OFV-511 is shown in figure 2.2.

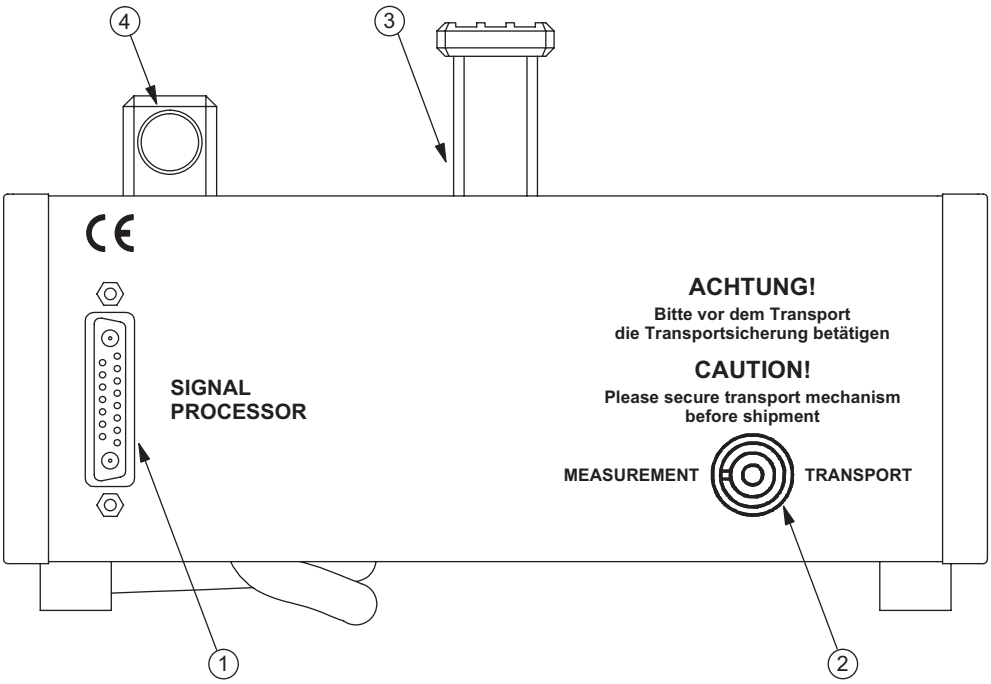


Figure 2.2: Rear view of the sensor head OFV-511

1 SIGNAL PROCESSOR connector (Sub-D jack)

Jack for the connecting cable to the controller

2 Transport safety mechanism

The transport safety mechanism is (de)activated by turning the screw with the Allen key provided (refer to section 4.8).

3 Transport handle

Caution!
Always activate the transport safety mechanism **before** moving the sensor head!

4 Sensor mount

To transport the sensor head, the mini sensor can be plugged into this sensor mount.

2.3.2 Sensor Head OFV-512

Front panel The front panel of the sensor head OFV-512 is shown in figure 2.3.

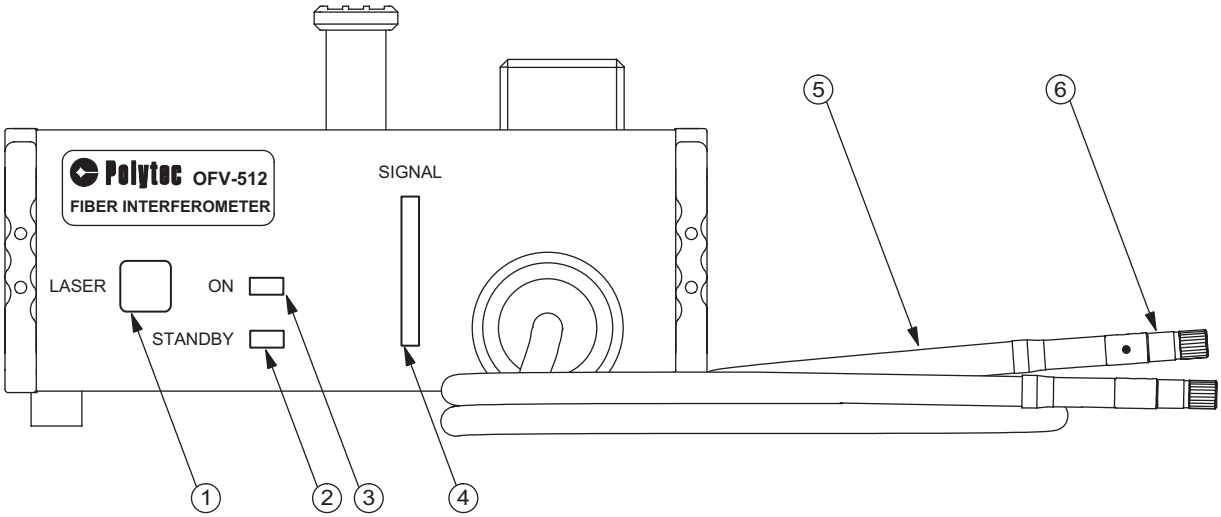


Figure 2.3: Front view of the sensor head OFV-512

1 **LASER** beam shutter key

Pressing this key the beam shutter is opened and pressing this key a second time the beam shutter is closed again (refer to section 4.2). The beam shutter is closed automatically when the controller is switched on (key switch on the controller in position I).

2 LASER **STANDBY** LED

The LED goes on when the controller is switched on. This then shows that the laser is operational. However, no laser beam is emitted yet as the beam shutter is still closed (LED ON is out). The LED goes out when the beam shutter key is pressed and thus the laser beam is emitted (LED ON is then on).

3 LASER **ON** LED

The LED goes on when the beam shutter key LASER is pressed and thus the laser beam is emitted. At the same time the LED STANDBY goes out. Pressing the beam shutter key LASER a second time the beam shutter is closed and the LED ON goes out and the LED STANDBY goes on again.

4 **Signal level display**

The length of the bar is a measure of the amount of light scattered back from the surface of the object.

5 **Fiber optic cable**

The fiber optic cable branches off via a Y-piece. The reference fiber is marked with a red dot.

6 **Mini sensors** (diameter 10 mm)

Each mini sensor contains a lens to focus the laser beam. The mini sensor of the reference fiber is marked with a red dot. Exchange of the mini sensors with fiber heads is described in section A.1.

Note!

