Operating Instructions

Polytec Scanning Vibrometer

PSV-500-3D

Front-End	**PSV-F-500-3D-M**
Scanning Heads	**PSV-I-500/PSV-I-520**
	PSV-I-560/PSV-I-570
Junction Box	**PSV-E-500**
PC	**PSV-W-500-M**

For the PSV-500-3D-M System

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 intended and as described in this operating instructions.

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 will find information on troubleshooting in this operating instructions.

Trademarks

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

Name Plates

PSV-F-500-3D-M
Front-End

PSV-I-500/-I-560
Scanning Head

PSV-I-520/-I-570
Scanning Head

PSV-I-520/-I-570
Scanning Head

PSV-W-500-M
Data Management System

PSV-E-500
Junction Box

Contents

1 Safety Information

1.1 Information on Using these Operating Instructions

- These operating instructions are part of the product. Keep them within easy reach.
- Read these operating instructions carefully before operating the instrument. Pay attention to any documentation provided by other manufacturers.
- Make the operating instructions available to the person using the instrument.
- If you hand over the instrument, please forward the operating instructions to the next user.
- If you should lose the operating instructions, please ask us for a replacement.

1.1.1 Warning Notices Used

The following warning notices are used in these operating instructions and will give you important advice on how to use the instrument safely.

WARNING!
"Type and source of danger"!
Indicates a dangerous situation or action which could lead to death or serious injury if this warning is not observed.
» Describes how to avoid the danger.

CAUTION!
"Type and source of danger"!
Indicates a dangerous situation or action which could lead to minor injury if this warning is not observed.
» Describes how to avoid the danger.

ATTENTION!
"Type and source of danger"!
Indicates a dangerous situation or action which could lead to property damage if this warning is not observed.
» Describes how to avoid the danger.

1.1.2 Notices Used

In addition, the following notice is used in these operating instructions which provides additional information on operating the instrument:

INFORMATION
Provides useful notes and information to simplify the operation of the device.

1.2 General Safety Information

1.2.1 Operating the Instrument Safely

Faultless and safe operation of the instrument presume proper transport and proper storage, installation and assembly as well as careful operation of the instrument. In addition, it is imperative for the safe operation of the device that you pay attention to the safety and warning notices which are listed in these operating instructions. When assembling, installing and operating the instrument, make sure that you adhere to the safety and accident prevention regulations applicable to the respective application.

1.2.2 Intended Use

The instrument is intended for use in a laboratory and for operation in an industrial environment. It may only be operated within the limits set in the technical specifications. Tampering with the instruments in any way is not necessary when using the equipment as intended and will invalidate the warranty.

Any use other than the one described in this operating instructions is not permitted. Polytec rejects any liability for damages which occur from improper use.

The instruments are designed in accordance with good engineering practice to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate.

1.2.3 User Qualification

Task	Qualification
Assembly, adjustment, operation	This instrument may only be used by qualified personnel who are familiar with electrical measuring instruments, have been trained to use the instrument and have been instructed on how to work with lasers.
Repair and maintenance	This instrument may only be maintained by the manufacturer or by qualified personnel who have been authorized by the manufacturer.
Exchange/installation of subassemblies	Subassemblies may only be exchanged or installed by authorized service personnel from Polytec.

1.2.4 Ambient Conditions

Operation and storage

Operate the instrument in the ambient conditions as specified in the technical specifications.

1.2.5 Cleaning

WARNING!

Electric shock caused by penetrating moisture!

If the devices are live, penetrating moisture can cause an electric shock.

» Always disconnect the corresponding mains plug before cleaning devices.

ATTENTION!

Damage to the housing surfaces caused by using unsuitable cleaning agents!

» Do not use any aggressive solvents such as acetone or ethanol.

Component	Cleaning Agents
Scanner mirrors (dust)	Bellows
Housing surfaces	Mild detergents or disinfectant solutions

1.2.6 Installing Other Components

ATTENTION!

Impairment of the system caused by installing third-party hardware or software components!

Off-system hardware or software components could damage the system or impair the function of the software. This also applies for the change of hardware drivers which were not provided by Polytec and the change of configurations of the driver options.

» Do not update installed drivers, especially when updating via Windows® update.

» Do not run optional updates.

» If you want to install components which have not been distributed by Polytec, please contact Polytec first.

1.2.7 Disposal

Device

Unless otherwise specified, instruments and their components which are defective or no longer required must be properly disposed in accordance with the applicable legal provisions.

1.3 Laser Safety

1.3.1 Important Warning Notices

WARNING!

Damage to eyes caused by incorrect usage of laser radiation!

» Do not look directly into the laser beam.

» Do not use mirrors or other optical instruments to look into the laser beam.

» If you are working in the laser beam path, do not wear any jewelry and do not use any tools which may reflect the laser beam and could deflect it into your eyes.

» If you need to intensively focus for a long time on the target area of the laser beam for adjustment purposes, wear laser adjustment eyewear suitable for the specified laser wavelength.

» Do not point the laser beam at people if radiation exposure of unprotected eyes cannot reliably be prevented.

» If the object under investigation is not available, shield the target point of the laser beam with suitable material so that the laser does not radiate unimpeded through the room.

» Avoid staying in the scanning area! The laser beam can exit the scanning head in an angle of ± 25°!

» Instruments which are not in use should be stored in places which unauthorized persons do not have access to.

1.3.2 Warning Labels Affixed on the Instrument

Warning labels PSV-500 Standard

The laser warning labels are shown in the following figure. For countries in the European Union (EU), labels [2] and [3] are affixed in the language spoken in the customer's country (see right-hand-side).

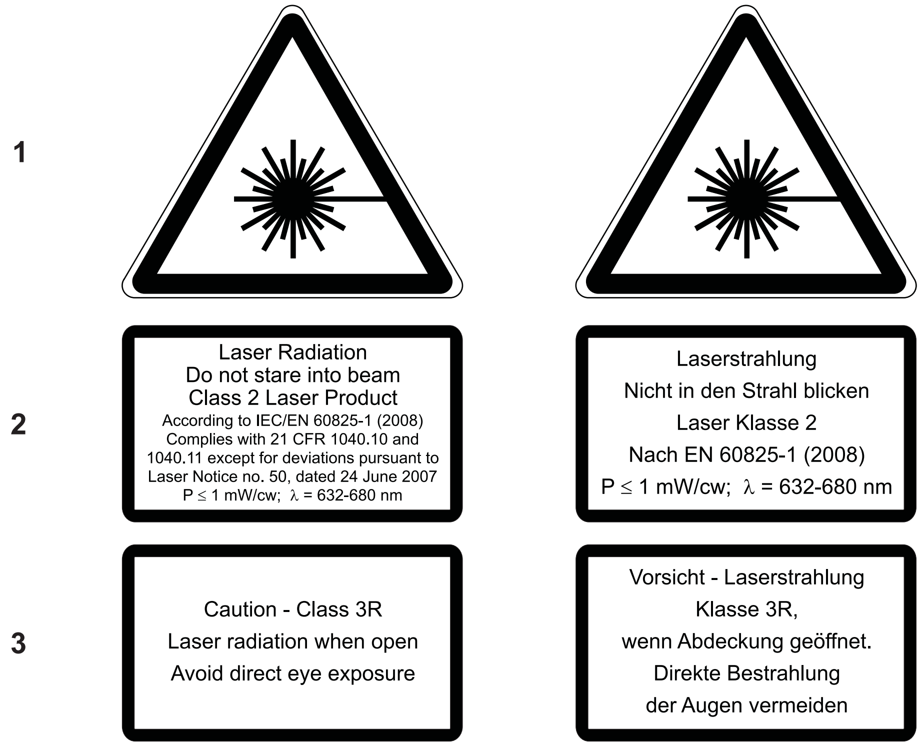


Figure 1.1: Laser warning labels

Warning labels PSV-500 Xtra

The laser warning labels are shown in the following figure. For countries in the European Union (EU), labels [2] and [3] are affixed in the language spoken in the customer's country (see right-hand-side).

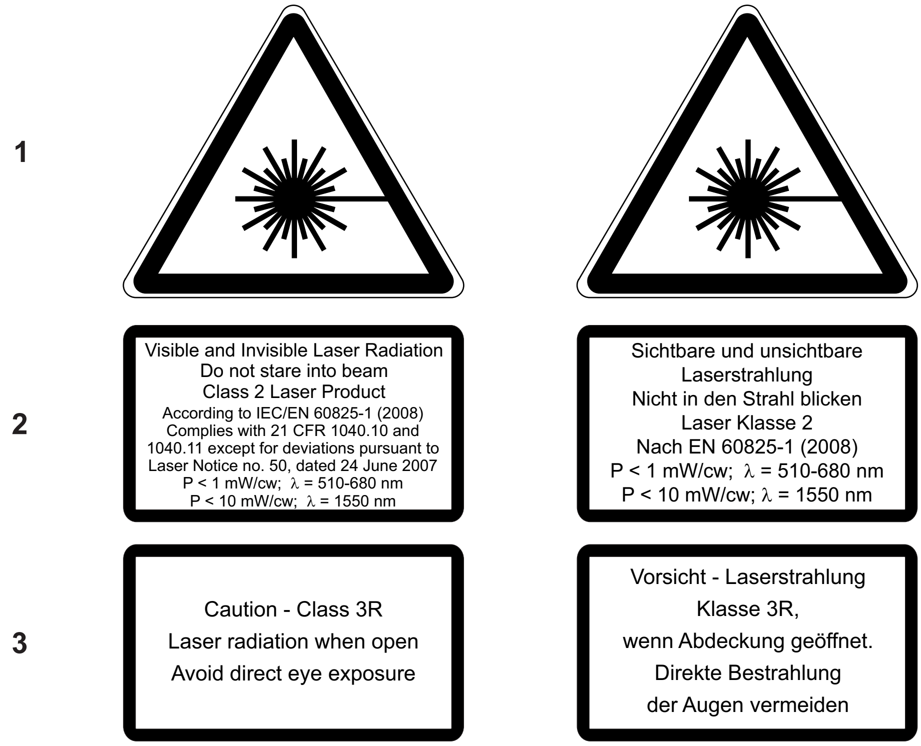


Figure 1.2: Laser warning labels

Position of the laser warning labels

The position of the laser warning labels on the scanning head is shown in the following figure.

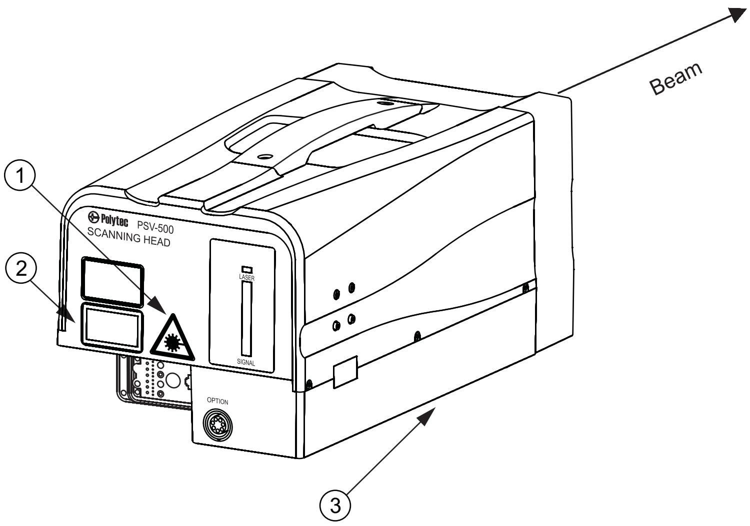


Figure 1.3: Position of the laser warning labels [1], [2] and [3] and beam exit aperture

1.3.3 Applicable Standards and Directives

Polytec instruments generally comply with the standards **IEC** and **EN 60825-1** and **US 21 CFR 1040.10** and **1040.11** respectively, except for deviations pursuant to Laser Notice no. 50, dated 24 June 2007.

CDRH Compliance Statement

Polytec GmbH confirms that its laser products are certified to be fully compliant with all applicable standards and regulations as set forth by the United States of America's Health and Human Services (HHS), Food and Drug Administration (FDA), Center for Devices and Radiological Health (CDRH) pursuant to 21 CFR 1040.10 for laser products.

1.3.4 Information on Laser Class 2 for PSV-500 Standard

The properties of laser light are different from those of conventional light sources. Due to the low divergence, laser light is generally extremely intense. When handling lasers, always take great care to make sure that the direct or reflected beam of the lasers do not enter anyone's eyes.

The instrument is equipped with two visible (red) lasers as light sources: the object laser (wavelength 633 nm) and the laser of the distance sensor (geometry laser, wavelength 670 nm). Both laser beams are superimposed directly on each other. Technical precautions have been taken to ensure that at any time only one of the two laser beams is emitted.

- The optical output power of the laser beam emitted from a scanning head is less than 1 mW provided the equipment is used in the manner for which it was intended. This means that the instrument conforms with **Laser Class 2**. With laser class 2, it is usually assumed that eyes are protected by prevention mechanisms including the blink reflex. This reaction offers appropriate protection under reasonably foreseeable operating conditions. This includes the use of optical instruments (magnifying glasses or binoculars) for observing the laser beam. Under any operating conditions, there is no risk to skin.
- Do not attempt to open the housing of the instrument which contains the laser unit as you will be exposed to a higher level of laser radiation (laser class 3R) that is potentially hazardous.
- If you use operating and adjusting devices or perform procedures other than those specified here, this may result in hazardous radiation exposure.

1.3.5 Information on Laser Class 2 for PSV-500 Xtra

The properties of laser light are different from those of conventional light sources. Due to the low divergence, laser light is generally extremely intense. When handling lasers, always take great care to make sure that the direct or reflected beam of the lasers do not enter anyone's eyes.

The instrument is equipped with one invisible and two visible lasers as light sources: the infrared object laser (wavelength 1550 nm), the green pilot laser (wavelength 520 nm) and the red laser of the distance sensor (geometry laser, wavelength 670 nm). The three laser beams are superimposed directly on each other.

When you switch on the instrument, the geometry laser is switched off while the pilot laser and the object laser are switched on. You can switch on the geometry laser if required but thereby the pilot laser will be switched off. Technical precautions have been taken to ensure that at any time only one of the visible laser beams is emitted.

- The optical output power of the invisible laser beam (of the object laser) emitted from a scanning head is less than 10 mW provided the equipment is used in the manner for which it was intended. The wavelength is beyond the visible and beyond the near infrared range (> 1400 nm). The invisible laser beam is eye-safe; in comparison with the visible pilot laser it represents no additional hazard. The power of both visible lasers is less than 1 mW. This means that the instrument conforms with **Laser Class 2**. With laser class 2, it is usually assumed that eyes are protected by prevention mechanisms including the blink reflex. This reaction offers appropriate protection under reasonably foreseeable conditions. This includes the use of optical instruments (magnifying glasses or binoculars) for observing the laser beam. Under any operating conditions, there is no risk to skin.
- Do not attempt to open the housing of the instrument which contains the laser unit as you will be exposed to a higher level of laser radiation (laser class 3R) that is potentially hazardous.
- If you use operating and adjusting devices or perform procedures other than those specified here, this may result in hazardous radiation exposure.

1.3.6 Equipment for PSV-500 Standard

Safety equipment

- You can switch on or off the laser with the key switch on the front-end.
- You can switch on or off the laser using the software.
- The geometry laser has to be switched on additionally via the software. Thereby the object laser is switched off.
- You can block the laser with a beam shutter on the scanning head.
- An emission indicator on the scanning head indicates the activity of the installed laser and thus the potential hazard of laser beams emitted.
- You can only remove the key if the front-end and therefore also the laser is switched off.