Each mini sensor is exactly adjusted to its fiber. **Never** exchange the mini sensors of a sensor head with each other or with mini sensors of other sensor heads!

Back panel

The back panel of the sensor head OFV-512 is shown in figure 2.4.

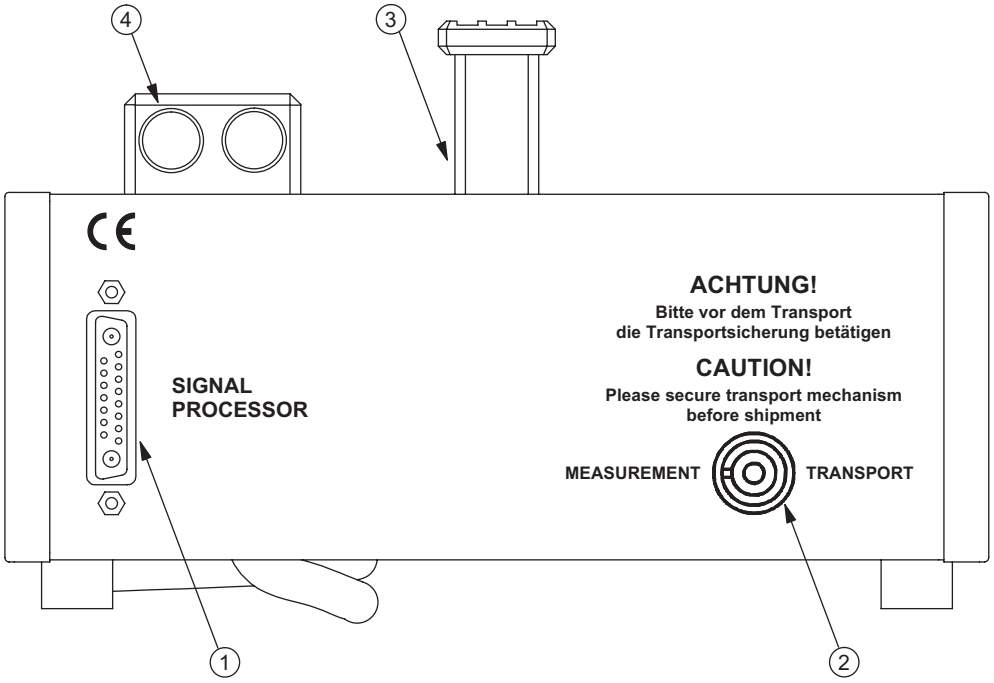


Figure 2.4: Rear view of the sensor head OFV-512

1 **SIGNAL PROCESSOR** connector (Sub-D jack)

Jack for the connecting cable to the controller

2 **Transport safety mechanism**

The transport safety mechanism is (de)activated by turning the screw with the Allen key provided (refer to section 4.8).

3 **Transport handle**

Caution!

Always activate the transport safety mechanism **before** moving the sensor head!

4 **Sensor mount**

To transport the sensor head the mini sensors can be plugged into this sensor mount.

2.4 Installation

For the installation of the sensor head, proceed as follows:

Preparing

1. **Only OFV-512**: Unscrew the mini sensor from the reference fiber. The reference fiber is marked with a red dot. Mount the reference head OFV-151 on the reference fiber as described in section 4.6.
2. Deactivate the transport safety mechanism on the back of the sensor head by turning the screw with the Allen key provided to position MEASUREMENT (refer to section 4.8).
3. Make sure that the key switch on the controller is in position O.
4. If applicable for your controller, check the setting on the mains voltage selector on the back of the controller as well as the fuses.

Cabling

5. Plug the connecting cable into the Sub-D jack SIGNAL PROCESSOR on the back of the sensor head and into the corresponding Sub-D jack on the back of the controller. Fix the connections with the screws provided.

   All connections must be easy to plug in. If not, check the plug for bent contact pins to avoid serious damage being incurred.
6. Use the earthed mains cable to connect the controller to a wall outlet providing protective grounding.

Now carry out a first functional test as described in the user manual of the controller.

3 Optimal Stand-off Distance

OFV-511

The stand-off distance is measured from the shoulder of the connector for the mini sensor or the fiber head. The optimal stand-off distances are:

$$\text{Optimal stand-off distance} = 135\,\text{mm} + (n \cdot l)\,\text{mm}$$

n = 0; 1; 2; ... l = 204 mm ±1 mm

i.e. for l = 204 mm the optimal stand-off distances are:
135 mm; 339 mm; 543 mm etc., refer also to section 6.3 and section 6.5

OFV-512

When making two point measurements the stand-off distance is the difference between the stand-off distances of both arms. The optimal stand-off distances are:

$$\text{Optimal stand-off distance} = 0\,\text{mm} + (n \cdot l)\,\text{mm}$$

n = 0; 1; 2; ... l = 204 mm ±1 mm

i.e. for l = 204 mm the optimal stand-off distances are:
0 mm; 204 mm; 408 mm etc., refer also to section 6.3 and section 6.5

When making single point measurements with the reference head OFV-151 the stand-off distance is measured from the shoulder of the connector for the mini sensor or the fiber head. The optimal stand-off distances are:

$$\text{Optimal stand-off distance} = 63\,\text{mm} + (n \cdot l)\,\text{mm}$$

n = 0; 1; 2; ... l = 204 mm ±1 mm

i.e. for l = 204 mm the optimal stand-off distances are:
63 mm; 267 mm; 471 mm etc., refer also to section 6.3 and section 6.5

Maxima of visibility

The light source of the vibrometer is a helium neon laser. This is a multimode laser in which a maximum of two modes can exist. The interference of the two modes leads to the intensity of the resulting optical signal varying periodically with the stand-off distance. The intensity increases to a maximum i.e. a maximum of visibility is present if the optical path difference is an even numbered multiple of the length of the laser cavity (204 mm ±1 mm). As the optical path difference is equal to twice the stand-off distance (the beam goes there and back), a maximum of visibility is present once per laser cavity length.

In practice, it is not usually necessary to search for the maximum of visibility as the vibrometer is sensitive enough to make a measurement even close to the minimum. A minimum is indicated during the warm-up phase by periodic fluctuation on the signal level display.

4 Operating the Sensor Head

4.1 Switching On and Off

The vibrometer is switched on by using the key switch on the front panel of the controller. To do so, turn the key switch to position I.The LED POWER above the key switch then lights up and shows that the controller is ready to operate.

Providing the connecting cable from the controller to the sensor head has been correctly installed, the LED LASER STANDBY on the front of the sensor head also lights up and shows that the sensor head is ready to operate and that the laser is active, even if the beam shutter is closed (refer to section 4.2).

4.2 Blocking the Laser Beam

The sensor head is equipped with a beam shutter. This can be used to block the laser beam without switching off the laser, thus keeping the system at a thermal equilibrium.

Warning!

Only open the beam shutter when you are making measurements!

Warning!

To position the sensor head, switch the beam shutter off. Only when the sensor head is roughly in place and has been fixed in a stable position, switch the beam shutter on!

The key for the beam shutter is on the front of the sensor head and is labeled LASER. When the controller is switched on, the beam shutter is automatically closed. To open the beam shutter, press the LASER key. To close the beam shutter again press the LASER key a second time.

4.3 Indicating Laser Activity

On the front of the sensor head the LEDs STANDBY and ON indicate the laser activity. The LED STANDBY is lit when the laser is active (key switch on the front of the controller in position I) and the beam shutter is closed. The LED indicates that the laser is active but the laser beam is not being emitted from the sensor head. The LED ON is lit as soon as the beam shutter is opened (key LASER is pressed) and shows that the laser beam is being emitted.

4.4 Focusing the Laser Beam

You can focus the laser beam manually by turning the mini sensor or the focusing ring of the fiber head mounted.

4.5 Optimizing the Focus of the Laser Beam

The signal level display helps you to optimize the focus of the laser beam.

The signal level is shown on the front of the sensor head as a 10-part bar display.

4.6 Exchanging the Mini Sensor

Exchanging the mini sensor of the reference fiber with a reference head is described in section 4.7 and section A.2.

Exchanging the mini sensors with fiber heads is described in section A.1.

> **Note!**
>
> Each mini sensor is **exactly** adjusted to its fiber. **Never** exchange the mini sensors of a sensor head with each other or with mini sensors of other sensor heads!

4.7 Making Single Point Measurements with the Sensor Head OFV-512

If single point measurements are carried out with the sensor head OFV-512, one of the two fibers must be terminated with a reference head. The reference head is marked with a red dot. Always mount the reference head to the reference fiber, also marked with a red dot.

As default each sensor head OFV-512 is delivered with the reference head OFV-151. The reference head is exactly adjusted to its sensor head. Therefore each reference head has a own serial number which is noted in the examination protocol.

> **Note!**
>
> **Never** exchange the reference head of a sensor head with a reference head of another sensor head!

Optionally you can use the reference head OFV-153 with adjustable stand-off distance. You will find information on this in section A.2.

Assembly

To mount the reference head OFV-151 onto the reference fiber, proceed as follows:

1. Unscrew the mini sensor from the reference fiber and keep in a safe place because each mini sensor is exactly adjusted to its fiber.

2. Screw the reference head onto the end of the fiber until it is securely fixed.

The reference head can now be used.

4.8 Activating Transport Safety Mechanism

Caution!

Always activate the transport safety mechanism **before** moving the sensor head!

If the sensor head is being transported, the shock absorbing feet of the housing do not provide sufficient protection. For this reason, the interferometer must additionally be secured with a transport safety mechanism.

To activate the transport safety mechanism, proceed as follows:

1. Turn the screw on the back of the sensor head to position TRANSPORT.

   An Allen key size 5 is supplied for this purpose in the tool kit for the vibrometer.

2. Only set the transport safety mechanism to position MEASUREMENT when you are making measurements or when the system is kept in one and the same position.

5 Fault Diagnosis

Simple tests are described in the following which you can carry out yourself in the case of malfunction. In the case of more difficult faults in individual functions, please contact our service personnel. The tests described here are not meant to lead you to carry out maintenance work yourself but to provide our service personnel with information which is as accurate as possible.

Testing the vibrometer is limited to such tests in which the housing does not have to be opened. Opening the housing without authorization invalidates the warranty.

If required, please contact our service department. Based on your fault description, further procedure will be determined.

If the vibrometer has to be sent back for repair, always use the original packaging and enclose an exact description of the fault.

Please use the corresponding checklist in the user manual of the controller, when you consult Polytec or your nearest representative.

5.1 No Laser Beam

If no laser beam is emitted, please check the following:

1. Is the connecting cable between the controller and the sensor head installed correctly?

2. Are the jacks on the connecting cable screwed in securely?

3. Is the LED LASER STANDBY on the front of the sensor head lit up after switching the controller on?

Warning!
Always disconnect from the mains **before** checking the fuses!

   If the LED is not lit up, it can be assumed that there is a a fault with the mains power supply of the controller. Disconnect the mains plug and check the fuses on the back of the controller. Note that there are two active fuses which can both lead to failure.

4. Is the beam shutter key LASER on the front of the sensor head pressed once after switching the controller on?

   The LED LASER ON lights up when the beam shutter key LASER is once pressed and thus the laser beam is emitted. At the same time the LED LASER STANDBY goes out. Pressing the beam shutter key LASER a second time the beam shutter is closed, at the same time the LED LASER ON goes out and the LED LASER STANDBY lights up again.

5. Is a break of the optical fiber cable visible?

5.2 No Measurement Signal

If the laser beam is emitted but there is no measurement signal, check the signal level display. To do so, proceed as follows:

1. Put a piece of reflective film at an optimal stand-off distance according to the information given in chapter 3 in the beam path.

2. Focus the laser beam on the reflective film. Does the signal level display react?

   If the signal level display does not react, the input section of the controller is faulty.

If the malfunction cannot be eliminated by above mentioned tests, please proceed with the fault diagnosis as described in the user manual of the controller.