1.3.7 Equipment for PSV-500 Xtra

Safety equipment

- You can switch on or off the green pilot laser and the infrared object laser with the key switch on the front-end. The green pilot laser and the invisible object laser will then light up immediately.
- You can also switch on the geometry Laser via the software, thereby the pilot laser is switched off. Pilot laser and geometry laser cannot be switched on simultaneously (refer also to SECTION 1.3.5).
- You can switch on or off the lasers using the software.
- You can block the lasers with a beam shutter on the scanning head.
- An emission indicator on the scanning head indicates the activity of the installed lasers (i.e. the mains supply of the lasers is active) and thus the potential hazard of visible and invisible laser beams.
- You can only remove the key if the front-end and therefore also the lasers are switched off.

1.4 Electrical Safety

1.4.1 Important Warning Notices

WARNING!

Fire risk caused by inaccessible or missing disconnection device!

A fire risk exists in case of overheating, e.g. due to a device fault. Furthermore, touching hot housing parts can cause burns. The mains switch disconnects the device from the power supply and is used to switch it off in case of danger. If the mains switch is not freely accessible, use the mains plug to disconnect the device in case of danger.

» Always keep the mains switch or respectively mains plug freely accessible.

» If you can keep neither the mains switch nor the mains plug freely accessible, install an additional disconnection device.

WARNING!

Electric shock caused by applied voltage!

» Always disconnect the instrument from the mains before maintaining or cleaning it.

WARNING!

Fire risk caused by wrong fuses!

» Replace defective fuses only by fuses of the same kind with the amperage given on the instrument.

1.4.2 Important Notices

INFORMATION

This device is subject to Limit Class A and can cause radio interferences with electrical devices in residential areas.

Take appropriate protective measures to exclude any such impairments.

1.4.3 Applicable Standards and Directives

The instrument complies with the electrical protection class 1 in accordance with the EU Directive 2014/35/EU (Low Voltage Directive). That means when the instrument is used as intended and connected to the power supply correctly, exposure to electric current is prevented by the closed, grounded metal housing.

The instrument is subjected to EU directive 2014/30/EU (EMC directive) and therefore conforms with the limits for emission and immunity specified in the standards this is based on. With the CE mark Polytec confirms that the instrument has been tested successfully.

2 Introduction

2.1 Area of Application and System Summary

The Polytec Scanning Vibrometer PSV measures the three orthogonal components of vibrational velocity on the basis of laser interferometry. The system components are shown in the following figure.

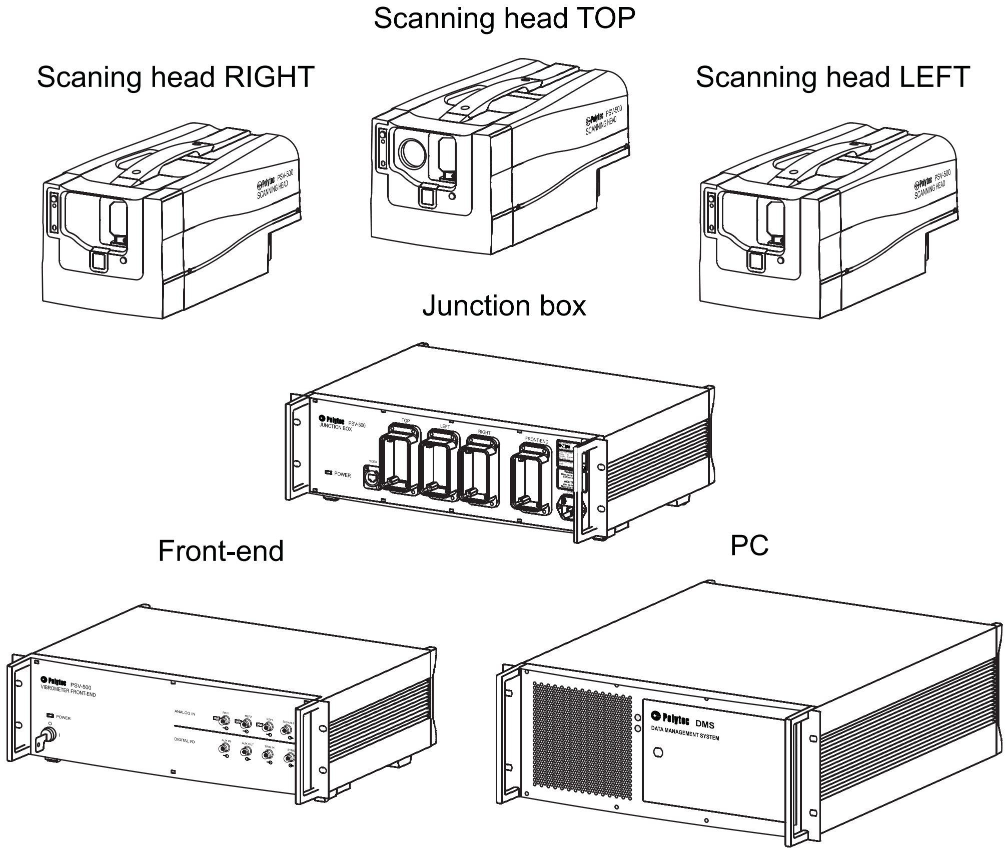


Figure 2.1: System components of the PSV-500-3D

Polytec Scanning Vibrometers consist of the basic components optics (scanning head), electronics (front-end), and control (data management system). The components are adapted to suit the intended area of application and can be customized by adding accessories and upgrading the hardware. The decoders to analyze the vibrometer signal are designed as digital wide range decoders and thus fit into the digital signal concept.

The interferometers and the scanner mirrors to deflect the laser beams are in the three scanning heads. The video camera to visualize the object and the geometry scan unit are in the TOP scanning head. In the Standard system, all scanning heads are fitted with a CoherenceOptimizer (to stabilize laser modes). The PSV-A-515 digital video camera is available as an accessory.

Scanning head details

Two versions of the scanning heads are available: Standard and Xtra.

In the Standard scanning head, a helium-neon laser with a wavelength of 632.8 nm and a maximum output power of 1 mW is used.

In the Xtra scanning head, an infrared laser with a wavelength of 1550 nm and a maximum output power of 10 mW is used. The Xtra version has a higher sensitivity and higher velocity ranges. In order to make the laser beam visible, this version uses a green pilot laser.

Front-end details

In the front-end, the interferometer signals of the vibrometers are demodulated using velocity decoders and transmitted to the PC via an analog interface. Synchronously to the vibrometer data, reference channels are acquired and generator signals are emitted.

The front-end recognizes automatically which scanning head versions are connected (Standard or Xtra). The scaling of the vibrometer ranges is adapted automatically. However, make sure to connect only scanning heads that have the same wavelengths!

Junction box details

The PSV-E-500 junction box is the connection point between the scanning heads and the front-end. In addition to that, the video signal from the TOP scanning head is transmitted to the PC via the junction box.

The measurement data is acquired and saved in the PC. The PSV software controls the entire measurement system and offers user-friendly functions to evaluate the measurement data.

2.2 Signal Flow between the System Components

2.2.1 Principle

In the front-end, the high-frequency Doppler signal coming from the scanning head is fed in the decoder. Here, the velocity information is extracted from the signal. Analog reference signals are connected to the front-end and generator signals are emitted. The measurement data is transmitted to the PC as analog signals. The signal flow in the system is shown in the following figure.

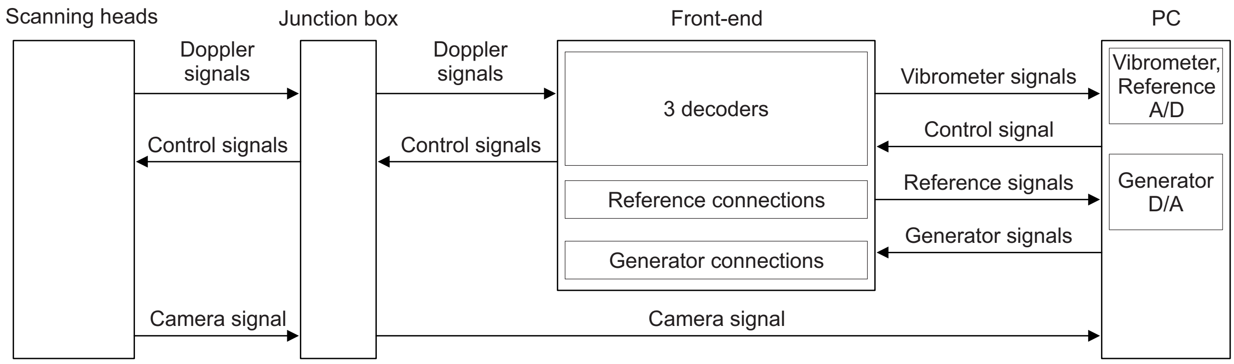


Figure 2.2: Schematic diagram of the signal flow in the PSV-500-3D

2.2.2 Decoders

Only digital velocity decoders are used in the PSV-500-3D. This enables very precise and high-resolution acquisition of vibrations. With the H system the decoder signals are directly transmitted digitally to the PC. With the M system the signals are converted into analog signals and transmitted to the data acquisition board of the PC.

The decoders are equipped with digital tracking filters which allow robust measurements even if the optical signals are weak.

DV-04 With 14 measurement ranges, the DV-04 velocity decoder covers the frequency range from 0 Hz to 2 MHz. This is the standard decoder of the PSV-500-3D-M.

2.3 Setup and Properties

The decoder in the front-end as well as the data acquisition board determine the metrological properties of the PSV. Depending on the application, there are different models available. Their properties are summarized in the following tables.

Table 2.1: Overview of PSV model 3D-M

Component/Properties	PSV-500-3D-M (Standard)	PSV-500-3D-M (Xtra)
Junction box	PSV-E-500	PSV-E-500
Front-End	PSV-F-500-3D-M	PSV-F-500-3D-M
Velocity decoder	DV-04	DV-04
Measurement ranges [mm/s]	14 ranges, 1 to 12 000	14 ranges, 2.5 to 30 000
Maximum frequency	1 MHz (2 MHz)[1]	1 MHz (2 MHz)[1]
PC	PSV-W-500-M	PSV-W-500-M
Data acquisition	PCI-6110	PCI-6110
Reference channels	1	1
Maximum bandwidth	1 MHz (2 MHz)[1]	1 MHz (2 MHz)[1]
Function generator	M2i.6030	M2i.6030
Output channels	1	1
Maximum bandwidth	1 MHz (2 MHz)[1]	1 MHz (2 MHz)[1]

[1] The specifications in brackets are available as an option.

3 First Steps

INFORMATION

The components marked with an (*) are described in detail in separate operating instructions.

Always pay attention to these operating instructions, too!

3.1 Unpacking and Inspection

ATTENTION!

Misalignment of the optics by shock!

The optics of the scanning head is highly sensitive. Its optics can get misaligned by shocks or vibrations.

» Protect the unpacked device from being shaken.

Unpacking

The scope of supply includes the following components:

Standard:

- 1 PSV-I-500 scanning head with video camera, PSV-G-500 geometry scan unit and PSV-A-560 CoherenceOptimizer
- 2 PSV-I-520 scanning heads with PSV-A-560 CoherenceOptimizer
- Laser adjustment eyewear

Xtra:

- 1 PSV-I-560 scanning head with video camera and PSV-G-500 geometry scan unit
- 2 PSV-I-570 scanning heads

Standard and Xtra:

- PSV-F-500-3D-M front-end
- PSV-E-500 Junction Box
- PSV-W-500-M data management system consisting of an industrial PC with mouse and keyboard
- TFT monitor with monitor cable and mains cable
- VIB-A-T02-S tripod system consisting of 3 individual VIB-A-T02 tripods with fluid heads
- PSV-A-014 system cabinet
- 3D connecting cable (3D Connecting)
- 3 main cables (Umbilical)
- 1 mains cable for the multiple mains socket
- 4 mains cables for the system components
- Acquisition cable
- Generator cable with SMB-SMB connecting cable
- 3 BNC cables
- 3 network cables
- PSV-A-450 reference object

Available as an option:

- PSV-A-430 acoustic gate unit with BNC cable*
- PSV-A-515 digital video camera with standard lens (optionally with zoom lens), IEEE-1394 cable (FireWire®) and tripod adapter angle
- Only for Standard: PSV-A-HNeBF optical block filter for the scanning head video camera
- External scanner control (EXT)
- PSV-A-526 protective window
- PSV-A-T34* close-up tripod
- PSV-A-MIR mirror set

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 components etc.).
3. In the case of a wrong delivery, damage or missing parts, immediately inform your local Polytec representative, stating the serial numbers of the instruments. The serial number can be found on the name plate. You will find the name plate on the instruments as well as on the inside cover of these operating instructions.
4. Carefully retain the original packaging in case you have to return the instruments.

3.2 Control Elements, Displays and Connections

3.2.1 Front-End

Front view The front view of the front-end is shown in the following figure.

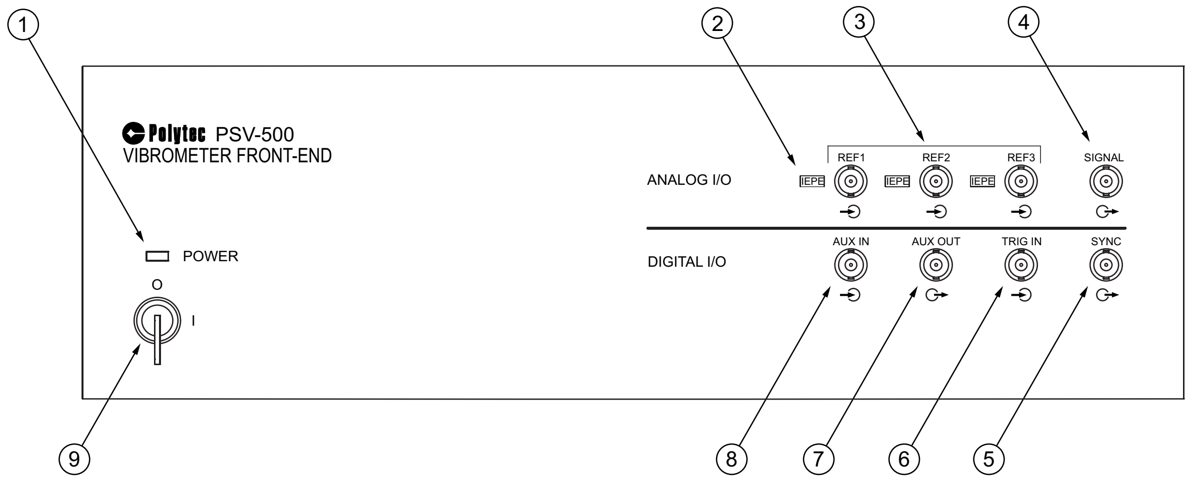


Figure 3.1: Front view of the front-end

1 POWER LED

LED is lit up: ready to operate (key switch in position I)

2 IEPE 1 LED

LED is lit up: IEPE power supply for the REF 1 reference input activated in the software

IEPE 2 and **IEPE 3** LEDs

LEDs are lit up: IEPE power supply for the corresponding reference input (REF 2 and REF 3) activated in the software (not for PSV-3D)

3 REF 1 analog input (BNC jack)

Analog voltage input for the reference signal. To this input you can also connect a sensor that is equipped with an integrated amplifier according to the IEPE concept, also known as ICP® (4 mA / 24 V). Activating or deactivating the IEPE power supply is described in your software manual.

REF 2 to **REF 3** analog inputs (BNC jacks)

There are two additional analog voltage inputs available for reference signals (not for PSV-3D).

4 SIGNAL generator output (BNC jack)

Analog voltage output for the signal of the function generator

5 SYNC TTL output (BNC jack)

TTL output for the SYNC signal of the function generator

6 TRIG IN TTL input (BNC jack)

TTL input for an external trigger signal

7 AUX OUT TTL output (BNC jack)

TTL output for special applications (programmable via Visual Basic® Engine)

8 AUX IN TTL input (BNC jack)

TTL input for special applications (programmable via Visual Basic® Engine) as well as for connecting the acoustic gate unit

9 I / O mains switch

Back view The back view of the front-end is shown in the following figure.

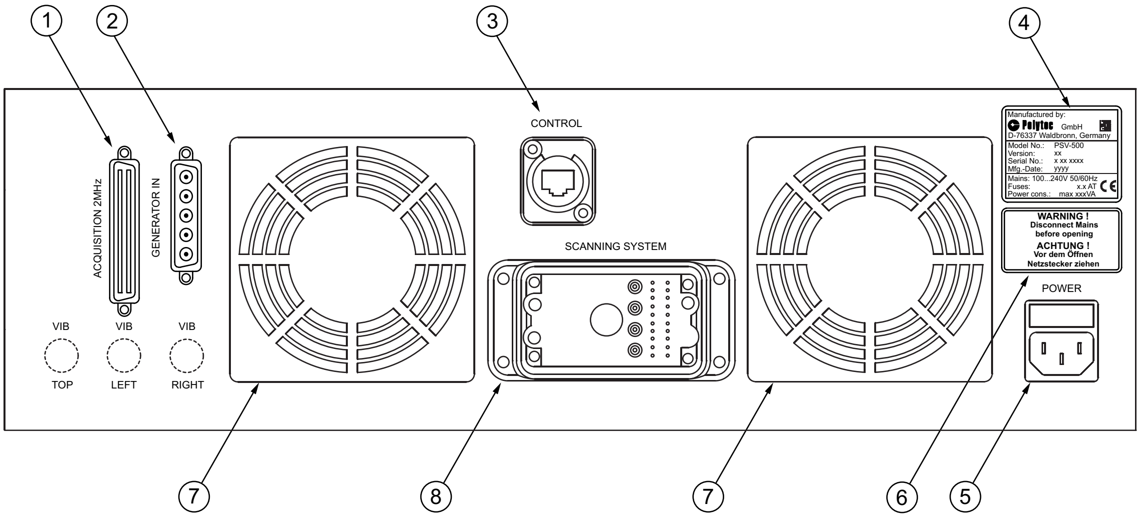


Figure 3.2: Back view of the front-end

1 **ACQUISITION 2MHz** connection (SCSI-II type)
Connector for the acquisition cable (Acquisition) to the PC to transmit the vibrometer, trigger, and reference signals

2 **GENERATOR IN** connection (Sub-D jack)
Connection for the generator cable from the PC to transmit the signals of the function generator

3 **CONTROL** network connection (marked in yellow)
Connection for the yellow network cable to the PC for data exchange and to control the system via the software.

4 Name plate
Plate with information on model, serial number, power specifications, etc.

5 **POWER** mains connection (socket for standard power cord with built-in fuses)

6 Warning label

7 Cooling fan

8 **SCANNING SYSTEM** connection (industrial-style connector)
Connection for the 3D connecting cable (3D Connecting) from the junction box

3.2.2 PSV-E-500 Junction Box

Back view The back view of the junction box is shown in the following figure.

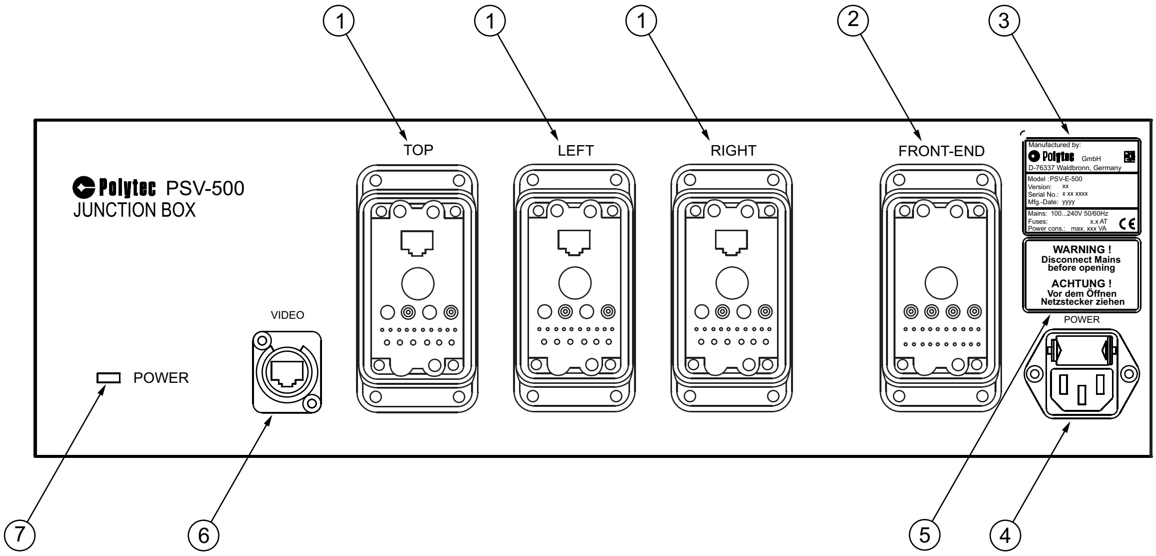


Figure 3.3: Back view of the junction box

1 Connection **TOP/LEFT/RIGHT** (industrial-style connector)
Connections for the main cables (Umbilical) from the TOP, LEFT or RIGHT scanning heads respectively

2 **FRONT-END** connection (industrial-style connector)
Connection for the 3D connecting cable (3D Connecting) to the front-end

3 Name plate
Plate with information on model, serial number, power specifications, etc.

4 **POWER** mains connection (socket for standard power cord with built-in fuses)

5 Warning label

6 **VIDEO** network connection (blue background)
Connection for the blue network cable to the PC to transmit the video signal of the video camera in the TOP scanning head

7 **POWER** LED
LED green: ready to operate

3.2.3 PC

Front view The front view of the PC is shown in the following figure. The lockable front flap is shown as transparent.

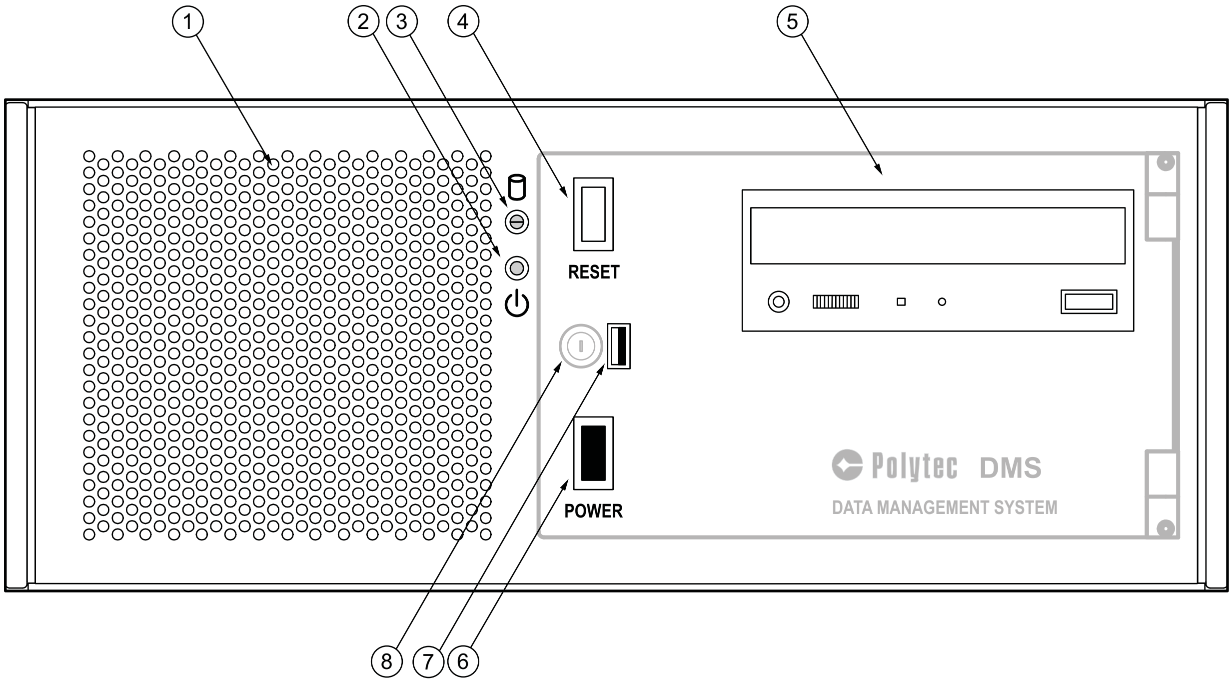


Figure 3.4: Front view of the PC

1 Cooling fan

2 Power LED
LED green: ready to operate

3 HDD LED
LED yellow: Hard disk drive (HDD) in the PC is active

4 **RESET** key
Reset and restart PC

5 DVD burner
For an exact description of the DVD burner see the manufacturer's device documentation.

6 **POWER** key
Switch on/off the device

7 USB interface (Universal Serial Bus, type A)
Connection for a mass storage device

8 Lock with key in the front flap
Front flap is lockable

Back view The back view of the PC is shown in the following figure. The order of the plug-in boards may vary from that shown in the figure.

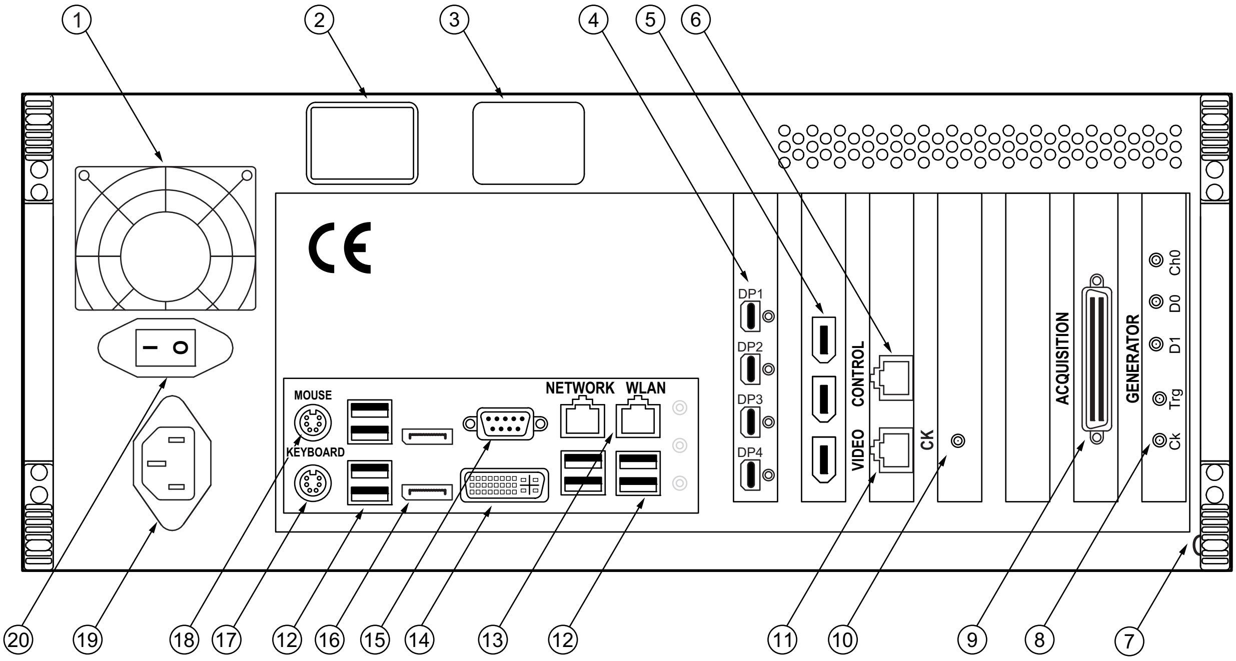


Figure 3.5: Back view of the PC

1 Cooling fan

2 Name plate
Plate with information on model, serial number, power specifications, etc.

3 Warning label

4 Monitor connections (Mini DisplayPort)
Connection for the monitor cable to the TFT monitor

5 IEEE-1394 interfaces (FireWire plugs)

6 **CONTROL** network connection (yellow background)
Connection for the yellow network cable from the front-end to control the system via the software and to transmit data

7 Connection for cable shielding (blade connector)
Not used

8 **GENERATOR** connections of the generator board (SMB jacks)
Connections for the generator cable to the front-end to transmit the signals of the function generator. The individual connections of the generator board are described in detail in the following in the Generator Board section.

9 **ACQUISITION** connector (SCSI-II type)
Connection for the Acquisition cable from the front-end to transmit the vibrometer, trigger, and reference signals

10 **CK** connection
Connector for the SMB-SMB connecting cable to synchronize the data acquisition board with the generator board

11 **VIDEO** network connection (blue background)

Connection for the blue network cable from the front-end/from the junction box to transmit the video signal of the video camera in the scanning head

12 USB interfaces (Universal Serial Bus, type A)

Alternative connections for peripheral devices such as mouse, keyboard, etc. or to connect the hardlock to release the software

13 **NETWORK** and **WLAN** network connections

Connection option for an Ethernet network and WLAN router network cable connection for using of the PSV Commander software

14 Monitor connection (DVI jack)

Not used

15 **COM 1** serial interface (9-pin Sub-D plug)

16 Monitor connections (DisplayPort)

Not used

17 **KEYBOARD** connection (6-pin circular jack)

Not used

18 **MOUSE** connection (6-pin circular jack)

Not used

19 Mains connection (socket for standard power cord)

20 **I / O** mains switch

Generator board

The connections of the Spectrum M2i.6030 generator board are shown in the following figure.

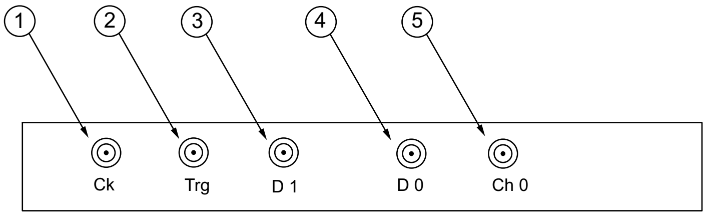


Figure 3.6: View of the generator board

1 **Ck** clock input (SMB jack)

Input for the clock signal (Clock) to synchronize the generator board with the data acquisition board

2 **Trg** signal input (SMB jack)

Input is not used!

3 **D 1** pulse output (SMB jack)

Output is not used!

4 **D 0** pulse output (SMB jack)

Synchronization pulse for the signal of the function generator

5 **Ch 0** signal output (SMB jack)

Signal output of the function generator

3.2.4 Scanning Head

Front view The front view of the scanning head is shown in the following figure.