6 Technical Specifications

6.1 Standards Applied

Laser safety:	EN 60825-1 (DIN VDE 0837)
Electrical safety:	EN 61010 (safety requirements for electrical equipment for measurement, control and laboratory use)
EMC:	EN 61326-1, EN 61326 / A1 (electrical equipment for measurement, control and laboratory use - EMC requirements)
	Emission: FCC Class B, EN 61000-3-2, EN 61000-3-3
	Immunity: EN 61000-4-2 and the following

6.2 General Data

Laser

Laser type:	helium neon
Wavelength:	633 nm
Cavity length:	204 mm ± 1 mm
OFV-511	
Laser safety class:	2 (in non-EC countries: II)
Laser output power:	< 1 mW
Length of fiber cable:	2000 mm (3000 mm for option OFV-C-11)
Minimum bending radius:	50 mm
OFV-512	
Laser safety class:	3R (in non-EC countries: IIIa)
Laser output power:	< 5 mW (< 1 mW per fiber)
Length of fiber cable from	
- housing to Y-junction:	1500 mm (2400 mm for option OFV-C-21)
- Y-junction to fiber head:	500 mm (600 mm for option OFV-C-21)
Minimum bending radius:	50 mm

Electrical Data

Power consumption:	ca. 15 W
Carrier frequency:	40 MHz

Ambient Conditions

Operating temperature:	+0°C ... +40°C (32°F ... 104°F)
Storage temperature:	−15°C ... +65°C (5°F ... 149°F)
Relative humidity:	max. 80%, non-condensing

Housing

Dimensions (without cable): 235 mm × 355 mm × 140 mm

Weight: approx. 8.0 kg

6.3 Optics

Characteristics

		Mini sensor	Fiber head		
			OFV-102	OFV-130-3	OFV-130-5
Focal length	mm	16	20	60	80
Minimum stand-off distance[1]	mm	60	80	55 ±2	76 ±2
Aperture diameter ($1/e^2$)	mm	3.2	4	16	16
Spot size (typ.)	µm				
@ 55 mm		15	-	3	-
@ 76 mm		20	-	-	5
@ 100 mm		27	27	-	-
@ 300 mm		90	75	-	-
@ 1000 mm		320	250	-	-
@ each additional meter plus		320	250	-	-

[1] The maximum stand-off distance depends on the back scattering properties of the object and is measured form the shoulder of the connector for the minisensor or the fiber head.

Maxima of Visibility

Sensor head	Maxima of visibility
OFV-511[1]	135 mm + (n · l) mm, n = 0; 1; 2; ..., l = 204 ±1 mm
OFV-512[2] (differential measurement)	0 mm + (n · l) mm, n = 0; 1; 2; ..., l = 204 ±1 mm
OFV-512[1] (single point measurement with the reference head OFV-151)	63 mm + (n · l) mm, n = 0; 1; 2; ..., l = 204 ±1 mm

[1] Measured from the shoulder of the connector for the mini sensor or the fiber head

[2] Difference between the stand-off distances of both arms

Focusing motion

A circular motion of the laser beam is visible during focusing. At 1 m stand-off distance, the maximum diameter of the circle is:

for the mini sensor: 5 mm

for the fiber head OFV-102: 0.25 mm

6.4 Dimensions

Fiber Heads

OFV-102

Length:	57 mm
Diameter:	20 mm
Diameter of the focusing ring:	24 mm

OFV-130-3, OFV-130-5

Length:	ca. 105 mm
Diameter:	20 mm
Diameter of the focusing ring:	24 mm

Side Exit Heads

OFV-C-102

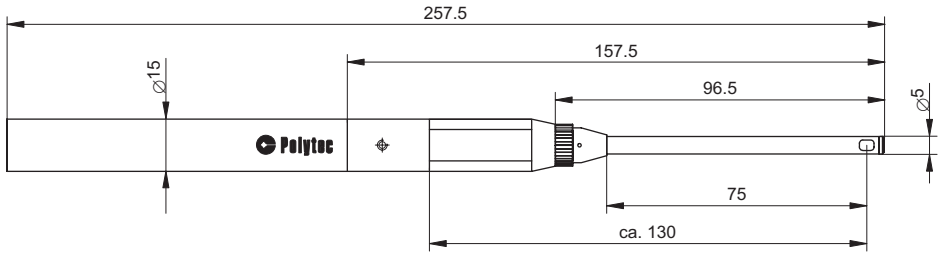


Figure 6.1: View of the side exit head OFV-C-102 (dimensions not specified are given in mm)

OFV-C-110

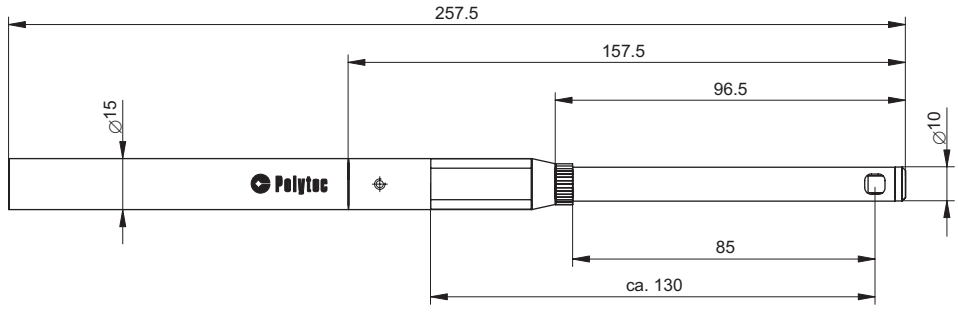


Figure 6.2: View of the side exit head OFV-C-110 (dimensions not specified are given in mm

Reference Heads

OFV-151

Length:	ca. 70 mm
Diameter:	20 mm
Diameter of the focusing ring:	22.5 mm

OFV-153 (refer also to section A.2)

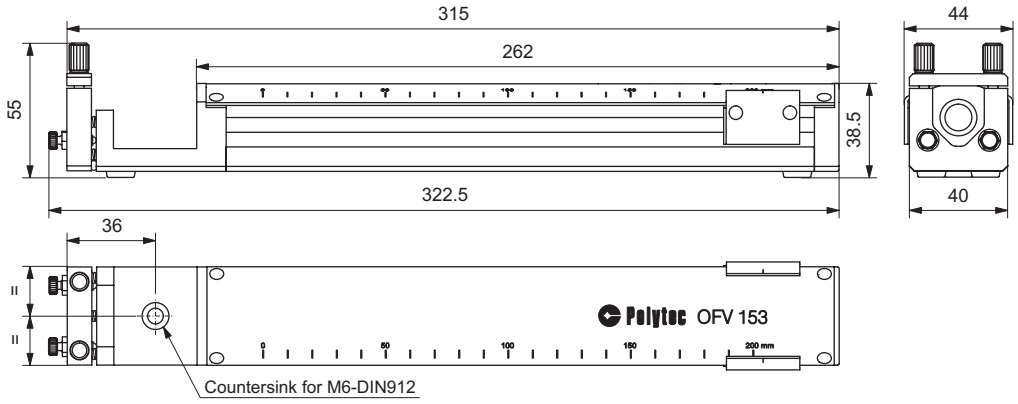


Figure 6.3: Reference head OFV-153

6.5 Table of the Maxima of Visibility

Sensor Head OFV-511

Maxima of visibility (in mm) for l = 204 mm					
135	1767	3399	5031	6663	8295
339	1971	3603	5235	6867	8499
543	2175	3807	5439	7071	8703
747	2379	4011	5643	7275	8907
951	2583	4215	5847	7479	9111
1155	2787	4419	6051	7683	9315
1359	2991	4623	6255	7887	9519
1563	3195	4827	6459	8091	...