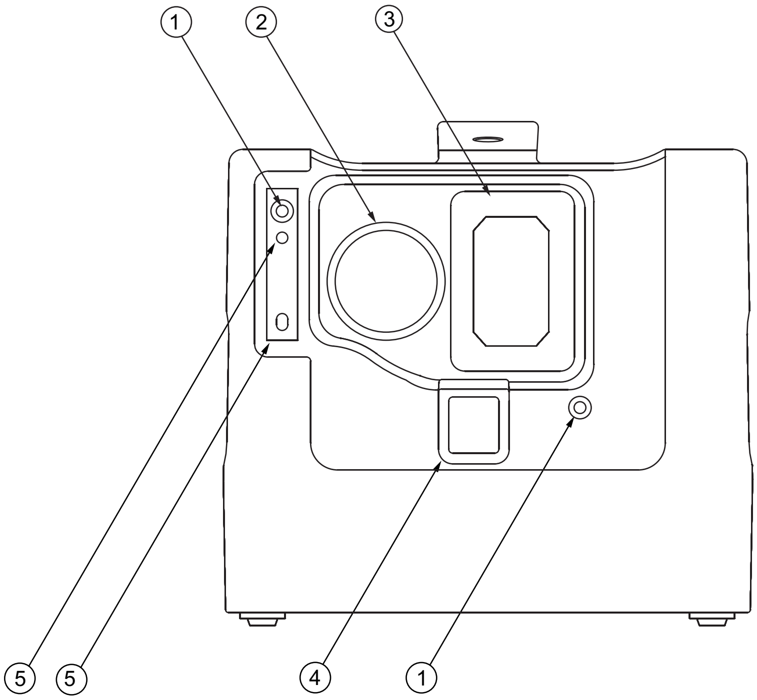


Figure 3.7: Front view of the scanning head

1 Mounting thread for the protective window or for the close-up unit (only PSV-1D)

2 Front lens of the video camera with M37 mounting thread for the filter (only Standard) and lenses (only PSV-1D)

3 Laser beam aperture

4 Beam shutter
For the laser beam aperture and the video camera lens

5 Fitting holes for fixing the protective window or the close-up unit (only PSV-1D)

Back view The back view of the scanning head is shown in the following figure.

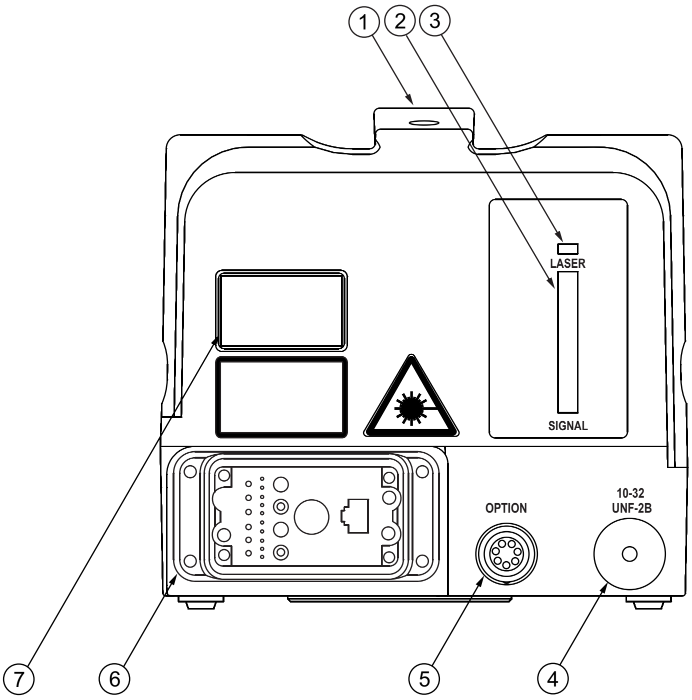


Figure 3.8: Back view of the scanning head

1 Transport handle

2 **SIGNAL** level display

Measure for the light scattered back from the measurement surface. The signal level display is deactivated when the geometry laser (Geo-Laser) is activated.

3 **LASER** LED

LED is lit up: cabled correctly, laser switched on

4 **10-32 UNF-2B** thread

Connection for the optional vibration sensor. The vibration sensor is used to compensate ambient vibrations.

5 **OPTION** connection (7-pin circular jack)

Connection for the connecting cable to the PSV-A-T11 pan-tilt head (only PSV-1D) to control the pan-tilt head via the software.

With EXT option: **OPTION** connection (8-pin circular jack)

Connection for the connecting cable or the bridging plug to the external scanner control

6 Main connection (industrial-style connector)

Connection for the main cable (Umbilical) to the front-end/to the junction box

7 Name plate

Plate with information on model, serial number, power specifications, etc.

Bottom view The bottom view of the scanning head is shown in the following figure.

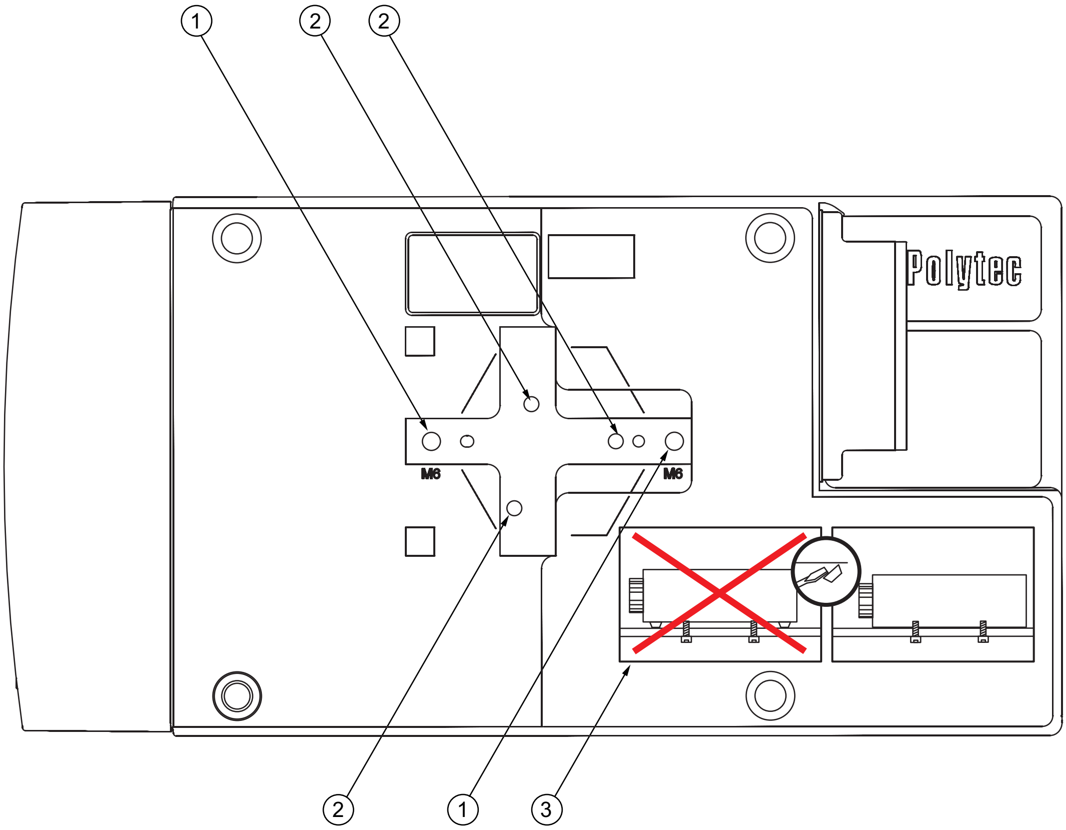


Figure 3.9: Bottom view of the scanning head

1 **M6** mounting threads
For the mounting or adapter plate, e.g. for mounting on a tripod system

2 Mounting threads for quick release plate
For fluid head, for example for assembly on the tripod

3 Warning label
Information for correct assembly

3.3 Assembly

ATTENTION!

Damage caused by unsuitable procedure!

It will be safer to handle the components of the system cabinet by two persons.

» Get help from a second person for unpacking the system cabinet.

» Mount the instrument with a second person.

ATTENTION!

Damage of the device caused by insufficient opportunity for air circulation!

Heat is created inside the device during operation. If the heat cannot exhaust from the housing it leads to heat accumulation. This will overheat the electronic parts inside the device and may result in a defect.

» Always keep free all air inlets and outlets of the device.

» Keep at least 50 mm distance to the wall if required when you set up the device!

» If the devices are in a system cabinet: Remove all covers of the system cabinet before switching on the devices.

» If you notice a cooling fan failure, switch off the device immediately.

ATTENTION!

Damage to the cables caused by lack of diligence!

It is important to handle the cables carefully so that the transmission quality is not affected and the functionality of the devices is ensured.

» Do not expose the cables to high temperatures.

» Prevent the cables from being damaged.

» Do not fall beyond the bending radius of the cables. Bending radius of the main cable (Umbilical): not below 120 mm. Bending radius of other cables: not below 50 mm.

INFORMATION

Before starting to assemble the instrument, make sure that all system components are in perfect condition! Check the devices for external damages such as scratches or the like. In the case of a wrong delivery, damage or missing parts, please inform your local Polytec representative immediately, stating the serial number of the devices.

INFORMATION

Keep the assembly instructions for all components in a safe place.

3.3.1 Scanning Heads

The scanning heads are mounted on VIB-A-T02 light duty tripods using fluid heads as shown in the following figure.

Figure 3.10: Scanning head mounted on the light duty tripod with fluid head

Position the scanning heads approximately in the shape of an equilateral triangle. The designations LEFT and RIGHT apply in the viewing direction of the laser beams.

WARNING!

Damage to eyes caused by incorrect usage of the beam shutter!

Incorrect usage of the beam shutter is dangerous as the laser beam may hit the naked eye. This may result in eye injuries.

» Always close the beam shutter before positioning the scanning head.

» Roughly align the scanning head and mount it securely before you open the beam shutter for fine positioning.

CAUTION!

Risk of falling of the stand caused by loose locking mechanisms and screws!

The scanning head has a high inherent weight and may easily fall down from the tripod if it is not secured appropriately. This may lead to considerable injuries or cause a damage of the scanning head.

» Always tighten all screws of the tripod and the trolley before you start mounting.

» Check all locking mechanisms on the tripod for safety.

ATTENTION!

Damage of the scanning head caused by too high ambient temperature!

If the ambient temperature exceeds 35 °C (95 °F), the scanning head may overheat. This could damage it.

» At ambient temperatures above 35 °C (95 °F) you must assemble the scanning head on a tripod (e.g. VIB-A-T02) so that also its bottom side of the scanning head is ventilated sufficiently.

ATTENTION!

Damage of the scanning head by distortion!

» Remove the rubber feet on the bottom of the scanning head before screwing the instrument on a flat surface.

ATTENTION!

Thread damage caused by overtightening the screws!

If you tighten the screws too firmly, you could damage the thread.

» Only tighten the M6 mounting screws of the scanning head with a max. torque of 5 Nm.

3.3.2 VIB-A-T02 Light Duty Tripod with Fluid Head

You can assemble the scanning head on the VIB-A-T02 tripod with fluid head. Start measurement

CAUTION!

Danger of injury caused by provisional assembly and insufficient safeguarding of the scanning head!

The scanning head has a high inherent weight and may easily fall down from the tripod if it is not secured appropriately. This may lead to considerable injuries or cause a damage of the scanning head.

» Do not set up the scanning head provisionally but mount it securely and as free of vibrations as possible on a stable tripod or an alternative stable base using the mounting threads.

» Check whether the safety lever on the quick release plate is completely engaged.

» Carry out the disassembly of the scanning head only in pairs.

» Hold the scanning head while a second person opens the safety lever.

1. Assemble the tripod as described in the assembly instructions provided by the manufacturer.
2. Assemble the fluid head on the tripod as described in the assembly instructions provided by the manufacturer.
3. Open the locking mechanism on the fluid head by simultaneously pressing the safety knob on the bottom side and moving the safety lever counterclockwise to the end position.

4. A suitable hexagonal quick release plate has been pre-assembled on the scanning head. Use the quick release plate to position the scanning head on the fluid head.

   The safety lever clicks into place automatically.

3.3.3 System Cabinet

Unpacking

The system cabinet is supplied with all system components assembled and cabled. The position of the individual components in the system cabinet is shown in FIGURE 3.12. In addition, the drawer has room for the optional tablet PC for remote control of the measurement system via the PSV Commander software. Unpack the system cabinet as follows:

1. Remove the lashing straps using a suitable tool, e.g. a pair of scissors.
2. Remove the ramp from the top of the packaging and place the ramp in front of the pallet.
3. In one of the inner sides of the box there is a recess for accessories separated from the other components by a smaller cardboard box. On this side, undo the screw connections using suitable tools, such as a pair of pliers.
4. Carefully remove the cardboard ring and take out the accessories.
5. Remove the cardboard box and all the shock-absorbing material.
6. Under the system cabinet there is a box with the documentation for the measurement system. Remove the cardboard box and keep it for later use.
7. Remove the square timber with leveling feet from below the system cabinet. Screw the nut [2] onto the leveling feet with the spanner provided, turning it counterclockwise upwards until it reaches the nut [1] (refer to FIGURE 3.11).
8. Screw the nut [1] clockwise downwards until the system cabinet stands on the pallet and the square timber can be freely moved.

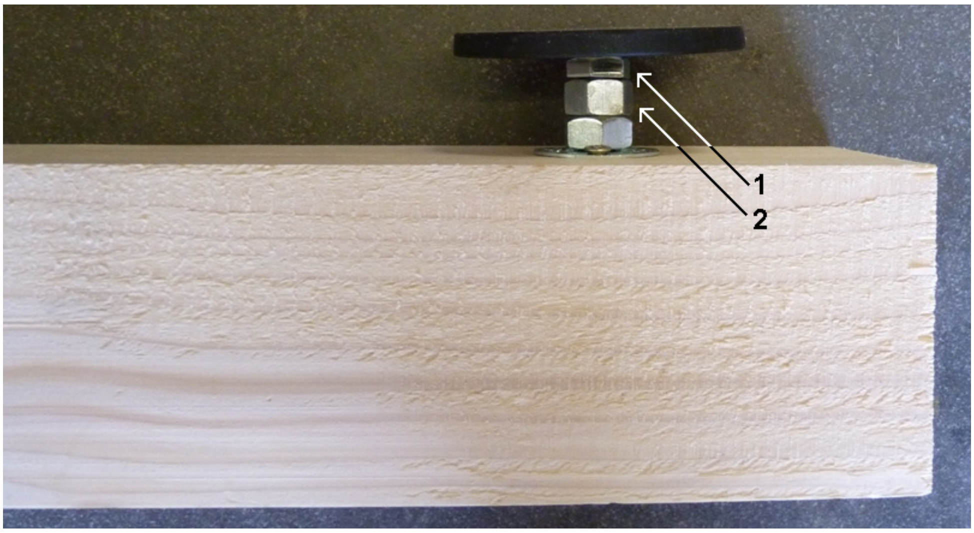


Figure 3.11: Square timber with leveling foot

9. Remove the square timber from below the system cabinet.

10. Release the locking brakes and move the system cabinet down the ramp to the desired location.

Build up

Build up the system cabinet. To do so, proceed as follows:

ATTENTION!

Damage to the instruments caused by crushed cables!

» Unplug all BNC cables from the fronts before you close the system cabinet with the cover!

---

1. Carefully remove the cover of the system cabinet by loosening the wing screws and releasing the locking hooks (refer to FIGURE 3.12 on the left).
2. Fold out the screen and remove the foam material.

   Store the foam material in the cover.
3. Carefully remove both front covers by loosening the wing screws and releasing the locking hooks.
4. Remove the main cable (Umbilical) from the upper cover and the mouse and keyboard from the lower cover.
5. Carefully remove the rear cover by loosening the wing screws and releasing the locking hooks.
6. Remove the two main cables (Umbilical) from the back cover.

   The position of the individual components in the system cabinet is shown in the following figure on the right.

Figure 3.12: System cabinet closed (left) and opened (right)

Shift the workplate

To have more legroom when working on the system, you can shift the work plate up to 12 cm forwards. To do so, proceed as follows:

CAUTION!

Risk of tilting caused by mishandling!

When folded out the screen loads the workplate one-sided and the work plate can tilt.

» Fold in the screen before unfixing the locking hooks and moving the workplate.

CAUTION!

Crushing hazard caused by careless handling!

During folding in the screen there is danger of crushing your fingers.

» Hold the screen on each side and fold it in slowly.

---

1. Remove the foam material from the cover and put it on the work plate.

Figure 3.13: Foam material on the work plate

2. Rotate the screen by 90° to the right.

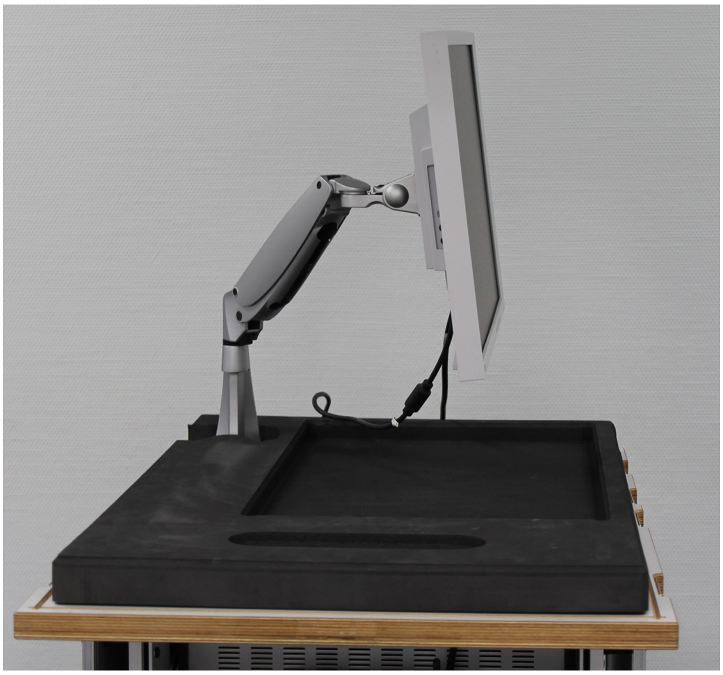


Figure 3.14: Screen rotated by 90°

3. Tilt the screen forward until it lays flat on the foam.

Figure 3.15: Screen tilted forward

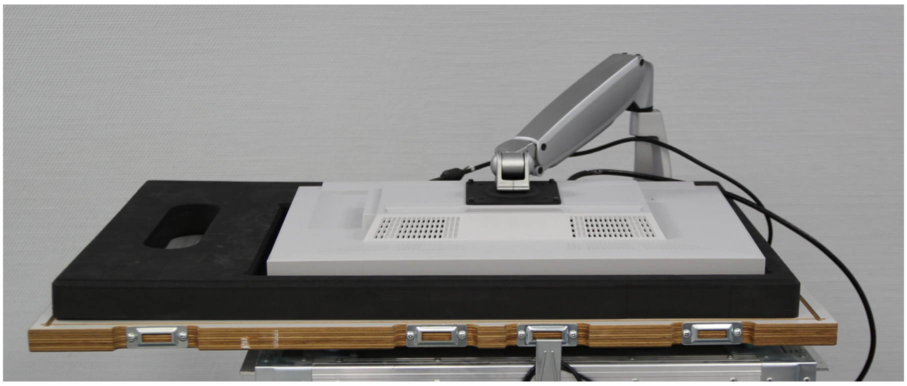


Figure 3.16: Screen completely folded in

4. Loosen the wing screws that fix the work plate and unfix the locking hooks.
5. Move the work plate into the front position.
6. Fix the locking hooks and tighten the wing screws again.
7. Fold out the screen again.

3.4 Cabling

In the following you will find a description of all the steps necessary to connect up the instrument. All the cabling connections are also shown in FIGURE 3.17 and FIGURE 3.18. Secure the connections appropriately.

If you have any problems connecting up the cables, please contact your local Polytec representative.

WARNING!

Electric shock caused by connection to wrong power supply!

» Connect up the instruments only using a three-pin mains cable to AC systems 50/60 Hz with a grounded protective conductor, and a nominal voltage of between 100 V and 240 V.

ATTENTION!

Damage to the instrument caused by overvoltage!

» First of all, connect up all components as described in this chapter before connecting the mains cable and switching on the instrument.

ATTENTION!

Damage to connections caused by bent contact pins!

All cables must be easy to plug in.

» Check the contact pins before plugging in the cables.
» Do not use any force when plugging in the cables.
» If necessary, replace defective cables with new cables.
» Contact your local Polytec representative.

INFORMATION

The main cable (umbilical) has a plug with a fixed (straight) cable connection and a connector with a rotatable (slightly angled) cable connection.

You can connect up the rotatable plug either to the front-end or to the scanning head. As a general rule, we recommend connecting the rotatable plug to the scanning head. Thus, you avoid bending or twisting the cable and thereby unnecessarily straining it when moving the scanning head.

3.4.1 Connecting the Hardware

Front-end to PC

1. Plug the yellow network cable into the CONTROL network connection on the back of the front-end and into the CONTROL network connection on the back of the PC.
2. Plug the generator cable into the GENERATOR IN Sub-D connection on the back of the front-end and into the corresponding GENERATOR SMB jacks (GEN_Ch0 and GEN_D0) on the back of the PC.
3. For cable shielding, plug the SHIELD blade receptacle on the generator cable into the blade connector on the PC housing.
4. To synchronize the generator board with the data acquisition board, plug the SMB-SMB connecting cable into the Ck SMB jack of the data acquisition board and into the Ck SMB jack of the generator board.
5. Plug the Acquisition cable into the ACQUISITION 2MHz SCSI plug connection on the back of the front-end and into the ACQUISITION SCSI plug connection on the back of the PC.

Front-end to PSV-E-500 junction box

6. Plug the 3D-connecting cable (3D Connecting) into the SCANNING SYSTEM industrial-style connection on the back of the front-end and secure the connection by turning the locking spindle clockwise beyond the resistance.
7. Plug the 3D-connecting cable (3D Connecting) into the FRONT-END industrial-style connection on the back of the junction box and secure the connection by turning the locking spindle clockwise beyond the resistance.

Junction box to scanning heads

8. Plug the main cables (Umbilical) into the TOP, LEFT and RIGHT industrial-style connections on the back of the junction box and secure the connections by turning the locking spindle clockwise beyond the resistance.
9. Plug the main cables (Umbilical) into the industrial-style connections on the back of the respective scanning head and secure the connections by turning the locking spindle clockwise beyond the resistance.

Junction box to PC

10. Plug the blue network cable into the VIDEO network connection on the back of the junction box and into the VIDEO network connection on the back of the PC.

PC peripherals

11. Connect up the mouse and the keyboard to the back of the PC.
12. Connect the monitor cable to the DisplayPort on the monitor and to one of the DP Mini DisplayPorts on the back of the PC.

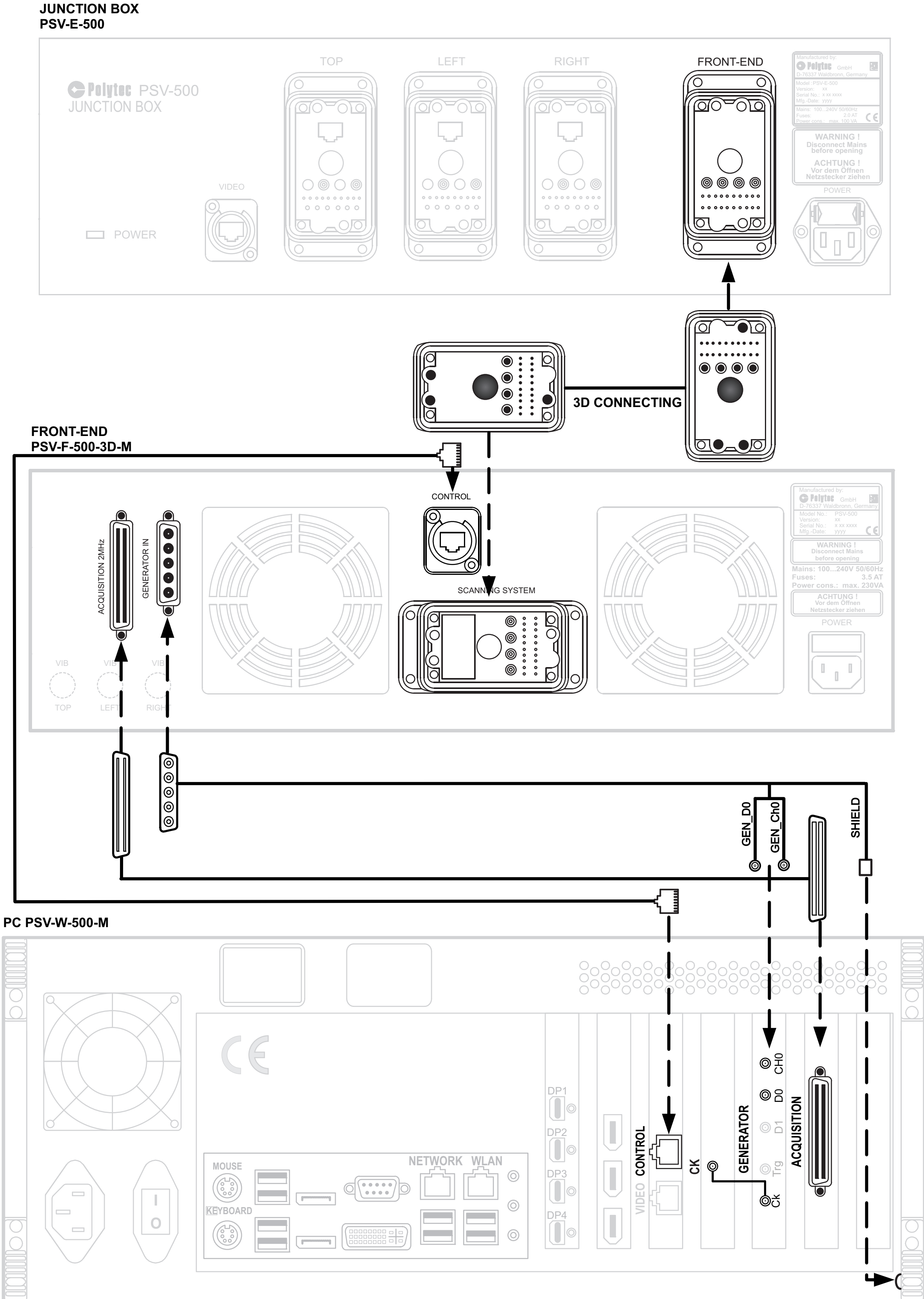


Figure 3.17: Cabling the front-end to the junction box and the PC

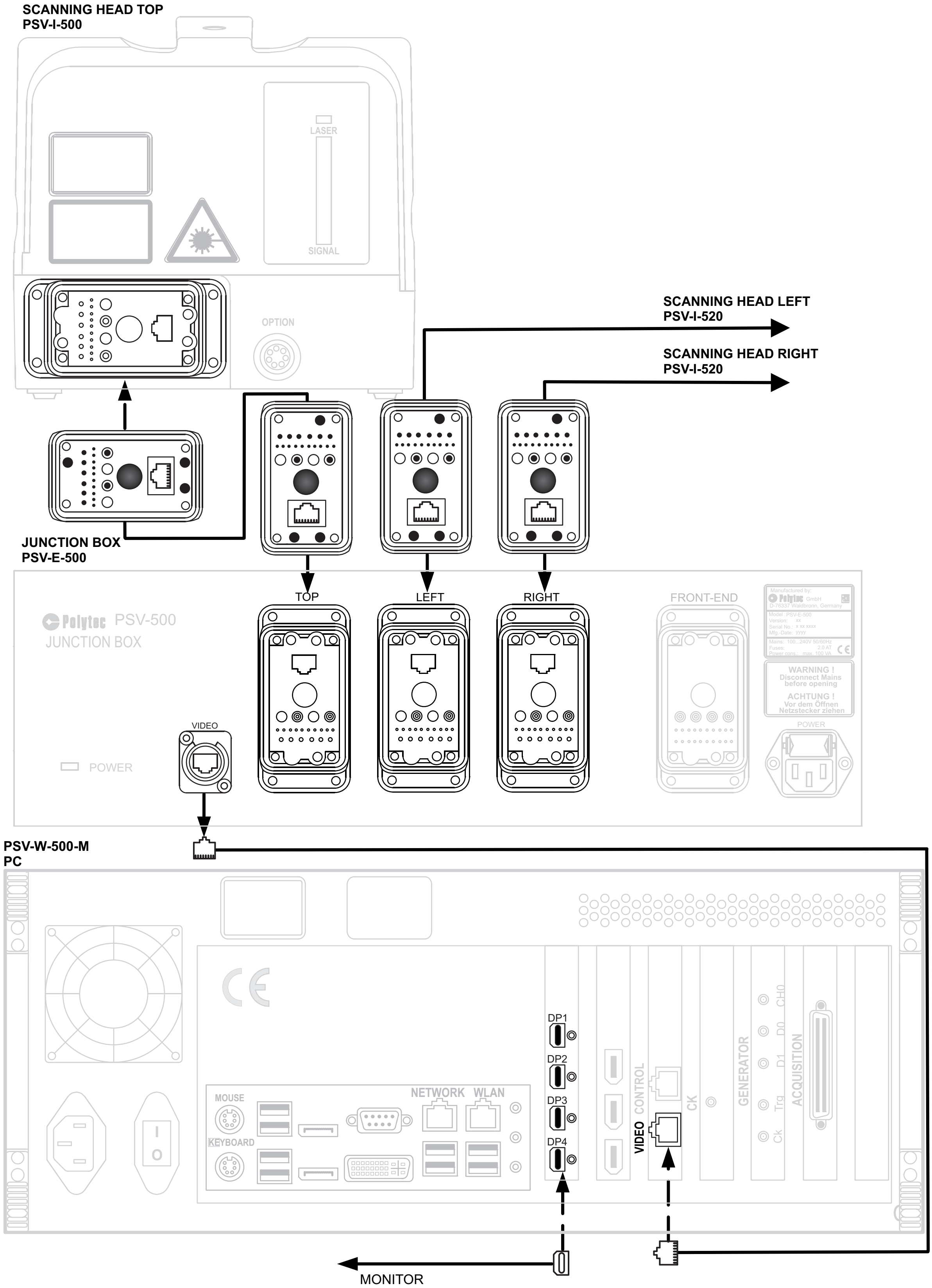


Figure 3.18: Cabling the junction box to the scanning heads and the PC

Vibration sensor

13. If required screw the isolation stud of the optional A-VIB-ACC1 vibration sensor into the 10-32 UNF-2B thread on the back of the scanning head.
14. Screw the vibration sensor on the isolation stud.
15. Connect up the vibration sensor to a REF BNC jack on the front of the front-end.