Sensor Head OFV-512

Maxima of visibility (in mm) for l = 204 mm					
0	1632	3264	4896	6528	8160
204	1836	3468	5100	6732	8364
408	2040	3672	5304	6936	8568
612	2244	3876	5508	7140	8772
816	2448	4080	5712	7344	8976
1020	2652	4284	5916	7548	9180
1224	2856	4488	6120	7752	9384
1428	3060	4692	6324	7956	...

Sensor Head OFV-512 with Reference Head OFV-151

Maxima of visibility (in mm) for l = 204 mm					
63	1695	3327	4959	6591	8223
267	1899	3531	5163	6795	8427
471	2103	3735	5367	6999	8631
675	2307	3939	5571	7203	8835
879	2511	4143	5775	7407	9039
1083	2715	4347	5979	7611	9243
1287	2919	4551	6183	7815	9447
1491	3123	4755	6387	8019	...

Appendix A: Optional Accessories for the Sensor Head

A.1 Fiber Heads

Overview The following fiber heads are available for the sensor head OFV-511/-512:

- OFV-102 standard fiber head
- OFV-130-3 for beam diameter 3µm
- OFV-130-5 for beam diameter 5µm

Assembly To mount the fiber head onto the fiber, you proceed as follows:

1. Unscrew the mini sensor from the fiber and keep in a safe place because each mini sensor is exactly adjusted to its fiber.
2. Screw the fiber head onto the end of the fiber until it is securely fixed.

The fiber head can now be used. For the technical specification, please refer to section 6.3 and to section 6.4.

A.2 Reference Head OFV-153 (Only for Sensor Head OFV-512)

Overview If you carry out single point measurements with the sensor head OFV-512, the reference fiber must be terminated with a reference head. The reference fiber is marked with a red dot.

As described in chapter 3, the intensity of the optical signal varies periodically with the stand-off distance. The reference head OFV-153 is suitable for adjusting the maximum of visibility if the stand-off distance of the fiber head can not be changed. The reference head OFV-153 is used in combination with the standard fiber head OFV-102. The mounted reference head OFV-153 is shown in figure A.1.

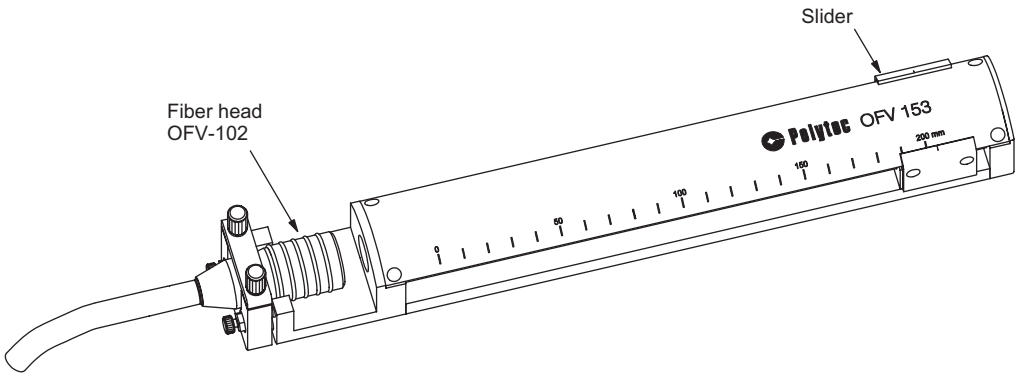


Figure A.1: Reference head OFV-153

Using the OFV-153, the distance between the mirror and the fiber can be varied. This is achieved by moving the retroprism in the reference head using the slider. In addition, the intensity of the signal can be optimized by collimating the laser beam onto the retroprism with the fiber head OFV-102.

Assembly

For mounting the reference head OFV-153, you proceed as follows:

1. Make sure that the beam shutter on the sensor head is closed.
2. Unscrew the mini sensor or the fiber head from the connector of the measurement fiber.
3. Screw the standard reference head OFV-151 onto the end of the measurement fiber until it is securely attached.
4. Screw the standard fiber head OFV-102 onto the connector of the reference fiber until it is securely attached.
5. Open the beam shutter and collimate the laser beam of the fiber head OFV-102 by turning the focusing ring.

> **Warning!**
>
> **Never** look directly into the laser beam with the naked eye or with the aid of mirrors or optical instruments!

Close the beam shutter and mount the fiber head OFV-102 to the reference head OFV-153 as shown in figure A.2.

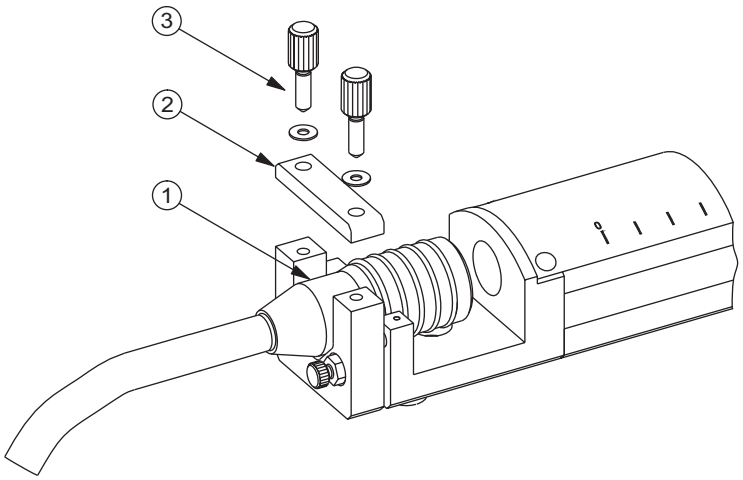


Figure A.2: Mounting the fiber head OFV-102 to the reference head OFV-153

> **Note!**
>
> Pay attention that the **whole** contact surface **1** of the fiber head fits to the holding device!

6. Secure the fiber head OFV-102 with the clamping device **2** and the two knurled screws **3** in figure A.2.

Adjust the laser beam

To correctly adjust the laser beam, you proceed as follows:

Move the slider **1** of the reference head OFV-153 in figure A.3 to its starting position at 0 mm.

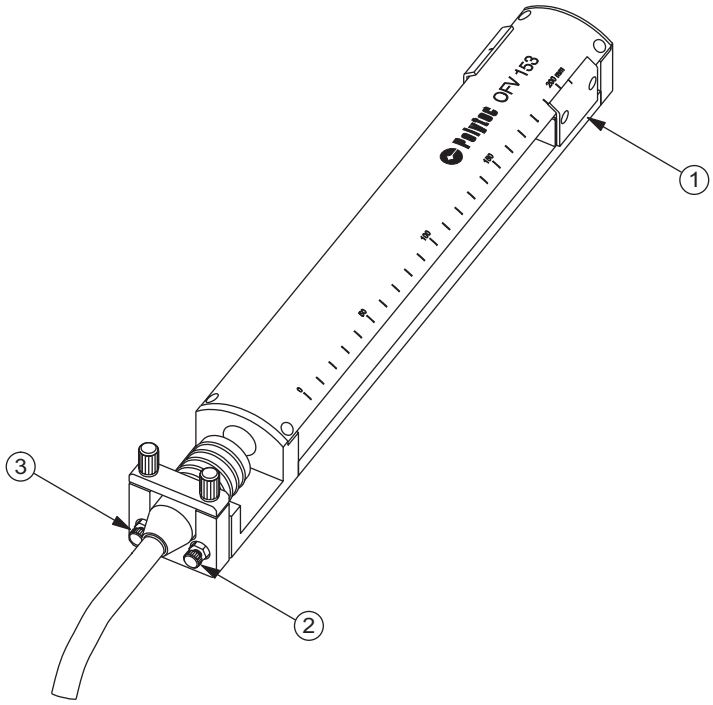


Figure A.3: Adjusting the laser beam in the reference head OFV-153

7. Adjust the signal level to an optimum by turning the knurled screws **2** and **3** in figure A.3.

8. Move the slider **1** to the end position at 200 mm and adjust the signal level to an optimum again using the knurled screws **2** and **3**.

9. Unscrew the reference head OFV-151 from the measurement fiber and keep it in a safe place because each reference head is exactly adjusted to its reference fiber.

10. Screw the mini sensor or the fiber head onto the connector of the measurement fiber.

11. Point the mini sensor or the fiber head on the object under investigation and adjust for maximum signal using the slider **1**.

Adjust the stand-off distance

To correctly adjust the stand-off distance, you proceed as follows:

1. Measure the distance from the connector for the mini sensor or fiber head to the object under investigation.
2. Compare it with the optimal stand-off distance described in chapter 3 and move the slider **1** to the position, which corresponds to the length difference between the measured length and the optimal stand-off distance.

   Now you are in a maximum of visibility.

Or:

1. Point the mini sensor or fiber head onto the object under investigation.
2. Focus the laser beam on the object.
3. If the signal level shown on the front of the sensor head periodically fluctuate, a minimum of visibility is indicated (refer to chapter 3).
4. Move the slider **1** approximately 100 mm away and the optimal stand-off distance is adjusted.

The reference head OFV-153 is now well assembled and adjusted. You can use the reference head as described in chapter 4. For the dimensions of the reference head, please refer to section 6.4.

A.3 Side Exit Head OFV-C-102 and OFV-C-110

Overview

The side exit heads have a mirror and a side exit window. The laser beam can thus be deflected by 90 degrees from the output direction from the fiber.

The following side exit heads are available for the sensor head OFV-511/-512:

- OFV-C-102, 90° steering head, diameter 5 mm
- OFV-C-110, 90° steering head, diameter 10 mm

For the dimensions of the side exit heads, please refer to section 6.4.

Assembly

The assembly of the side exit head OFV-C-102 and OFV-C-110 is made in the same way. The side exit head OFV-C-110 with mini sensor mounted is shown in figure A.4.

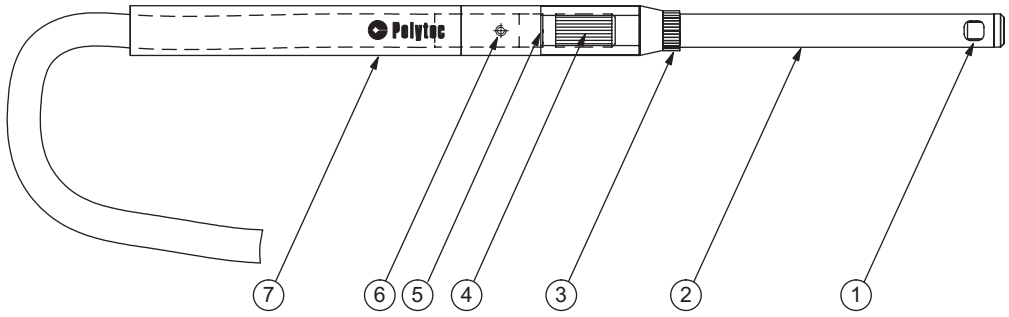


Figure A.4: Side exit head OFV-C-110 with mini sensor mounted

To mount the side exit head, you proceed as follows:

1. Place the mini sensor **4** into the side exit head as far as the shoulder of the connector for the mini sensor is positioned at the edge of the opening **5**.

   *The distance from the edge of the opening **5** to the exit window **1** is about 130 mm.*

2. Fix the mini sensor by gently tightening the stud screw **6**.

3. Fix the holding device provided onto the grip **7** of the side exit head.

4. Position the side exit head at the measurement location.

5. You can position the exit window **1** subsequently by removing the knurled screw **3**, turning the probe **2** and fixing the knurled screw again.

6. Focus the laser beam by turning the focusing ring of the mini sensor **4** through the opening on the side exit head.

A.4 Flexible Arm OFV-039

The flexible arm OFV-039 is a mount device for the mini sensor of the sensor head OFV-511/-512. The mini sensor can thus be easily positioned in places which are difficult to access. The heavy steel base ensures that it stands securely and if required the steel base can be screwed onto the surface beneath via the drilled mounting holes (refer to figure A.6). Alternatively, the flexible arm can be attached to any magnetic surface which is large enough using the magnetic base. The flexible arm is shown in figure A.5.