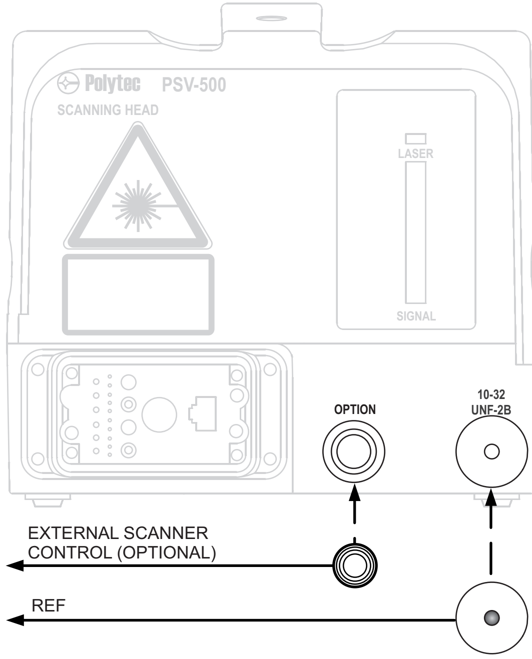


Figure 3.19: Cabling of the scanning head

3.4.2 Connecting the Signals

Reference signal

1. Connect up the reference signal to the REF 1 BNC jack on the front of the front-end.

External trigger

2. If required, connect the external trigger signal to the TRIG IN BNC jack on the front of the front-end.

Function Generator

3. The function generator signal is available at the SIGNAL BNC jack on the front of the front-end.
4. The synchronization pulse of the generator signal is available at the SYNC BNC jack on the front of the front-end.

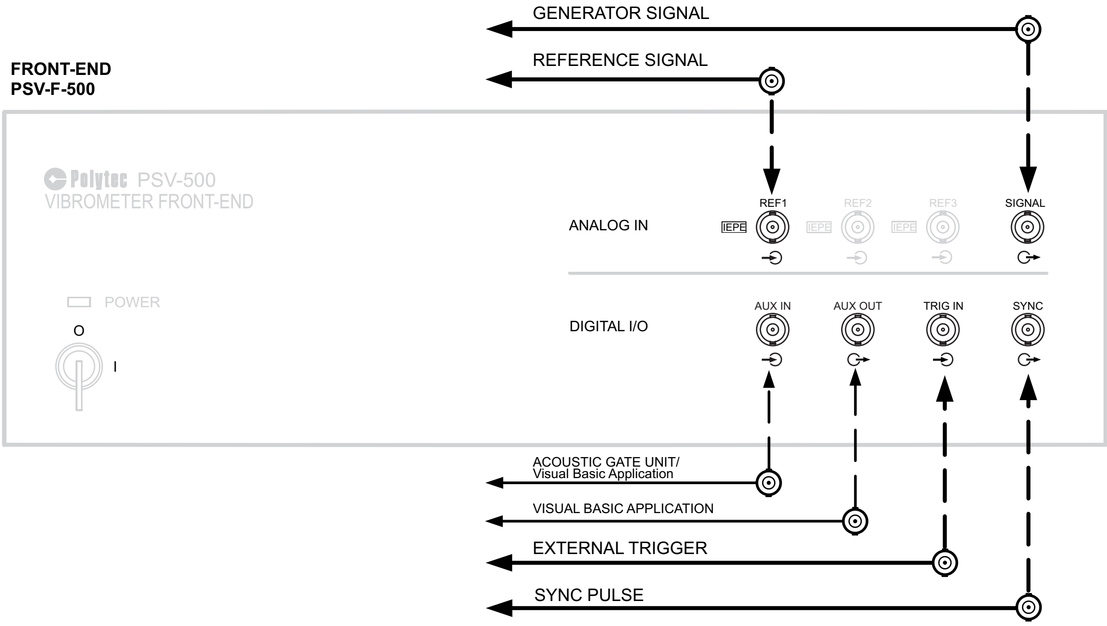


Figure 3.20: Cabling of the front-end

3.4.3 Connecting the Mains Cables

Connect all mains cables of the measurement system to the same earthed wall outlet to avoid ground loops. Proceed as follows:

1. Connect up all components with the supplied mains cables to the multiple socket.
2. Connect up the multiple socket with the mains cable to an earthed wall outlet.

3.5 Functional Test

INFORMATION
Only switch on the PC after having cabled all instruments so that the PC software detects the instruments connected.

The implementation of a first functional test is described in the following. If the instrument does not perform as described, read through the information on troubleshooting in Chapter 6 and if required, contact your local Polytec representative.

For an initial functional test, proceed as follows:

Prepare

1. Assemble and cable the system as described in Section 3.3 and Section 3.4.
2. Turn the key switch on the front of the front-end to position O.
3. Close the beam shutters on the front of the scanning heads.
4. Position the scanning heads so that the laser beam apertures are roughly aligned with a test surface.

Switch on

5. Switch on the front-end by turning the key switch to position I.

   The POWER LED on the front of the front-end lights up. If all the connecting cables are correctly installed, then the POWER LED on the junction box and the LASER LEDs on the scanning heads light up. Laser light may not be emitted yet as the beam shutters are still closed.
6. Switch on all optional peripheral devices.
7. Switch on the PC.
8. Start the data acquisition as described in your software manual.

INFORMATION
Read the information on laser safety in Section 1.3 before working with laser radiation!

Test

9. Test the scanning head control (position and focus the laser beam, zoom and focus the video camera) as described in your software manual.
10. Put a matt, white test surface, such as a piece of paper, approximately 50 cm away from the front of the individual scanning heads in the beam path.
11. Focus the laser beams on the test surface.

    The scanning heads are working correctly if the signal level displays on the scanning heads light up.

INFORMATION
The instrument does not reach its optimal metrological properties until a warm-up period of approx. 30 minutes. For measurement tasks with high angular stability requirements we recommend a warm-up period of 120 minutes. This applies especially when you are working with imported 3D geometries.

Direction convention

The following direction convention applies to the output signals:

A movement towards the scanning head is seen as being positive. In this case the velocity output provides a positive signal.

4 Measuring

Data acquisition and storage is controlled via the software. A live video image of the object is displayed on the monitor and you can define scan points directly on this live video image. You set all acquisition properties in the software. For evaluation, the acquired data is overlaid directly onto recorded video image. You can also export data to various software packages, e.g. for modal analysis.

4.1 Starting the System

To make a measurement, proceed as follows:

Setup

1. Assemble and cable the system as described in SECTION 3.3 and SECTION 3.4.
2. Turn the key switch on the front of the front-end to position O.
3. Close the beam shutters on the front of the scanning heads.
4. Position the scanning heads so that the laser beam apertures are roughly aligned with the object. If possible, set up the scanning heads at an optimal stand-off distance to the object to be measured. You will find information on optimal stand-off distances in SECTION 4.3.

Switch on

5. Switch on the front-end by turning the key switch to position I.

   The POWER LED on the front of the front-end lights up. If all the connecting cables are correctly installed, then the POWER LED on the junction box and the LASER LEDs on the scanning heads light up. Laser light may not be emitted yet as the beam shutters are still closed.
6. Switch on all optional peripheral devices.
7. Switch on the PC.
8. Start the data acquisition as described in your software manual.

INFORMATION
Read the information on laser safety in SECTION 1.3 before working with laser radiation!

9. Open the beam shutters on the front of the scanning heads.

   The laser beams are now emitted from the scanning heads.

Measure

10. Data acquisition is now fully controlled by the software. Once the laser has warmed up you can setup the software, set the optics, define scan points and make measurements as described in your software manual.

INFORMATION
The instrument does not reach its optimal metrological properties until a warm-up period of approx. 30 minutes. For measurement tasks with high angular stability requirements we recommend a warm-up period of 120 minutes. This applies especially when you are working with imported 3D geometries.

4.2 Selecting Suitable Settings

4.2.1 Frequency Range

With the PSV-3D, the accuracy of the in-plane vibration measurement depends on the following parameters:

- Accuracy of the laser beam overlap
- Local wavelength of the vibration

The accuracy of the laser beam overlap should be at least one order of magnitude better than the local wavelength of the vibration. In general, for 3D measurements it is recommended to use video triangulation to optimize the overlap accuracy of the laser beams.

With vibration frequencies in the MHz range, the local wavelength of the vibration and the diameter of the focused laser beam may have the same order of magnitude. In this case you have to be aware of considerable measurement uncertainties with the in-plane components of the measurement signal, even if you use video triangulation.

For bandwidths in the MHz range, it is generally recommended to estimate the measurement uncertainty for the concrete measurement task. As the measurement uncertainties depend on the local wavelength of the vibration, it is not possible to specify a general frequency limit.

4.2.2 Measurement Range

The available measurement ranges depend on the bandwidth set. For this reason, first select the bandwidth. Thus, the list of the available measurement ranges is updated. Select your measurement range depending on the expected maximum velocity. The available measurement ranges are given in the specifications (refer to SECTION 7.2.3).

Many applications are covered by the 50 mm/s measurement range. Therefore select this measurement range for the first measurements with the system. Use the smallest possible measurement range to minimize the noise and to maximize the optical sensitivity.

If either the positive or the negative limit of a measurement range is reached, the Overrange of the measurement range is displayed in the software. Then select the next highest measurement range. However, note that this Overrange display can also be activated by very brief overloading which is caused by noise spikes. In such cases, you can maintain the velocity measurement range as long as it is suitable for the amplitude of the wanted signal. Observe the signal in the time domain to obtain information about this.

When there is an extremely weak optical signal, a permanently Overrange display can be caused by noise due to the system. If switching on the tracking filter (refer to SECTION 4.2.3) does not resolve this problem, check the following:

- Have you focused the laser optimally?
- Can you treat the surface of the object under investigation for optimizing the reflectivity?
- Can you change the stand-off distance?

4.2.3 Tracking Filter

Function

The tracking filter can be used to improve the signal-to-noise ratio of the signal from the scanning head. This filter bridges brief dropouts. These dropouts occur due to the speckle nature of the light scattered back from the object. Thus the tracking filter increases the optical sensitivity of the vibrometer.

There are four tracking filter settings available: Slow, Medium, Fast, and Off. With the Off setting you can switch off the tracking filter.

The different tracking filters have different maximum accelerations. The lower the maximum acceleration, the higher the optical sensitivity.

With the Fast setting, the tracking filter is always adjusted to the highest possible acceleration values that result from the bandwidth set and the selected measurement range. Thus, the Fast setting is suitable for all velocities and frequencies that may occur within the measurement range.

With the Medium setting, the tracking filter is optimized for a maximum acceleration of 10% of the Fast setting. If the acceleration does not exceed this value, the Medium setting has a better effect than Fast. It is suitable for noise excitations, as generally in this case the maximum accelerations of the measurement ranges are not fully used.

With the Slow setting, the tracking filter is optimized for a maximum acceleration of 1% of the Fast setting. This setting is suitable if the velocity range is nearly saturated by a low-frequency distortion and at the same time the actual high-frequency wanted signal only has a low amplitude. This is particularly the case with measurements on rotating parts. The Slow setting has the highest optical sensitivity.

Cutoff frequencies

In addition, the different tracking filter settings are designed for different cutoff frequencies.

Setting	Cutoff frequency
Fast	1 MHz
Medium	500 kHz
Slow	200 kHz

The tracking filter can also be used for bandwidths that exceed the respective cutoff frequencies of Slow, Medium, and Fast. This is particularly useful for measurements in the time domain as in this case, to obtain a better time resolution, you often select a higher bandwidth than it would be required by the signals. Signal components above the respective cutoff frequency are damped with 15…30 dB/decade.

Selection

For the tracking filter settings, you may use the following rules of thumb:

- Use the tracking filter to improve the signal-to-noise ratio if the optical signal is weak. If you have a good optical signal, it is not possible for the tracking filter to improve the signal-to-noise ratio for physical reasons. In this case you should switch it off.
- Select the Slow, Medium, or Fast mode depending on the peak acceleration.
- The Medium and Slow settings are not suitable for high accelerations. When the maximum acceleration is exceeded, the optical sensitivity is reduced. However, an exceeding within the range of the crosshatched area is harmless (refer to the following figure). If the maximum acceleration of Slow is exceeded, the Medium setting takes better effects. If the maximum acceleration of Medium is exceeded, the Fast setting takes better effects. So, if necessary, you will have to try out the most favorable setting of the tracking filter. To do so, select sample points with a high vibration amplitude.

When you perform particularly precise measurements at high optical signal level, switch off the tracking filter as frequency response errors, linearity errors, and harmonic distortions can also be generated by the Fast setting. The additional frequency response error can be up to 0.25 dB.

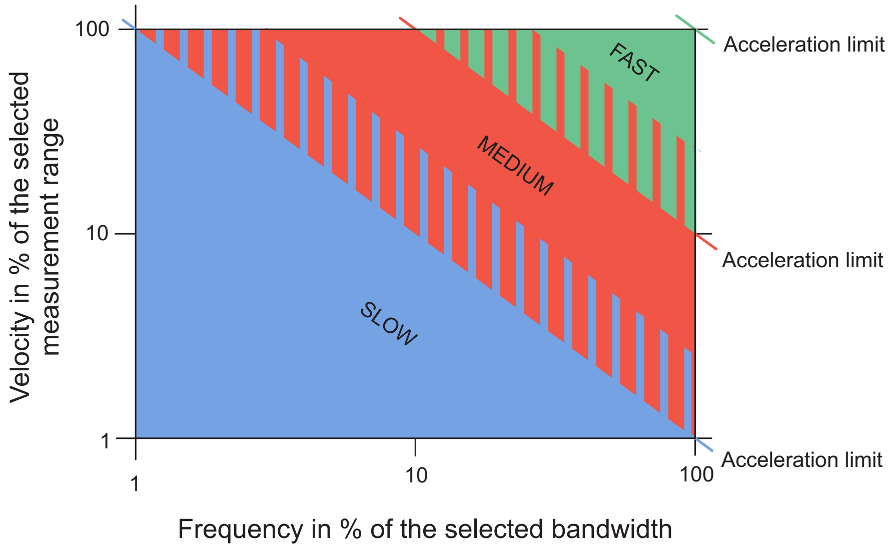


Figure 4.1: Selection of suitable tracking filter settings depending on velocity and frequency

4.3 Setting Up Optimal Stand-Off Distance (Only for PSV-500 Standard)

4.3.1 Relation between Stand-Off Distance and Visibility Maximum

INFORMATION
With PSV-500 Xtra there are no visibility minima and therefore no periodic fluctuations of the signal level depending on the stand-off distance.

Visibility maxima

The signal-to-noise ratio (SNR) of the data is primarily determined by the signal level. The higher the signal level, the higher the signal-to-noise ratio. The height of the signal level depends on the surface properties of the object, on random speckle effects, and on the stand-off distance. Rule of thumb: The higher the stand-off distance, the lower the signal level. This coherency may be superimposed by periodic fluctuations that are described in the following.

The light source of the instrument is a helium-neon laser. This is a multi-mode laser, in which there can be typically two longitudinal modes. Interference between the laser modes can result in a lower signal level. The degree of this lowering depends on the stand-off distance and the temperature. The laser cavity length varies caused by changes in temperature. Yet small changes in temperature can lead to considerable changes in the ratio of the intensities of the laser modes and thus to important changes of the signal level.

The stand-off distances where the signal level is at its maximum are called visibility maxima. The visibility maxima recur every 204 mm (± 1 mm) corresponding to the laser cavity length.

The diagram in FIGURE 4.3 shows the signal level depending on the stand-off distance. At certain distances (visibility maxima) the signal level is constantly high. Between two visibility maxima there is a visibility minimum each in which under certain circumstances the signal level may drop completely. Depending on the ratio of the intensities of the laser modes different progresses will result. At equal intensity of both modes (black line) you have the strongest loss of signal level. One of both modes dominates, then depending on the stand-off distance the signal level hardly fluctuates (gray line) or does not fluctuate at all (dashed gray line).