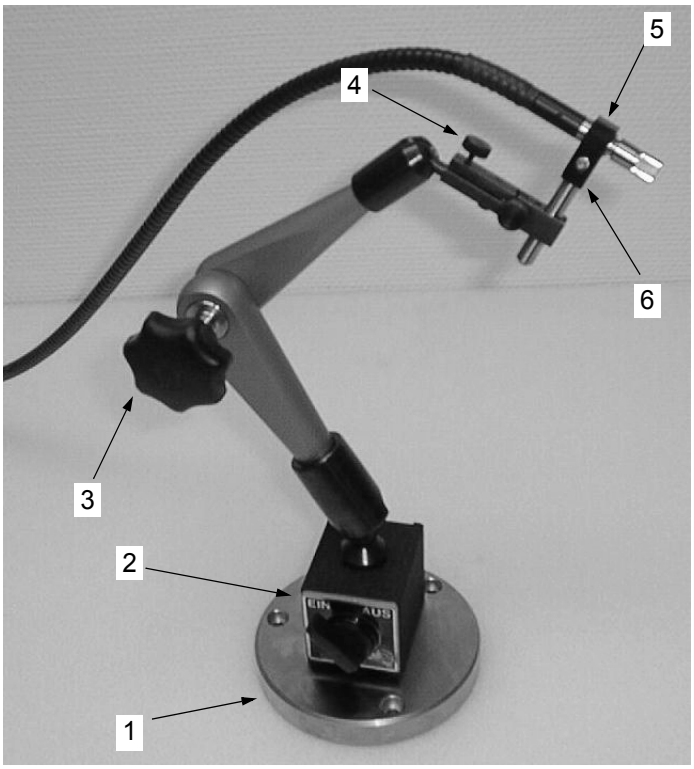


Figure A.5: Flexible arm OFV-039 for the mini sensor

1 Base plate with drilled mounting holes (refer also to figure A.6)

2 Magnet foot with switch

3 Locking wheel for the joints

4 Knurled screw for fine positioning

5 Mount for the mini sensor

6 Allen screw M3 to mount the mini sensor

Technical Specifications

Weight (incl. base plate):	3.2 kg
Height:	max. 400 mm
Base plate dimensions:	refer to figure A.6

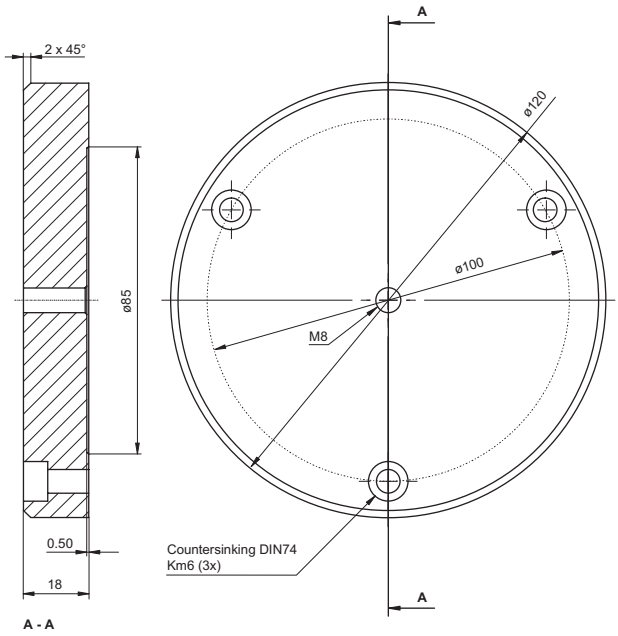


Figure A.6: Base plate for the flexible arm OFV-039 (dimensions not specified are given in mm)

Appendix B: Basics of the Measurement Procedure

B.1 Theory of Interferometric Velocity and Displacement Measurement

Optical interference can be observed when two coherent light beams are made to coincide. The resulting intensity e.g. on a photo detector varies with the phase difference $\Delta\varphi$ between the two beams according to the equation

$$I(\Delta\varphi) = \frac{I_{max}}{2} \cdot (1 + \cos\Delta\varphi) \qquad \text{Equation B.1}$$

The phase difference $\Delta\varphi$ is a function of the path difference L between the two beams according to

$$\varphi = 2\pi \cdot \frac{L}{\lambda} \qquad \text{Equation B.2}$$

where λ is the laser wavelength.

If one of the two beams is scattered back from a moving object (the object beam), the path difference becomes a function of time L=L(t). The interference fringe pattern moves on the detector and the displacement of the object can be determined using directionally sensitive counting of the passing fringe pattern.

The velocity component in the direction of the object beam is a function of the path difference L according to

$$\frac{dL(t)}{dt} = v(t) \cdot 2. \qquad \text{Equation B.3}$$

For a constant movement v

$$\left|\frac{dL(t)}{dt}\right| = \frac{\lambda}{2\pi} \cdot \left|\frac{d\varphi}{dt}\right| = f_D \cdot \lambda = |v| \cdot 2 \qquad \text{Equation B.4}$$

applies with

$$f_D = 2 \cdot \frac{|v|}{\lambda}. \qquad \text{Equation B.5}$$

Thus a constant movement of the object causes a frequency shift at the object beam which is called Doppler shift f_D. Superimposing object beam and internal reference beam, i.e. two electromagnetic waves with slightly different frequencies, generates a beat frequency at the detector which is equal to the Doppler shift. The ratio B.5 to determine the velocity is, however, independent of its sign. The direction of the velocity can be determined by introducing an additional fixed frequency shift f_B in the interferometer to which the Doppler shift is added with the correct sign.

Thus the resulting frequency at the detector f_{mod} is given by

$$f_{mod} = f_B + 2 \cdot \frac{v}{\lambda}. \qquad \text{Equation B.6}$$

Interferometers of this type which are directionally sensitive are described as heterodyne.

B.2 Optical Configuration in the Sensor Head OFV-511/-512

In Polytec's vibrometers, the velocity and displacement measurement is carried out using a modified Mach-Zehnder interferometer.

OFV-511 The optical configuration in the sensor head OFV-511 is shown schematically in figure B.1.

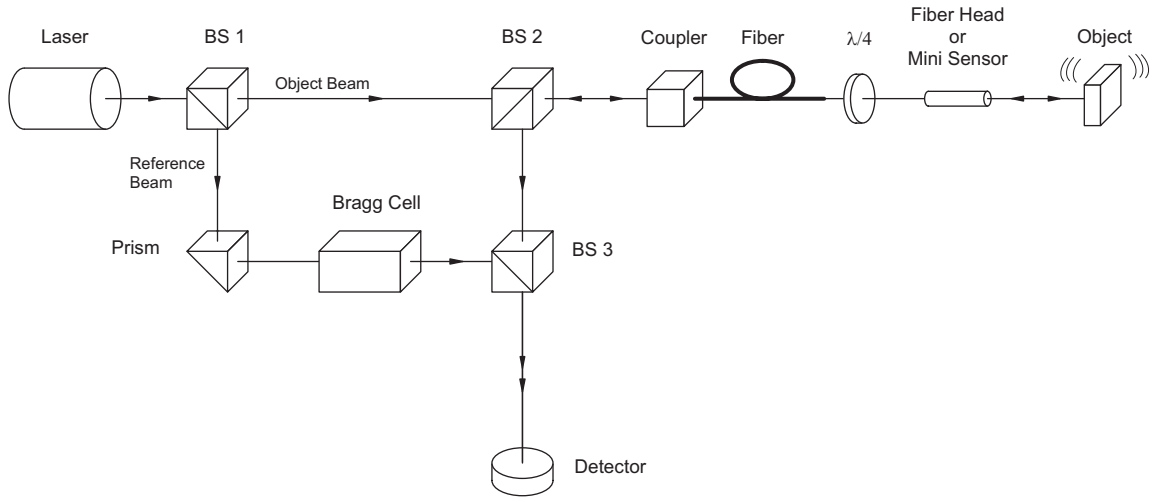


Figure B.1: Optical configuration of the interferometer in the sensor head OFV-511

The light source is a helium neon laser which provides a linear polarized beam. The polarizing beam splitter BS1 splits the beam into the object beam and the reference beam.

The object beam passes through the polarizing beam splitter BS2 and is focused into the fiber with an input coupler. The beam is then emitted from the end of the fiber, passes through a $\lambda/4$ plate and is focused using the fiber head or the mini sensor on the object and scattered back from there. The polarizing beam splitter BS2 then functions as an optical directional coupler together with the $\lambda/4$ plate, and deflects the object beam to the beam splitter BS3. As both arms of the internal interferometer are symmetrical, the optical path difference vanishes within the interferometer. The resulting path difference is equal to twice the distance between the beam splitter BS2 and the object.

The Bragg cell in the reference arm generates the additional frequency offset to determine the sign of the velocity.

The resulting interference signal of the object beam and reference beam is converted into an electrical signal in the photo detector and subsequently decoded in the controller.

OFV-512

The optical configuration of the sensor head OFV-512 is shown schematically in figure B.2.

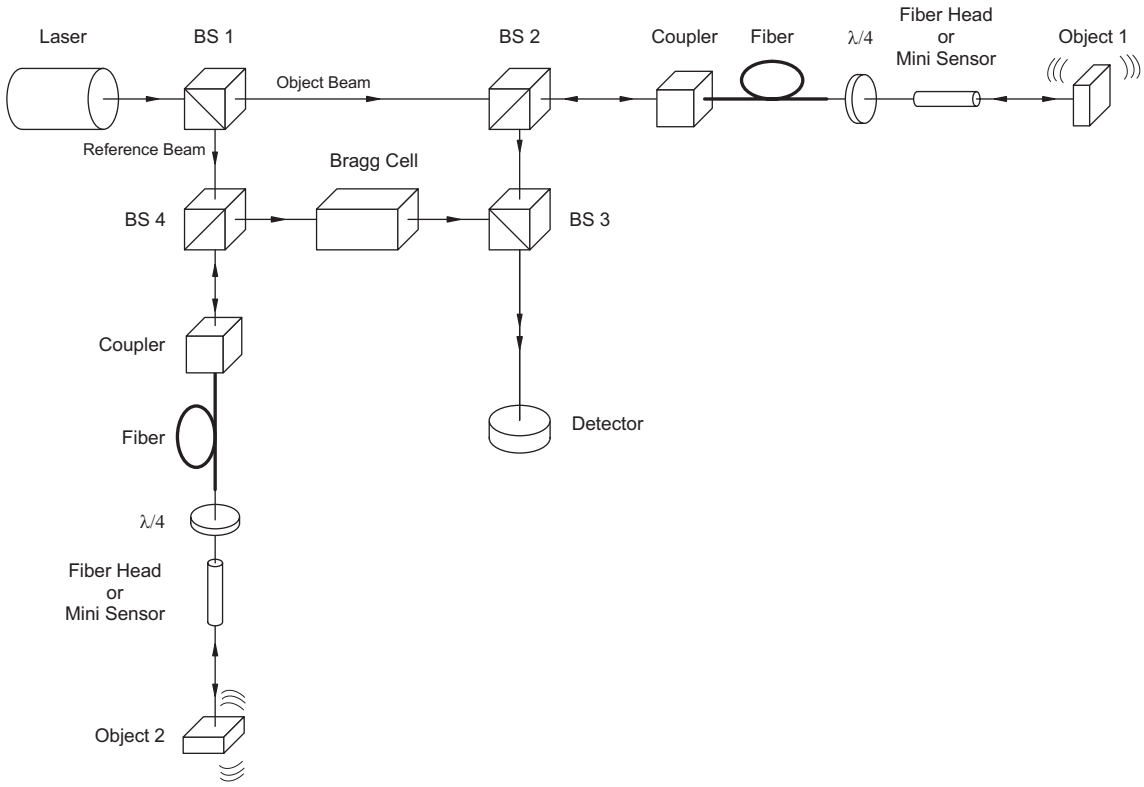


Figure B.2: Optical configuration of the interferometer in the sensor head OFV-512

In contrast to the OFV-511, the beam is coupled out of the reference arm as well as the object arm here. As the resulting signal only depends on the path difference, this allows optical generation of a true difference signal. With the OFV-512 the prism in the reference arm is replaced by another beam splitter BS4 which has the same characteristics as the beam splitter BS2. The signal measured here is thus the relative velocity or displacement between the two objects.

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