To get the best signal level independent of the laser state, choose a stand-off distance near the visibility maximum.

For larger objects it is not possible for all sample points to position the scanning head into the visibility maximum. Since the laser for sample points on the edge of the area of interest usually hits the surface at an unfavorable angle, the signal level is lower there. In this case, optimize the stand-off distance for sample points on the edge of the area of interest.

Stand-off distance The stand-off distance is measured from the front of the scanning head (refer to the following figure).

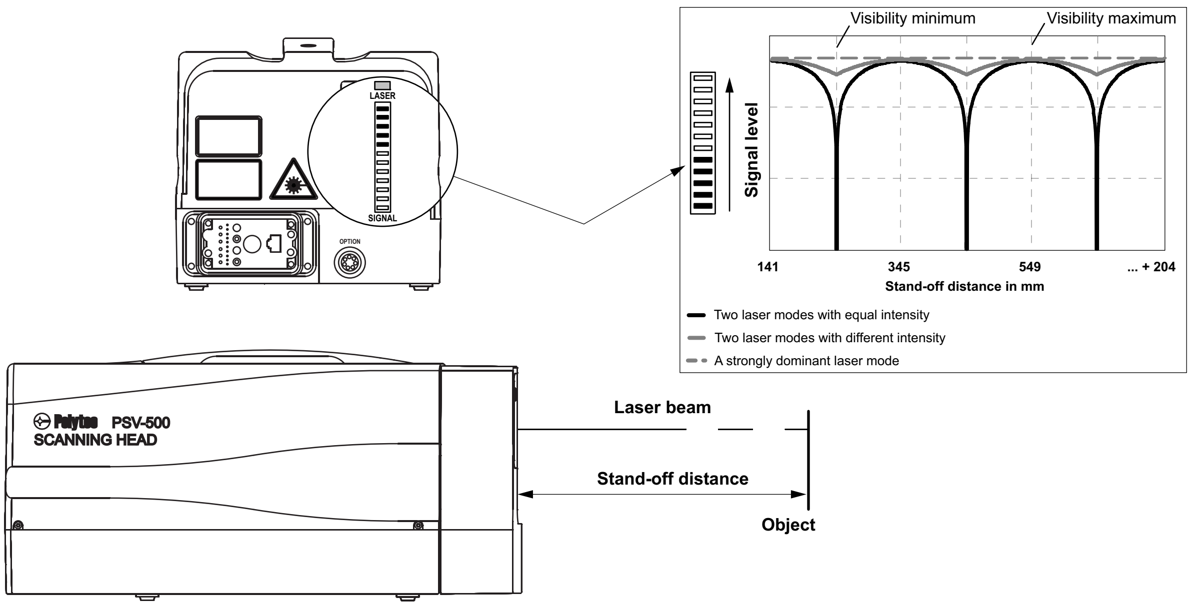


Figure 4.2: Measuring the stand-off distance

4.3.2 Optimal Stand-Off Distances

The relation between stand-off distance and signal level is shown in the following figure. The optimal stand-off distances are marked as visibility maximum.

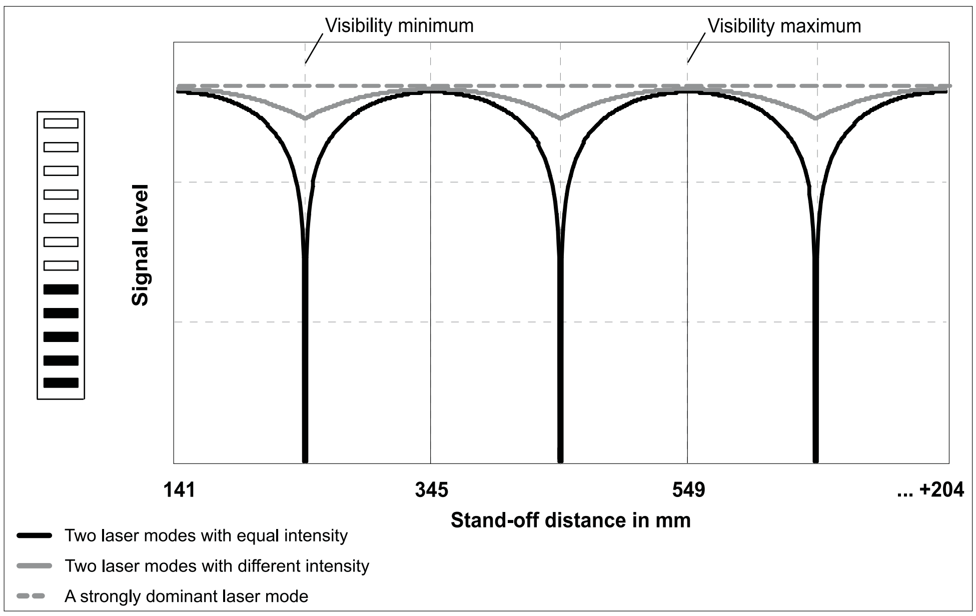


Figure 4.3: Relation between stand-off distance and signal level

Optimal stand-off distance = 141 mm + (n · l) mm

n… 0, 1, 2, …

l… 204 mm ± 1 mm

This means the optimal stand-off distances are: 141 mm, 345 mm, 549 mm, 753 mm, 957 mm etc.

4.3.3 Optimal Stand-off Distances with PSV-A-560 CoherenceOptimizer

INFORMATION

The CoherenceOptimizer is available for all PSV-500 Standard systems (1D: optionally, 3D: provided as standard).

The laser mode only reaches a constant state once the laser temperature is constant. Without the CoherenceOptimizer, this temperature equilibrium is only reached several hours after switching on the laser. It is impossible to predict whether a particularly advantageous state is reached with one strongly dominant laser mode, or alternatively, a particularly disadvantageous state is reached with two modes of equal strength. The slightest temperature fluctuations can already change the state of the laser mode.

The CoherenceOptimizer is a system to stabilize the laser modes. It adjusts the laser resonator to a constant length so that a strongly dominant laser mode is formed. This minimizes signal level drops in the visibility minimum. If in the software the CoherenceOptimizer is displayed as being stable, the signal level hardly varies over the stand-off distance. This means that with the CoherenceOptimizer it is no longer necessary to position the object at the stand-off distance of a visibility maximum. In addition to that, the time that the scanning head takes to warm-up is also reduced.

The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics. Switch off the CoherenceOptimizer if this interferences affect the measurement result. For measurements with CoherenceOptimizer being switched off, pay attention to the optimal stand-off distances in SECTION 4.3.2.

If the three laser beams are optimally aligned at a measurement point, then depending on the laser mode states, it is possible there may be some crosstalk between the three vibrometers. With the PSV-500-3D, the laser stabilization operating points are set so that this crosstalk is prevented. In the software, the state of the CoherenceOptimizer is displayed as being stable once all three scanning heads have stabilized.

4.4 PSV-G-500 Geometry Scan Unit

4.4.1 Introduction

The geometry scan unit is in the scanning head. It helps you to determine the distance to the object under investigation. If you make a geometry scan, within a few milliseconds the system switches from the vibrometer laser to the geometry laser and determines the exact distance to the object.

Measurement principle

The distance measurement in the geometry scan unit is based on the transit time technique. The distance is determined based on the time the light needs to reach the object and to return from it.

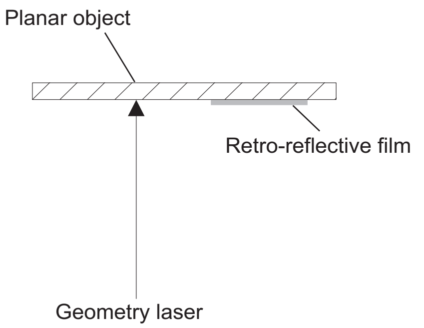
Optimal measurement

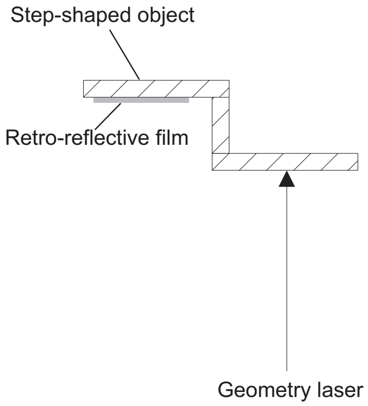
In the same way as it is with a vibrometry measurement, the detected radiation is independent from the scattering characteristic of the surface and the distance. To get an optimal measurement result you should use a diffuse white surface in the close-up range (below 1.5 m) and a retro-reflective film at longer distances.

INFORMATION

If you use a retro-reflective film in the range below 1.5 m, the sensor may overload and affect the measurement result. Therefore, use retro-reflective film only at distances longer than 1.5 m.

You can make a distance measurement without retro-reflective film. If retro-reflective film is on the object under investigation, set the scan points onto the retro-reflective film or cover the retro-reflective film. If retro-reflective film is in the proximity of the scan points, the measurement result can be falsified, although the geometry laser is not pointed onto the retro-reflective film. Pay attention to the following information when you carry out a distance measurement.

Object under investigation	Distance to the object	Precautions
	< 1.5 m	Cover the retro-reflective film in any case. With optically poorly reflective surfaces treat the object with white paper and carry out the distance measurement.
	≥ 1.5 m	Carry out the distance measurement on the retro-reflective film.

Object under investigation	Distance to the object	Precautions
	< 1.5 m	Cover the retro-reflective film in any case. With optically poorly reflective surfaces treat the object with white paper and carry out the distance measurement.
	≥ 1.5 m	Treat the object with retro-reflective film and carry out the distance measurement on the retro-reflective film.

4.4.2 Functional Test

For an initial functional test with the geometry scan unit, proceed as follows:

1. Carry out a functional test with the system as described in SECTION 3.5 and in the software manual.
2. Make a distance measurement (Geometry Point) as described in your software manual.
3. Check the determined stand-off distance (distance between scanning head and scan point), e.g. with a measuring tape.

If the functional test has been successful you can now make measurements with the system and the geometry scan unit as described in SECTION 4.1, SECTION 4.2, SECTION 4.3, and in your software manual.

If your system does not perform as described above, read through the information on troubleshooting provided in CHAPTER 6 and contact your local Polytec representative.

5 Operating the PSV

In the software manual, you will find the following detailed information on how to control the system via the software:

- Setting the optics
- Aligning coordinates
- Defining and editing scan points
- Setting the parameters for Data Acquisition

5.1 Switching On and Off

Front-end

Switch on the front-end by turning the key switch on the front of the controller to position I. The POWER LED above the key switch lights up and shows that the instrument is ready to operate.

If the system is cabled correctly as described in SECTION 3.4, then the POWER LED on the junction box and the LASER LEDs on the scanning heads are still lit up and show that the scanning heads are ready to operate and the lasers are active, even though the beam shutters are closed (refer to SECTION 5.2 and SECTION 5.3).

PC

Switch on the PC by setting the mains switch on the back to position I. Then open the front flap using the key and press the POWER key.

Software

When the system is cabled completely and all instruments are switched on, start the software. Refer to your software manual.

5.2 Blocking the Laser Beam

Each scanning head is equipped with a beam shutter. This can be used to block the laser beam without switching off the laser.

The beam shutter is on the front of the scanning head. To block the laser beam, move the beam shutter upwards until the exit aperture for the laser beam and the video camera is completely closed.

WARNING!

Damage to eyes caused by incorrect usage of the beam shutter!

Incorrect usage of the beam shutter is dangerous as the laser beam may hit the naked eye. This may result in eye injuries.

» Always close the beam shutter before positioning the scanning head.

» Roughly align the scanning head and mount it securely before you open the beam shutter for fine positioning.

5.3 Indicating Laser Activity

Each scanning head is equipped with a LASER LED which indicates laser activity. The LASER LED is on the back of the scanning head.

- The LASER LED is lit when the laser is switched on (key switch on the front of the front-end in position I).
- The LASER LED is lit regardless of whether the beam shutter is open or closed.
- The LASER LED is lit, too, if the laser is switched off with the aid of the software.

5.4 Setting Up the Scanning Head

Fluid head

If the system is equipped with a light duty tripod with fluid head, you can manually set up the scanning head using the three hand-grips as described in the assembly instruction provided by the tripod manufacturer.

Stand-off distance

While aligning the scanning head, also pay attention to the information on optimal stand-off distances for the scanning head provided in SECTION 4.3.

6 Troubleshooting

Approach

Simple tests are described in the following for you to carry out yourself in the case of malfunctions. In the case of more difficult problems with 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 instrument is limited to such tests in which the housings do not have to be opened.

INFORMATION

Tampering with the instruments in any way is not necessary when using the equipment as intended and will invalidate the warranty. Exchanging or retrospectively installing subassemblies may only be carried out by authorized service personnel of Polytec.

If faults or malfunctions cannot be solved by the measures described here or if faults/malfunctions occur which are not mentioned here, please contact our service department. Further procedure will be determined based on your fault description.

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

WARNING!

Fire risk caused by wrong fuses!

» Replace defective fuses only by fuses of the same kind with the amperage given on the instrument.

WARNING!

Electric shock caused by applied voltage!

When the instrument is live, an improper handling of replacing fuses can cause an electric shock.

» Always disconnect the mains plug before you check the fuses.

6.1 General Tests

In case of a malfunction, first check the following:

1. Have you connected up the system correctly as described in SECTION 3.4?

Front-end

2. Have you used the original network cables from Polytec?
3. Have you connected up correctly the VIDEO and CONTROL network cables?
4. Have you turned the key switch on the front of the front-end to position I?
5. Is the POWER LED lit up on the front of the front-end?

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

Hardware configuration

If at the start of the PSV Acquisition an error message concerning the front-end, the Windows firewall or the video camera is displayed, proceed as follows:

1. Exit the PSV software.
2. Start the Polytec Configuration Tool with administrator rights. To do so, click Start > Programs > Polytec Configuration Tool > Polytec Configuration Tool.

   The application window Polytec Configuration Tool *appears.*
3. Click Configure.

   The Polytec Configuration Tool *configures the windows firewall and the network adapters for the front-end and optionally for the video camera and the accessory. The progress of the configuration is shown in the message window. You can recognize the meaning of the messages by their respective color:*

Blue messages:	Status reports
Green messages:	The configuration could be carried out.
Red messages:	The configuration could not be carried out.

4. If the configuration could not be carried out, send the log file together with the fault description to the service department of Polytec.

Data acquisition board

Check whether the PCI-6110 data acquisition board is correctly installed. To do so, proceed as follows:

1. Double-click the Measurement&Automation icon on the desktop.
2. Change to the Devices and Interfaces directory.

   The PCI-6110 data acquisition board is correctly installed if it is displayed in the Devices and Interfaces *directory. If it is not displayed, then there is a problem with the data acquisition board.*

Generator board

The M2i.6030 generator board is installed correctly if it is displayed in the Device Manager of your operating system. If it is not displayed press the F5 key on your keyboard to refresh the display. If the generator board is not displayed yet, check whether the board is properly inserted into its slot in the PC. If the generator board still does not appear, then contact the service department of Polytec.

6.2 Problems with the Laser

6.2.1 No Laser Beam

If no laser beam is emitted, check the following:

1. Have you connected up the system correctly as described in SECTION 3.4?
2. Have you turned the key switch on the front of the front-end to position I?
3. Have you opened the beam shutter on the front of the scanning head?
4. Is the LASER LED on the back of the scanning head lit up?

   If the LED is not lit up, it can be assumed that there is a fault in the mains supply of the front-end. Disconnect the mains plug and check the fuses on the back of the front-end. Note that there are two active fuses which can both lead to failure.
5. Is the POWER LED lit up on the front of the front-end?

   If not, it can be assumed that there is a fault in the mains supply of the front-end. In this case, disconnect the mains plug and check the fuses on the back. Note that there are two active fuses which can both lead to failure.
6. Have you activated the laser in the software?

6.2.2 Highly Fluctuating Signal Level Display (Only PSV-500 Standard)

If the signal level display on the back of the scanning head or in the software periodically fluctuates highly, proceed as follows:

1. Wait until the CoherenceOptimizer state is shown as being stable in the software. Refer also to your software manual.

   The CoherenceOptimizer stabilizes the laser and the fluctuation of the signal level display stops.
2. Check if your object is positioned unfavorably in a visibility minimum of the laser.

   If so, change the distance between the scanning head and the object. You will find detailed information on optimal stand-off distances and visibility maxima in FIGURE 4.3.

6.2.3 Failure of the Pilot Laser (Only PSV-500 Xtra)

When the pilot laser has reached the end of its usable life, this will be indicated by the pilot laser blinking. First, the blinking appears in full brightness. You can continue using the pilot laser for a limited period by reducing the brightness in PSV software.

Please contact our service personnel in order to exchange the pilot laser.

A safe operation of the instrument is still possible, even if the pilot laser is blinking or defective. This means e.g. that you can finish a measurement if the pilot laser fails during a measurement.

Exception: When using VideoTriangulation, the pilot laser is necessary.

6.3 No Measurement Signal or Implausible Measurement Signals

If the laser beam is emitted, but there is no measurement signal or just implausible measurement signals, check the following. Refer also to the software manual.

1. Have you connected up the system correctly as described in SECTION 3.4?
2. In PSV Acquisition, select Setup > Preferences.

   The Preferences *dialog appears.*
3. On the Devices page, select the PSV-F-500-3D (1D) junction box.
4. Click OK.
5. Select Acquisition > Settings.

   The Acquisition Settings *dialog appears.*
6. Display the Channels page.
7. In the Active column, tick the boxes for the Vibrometer Top, Vibrometer Left, Vibrometer Right and Reference 1 channels.
8. In the Ref column, tick the box for the Reference 1 channel.

INFORMATION
In the Ref column, the boxes for the Vibrometer Top, Vibrometer Left and Vibrometer Right channels must not be ticked.

You can now check the function of each of the scanning heads independently of each other.

9. Put a matt white test surface such as a piece of paper approximately 50 cm away from the front panel of the TOP scanning head in the beam path.
10. Focus the laser on the test surface. Does the signal level display react to focusing?

    If the signal level display does not react, the scanning head is defective.
11. Repeat step 9 and step 10 for LEFT and RIGHT scanning heads.

Data acquisition

Check the correct operation of the data acquisition and the software. To do so, proceed as follows:

1. Connect up the signal output of a function generator to the REF1 reference channel.
2. Display the time signal of the reference channel in an analyzer as described in your software manual.

   The data acquisition and the software work properly if the signal of the function generator is displayed correctly. In this case there is a problem in the front-end.

Vibrometer signal

Check the vibrometer signals of the front-end. To do so, proceed as follows. Refer also to the software manual.

1. Set the 50 mm/s measurement range and a bandwidth of 10 kHz.
2. Put a matt white test surface such as a piece of paper approximately 50 cm away from the front panel of the TOP scanning head in the beam path.
3. Focus the laser on the test surface.
4. Display the time signal of the Top vibrometer channel in an analyzer.
5. Move the test surface and check whether the output signal reacts to the test surface moving.
6. Repeat steps 2 to 5 for LEFT and RIGHT scanning heads.

7 Technical Specifications

7.1 Harmonized Standards Applied

Laser safety:	IEC/EN 60825-1:2008-05 (Safety of Laser Products, complies to US 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice no. 50, dated 24 June 2007)
Electrical safety:	IEC/EN 61010-1:2011-07 (Safety requirements for electrical equipment for measurement, control, and laboratory use)
EMC:	IEC/EN 61326-1:2013-07 (EMC requirements on Emission and Immunity - Electrical equipment for measurement, control, and laboratory use)
	Emission: Limit Class A IEC/EN 61000-3-2 and 61000-3-3
	Immunity: IEC/EN 61000-4-2 to 61000-4-6 and IEC/EN 61000-4-11

7.2 Front-End

7.2.1 General Data

Mains Connection

Mains voltage:	100…240 VAC ±10%, 50/60 Hz
Power consumption:	200 VA
Fuses:	3.15 A/slow-blow
Protection class:	1 (protective grounding)

Ambient Conditions

Operating temperature:	+5 °C…+40 °C (41 °F … 104 °F)
Storage temperature:	−10 °C…+65 °C (14 °F … 149 °F)
Humidity:	max. 80%, non-condensing

Housing

Protection rating:	IP20 (according to EN 60529)
Dimensions (w x h x d):	Without angle brackets: 450 mm x 150 mm x 380 mm (19", 84 HP/3 U) With angle brackets: 485 mm x 150 mm x 380 mm (19", 84 HP/3 U)
Weight:	10 kg

Calibration

Recommended calibration interval:	2 years

7.2.2 Signal Inputs and Outputs

REF 1 to REF3 (PSV-3D only REF 1)

Input voltage range:	±200 mV … ±10 V
Input impedance:	1 MΩ, in parallel with 100 pF
Input coupling:	AC / DC, adjustable in the software AC −3 dB cutoff frequency: 0.05 Hz
Overvoltage protection:	±42 V (against damage)

IEPE mode

Sensor supply:	nom. 4 mA/24 V, IEPE compatible
Time constant:	3.3 s

TRIG IN, AUX IN

Compatibility:	TTL / CMOS
Overvoltage protection:	± 5.5 V (against damage)
Input resistance:	10 kΩ

SIGNAL

Output voltage swing:	max. ±10 V at high-impedance load
	max. ±5 V into 50 Ω
Output current:	max. ±100 mA
Output resistance:	50 Ω
Short-circuit protection:	permanently short-circuit proof

SYNC, AUX OUT

Compatibility:	TTL/CMOS
Output voltage HIGH:	min. 2.4 V (I_{out} = 5 mA)
Output voltage LOW:	max. 0.4 V (I_{out} = 2 mA)
Output resistance:	100 Ω

AUX OUT

Compatibility:	TTL / CMOS
Output voltage HIGH:	min. 2.4 V (I_{out} = 5 mA)
Output voltage LOW:	max. 0.4 V (I_{out} = 2 mA)

7.2.3 Metrological Properties (PSV-500-3D Standard)

DV-04 Digital Velocity Decoder

Table 7.1: Metrological properties of the DV-04 decoder for PSV-500-3D Standard (1 of 5)

Full scale value (peak)	**1**	**2**	**5**	mm/s
Scaling of analog output	0.25	0.5	1.25	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	10	20	50	kHz
Max. acceleration	6.4	25.6	160	g
Frequency response[1]	±0.1	±0.1	±0.1	dB
Resolution analog output	0.038	0.076	0.19	µm/s
Resolution[2]				
Frequency-dependent[3]	0.01	0.01	0.01	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.01	0.01	0.01	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< -44	< -46	< –48	dBc
Spurious signals (non-harmonic)[8]	< -60	< -60	< -64	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale.An exception of this is just a peak in the frequency range 20…25 kHz and its multiples. This peak is generated by the laser in the optical sensor, the amplitudes depend on the stand-off distance. The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics.

Table 7.2: Metrological properties of the DV-04 decoder for PSV-500-3D Standard (2 of 5)

Full scale value (peak)	**10**	**20**	**50**	mm/s
Scaling of analog output	2.5	5	12.5	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	100	200	500	kHz
Max. acceleration	640	2 560	16 000	g
Frequency response[1]				
0.0 Hz…100 kHz	±0.1	±0.1	±0.1	dB
100 kHz…500 kHz	–/–	+0.2/–0.5	+0.2/–0.5	dB
Resolution analog output	0.38	0.76	1.9	µm/s
Resolution[2]				
Frequency-dependent[3]	0.02	0.02…0.03	0.02…0.08	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.02	0.03	0.05	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5]				
T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< –48	< -52	< -52	dBc
Spurious signals (non-harmonic)[8]	< -70	< -75	< -80	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale.An exception of this is just a peak in the frequency range 20…25 kHz and its multiples. This peak is generated by the laser in the optical sensor, the amplitudes depend on the stand-off distance. The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics.

Table 7.3: Metrological properties of the DV-04 decoder for PSV-500-3D Standard (3 of 5)

Full scale value (peak)	**100**	**200**	**500**	mm/s
Scaling of analog output	25	50	125	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	1 000	2 000	2 000	kHz
Max. acceleration	64 000	256 000	640 000	g
Frequency response[1]				
0.0 Hz…100 kHz	±0.1	±0.1	±0.1	dB
100 kHz…1 MHz	+0.2/–0.5	+0.2/–0.5	+0.2/–0.5	dB
1 MHz…2 MHz		+0.2/-1.0	+0.2/-1.0	dB
Resolution analog output	3.8	7.6	19	μm/s
Resolution[2]				
Frequency-dependent[3]	0.04…0.2	0.06…0.4	0.1…0.6	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.1	0.2	0.3	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5]				
T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< -52	< -52	< -52	dBc
Spurious signals (non-harmonic)[8]	< -85	< -85	< -85	dBFS

1 The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

2 The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

3 The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 μm/s with 1 Hz spectral resolution.

4 The typical value refers to the center of the operating frequency range.

5 Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

6 The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

7 Harmonic distortions are specified up to 70% of full scale for the wanted signal.

8 The maximum amplitude of the distortions refers to the full scale.An exception of this is just a peak in the frequency range 20…25 kHz and its multiples. This peak is generated by the laser in the optical sensor, the amplitudes depend on the stand-off distance. The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics.

Table 7.4: Metrological properties of the DV-04 decoder for PSV-500-3D Standard (4 of 5)

Full scale value (peak)	**1 000**	**2 000**	**5 000**	mm/s
Scaling of analog output	250	500	1 250	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	2 000	2 000	2 000	kHz
Max. acceleration	1280000	2560000	6400000	g
Frequency response[1]				
0.0 Hz…100 kHz	±0.1	±0.1	±0.1	dB
100 kHz…1 MHz	+0.2/–0.5	+0.2/–0.5	+0.2/–0.5	dB
1 MHz…2 MHz	+0.2/-1	+0.2/-1	+0.2/-1	dB
Resolution analog output	38	76	191	µm/s
Resolution[2]				
Frequency-dependent[3]	0.2…0.8	0.4…1.0	1.0…1.5	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.4	0.6	1.0	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< -52	< -52	< -52	dBc
Spurious signals (non-harmonic)[8]	< -85	< -85	< -85	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale.An exception of this is just a peak in the frequency range 20…25 kHz and its multiples. This peak is generated by the laser in the optical sensor, the amplitudes depend on the stand-off distance. The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics.

Table 7.5: Metrological properties of the DV-04 decoder for PSV-500-3D Standard (5 of 5)

Full scale value (peak)	**10 000**	**12 000**	mm/s
Scaling of analog output	2 500	3 000	$\frac{mm}{s}$/V
Frequency range f_{min} f_{max}	 0 2 000	 0 100	 Hz kHz
Max. acceleration	12 800 000	768 000	g
Frequency response[1] 0.0 Hz…100 kHz 100 kHz…2 MHz	 ±0.1 +0.2/–0.5	 ±0.1 –/–	 dB dB
Resolution analog output	381	458	µm/s
Resolution[2] Frequency-dependent[3] typically[4]	 2.0…2.5 2.0	 2.5…3 2.5	 $\frac{\mu m}{s}/\sqrt{Hz}$ $\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	%
Harmonic distortions[7]	< -52	< -52	dBc
Spurious signals (non-harmonic)[8]	< -85	< -85	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale.An exception of this is just a peak in the frequency range 20…25 kHz and its multiples. This peak is generated by the laser in the optical sensor, the amplitudes depend on the stand-off distance. The CoherenceOptimizer can cause interferences at a frequency of 610 Hz and harmonics.

7.2.4 Metrological Properties (PSV-500-3D Xtra)

Table 7.6: Metrological properties of the DV-04 decoder for PSV-500-3D Xtra (1 of 5)

Full scale value (peak)	**2.5**	**5**	**12.5**	mm/s
Scaling of analog output	0.612	1.22	3.06	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	10	20	50	kHz
Max. acceleration	16	64	400	g
Frequency response[1]	±0.1	±0.1	±0.1	dB
Resolution analog output	0.095	0.19	0.48	μm/s
Resolution[2]				
Frequency-dependent[3]	0.04…0.14	0.04…0.14	0.04…0.14	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.1	0.13	0.13	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< –44	< –46	< –48	dBc
Spurious signals (non-harmonic)[8]	< –60	< –65	< –70	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 μm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale at a stand-off distance of 0.5 m.

Table 7.7: Metrological properties of the DV-04 decoder for PSV-500-3D Xtra (2 of 5)

Full scale value (peak)	**25**	**50**	**125**	mm/s
Scaling of analog output	6.12	12.2	30.6	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	100	200	500	kHz
Max. acceleration	1 600	6 400	40 000	g
Frequency response[1]				
0.0 Hz…100 kHz	±0.1	±0.1	±0.1	dB
100 kHz…500 kHz	–/–	+0.2/–0.5	+0.2/–0.5	dB
Resolution analog output	0.95	1.9	4.8	μm/s
Resolution[2]				
Frequency-dependent[3]	0.04…0.14	0.05…0.2	0.06…0.4	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	0.13	0.13	0.2	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< –48	< –52	< –52	dBc
Spurious signals (non-harmonic)[8]	< –70	< –70	< –75	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 μm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale at a stand-off distance of 0.5 m.

Table 7.8: Metrological properties of the DV-04 decoder for PSV-500-3D Xtra (3 of 5)

Full scale value (peak)	**250**	**500**	**1 250**	mm/s
Scaling of analog output	61.2	122	306	$\frac{mm}{s}/V$
Frequency range f_{min} f_{max}	 0 1 000	 0 2 000	 0 2 000	 Hz kHz
Max. acceleration	160 000	640 000	1600000	g
Frequency response[1] 0.0 Hz…100 kHz 100 kHz…1 MHz 1 MHz…2 MHz	 ±0.1 +0.2/–0.5 –/–	 ±0.1 +0.2/–0.5 +0.2/-0.8	 ±0.1 +0.2/–0.5 +0.2/-0.8	 dB dB dB
Resolution analog output	9.5	19	48	μm/s
Resolution[2] Frequency-dependent[3] typically[4]	 0.08…0.8 0.4	 0.1…1.0 0.5	 0.25…1.2 0.6	 $\frac{\mu m}{s}/\sqrt{Hz}$ $\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5] T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]	< –52	< –52	< –52	dBc
Spurious signals (non-harmonic)[8]	< –80	< –85	< –85	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale at a stand-off distance of 0.5 m.

Table 7.9: Metrological properties of the DV-04 decoder for PSV-500-3D Xtra (4 of 5)

Full scale value (peak)	**2 500**	**5 000**	**12 500**	mm/s
Scaling of analog output	612	1 225	3 062	$\frac{mm}{s}/V$
Frequency range				
f_{min}	0	0	0	Hz
f_{max}	2 000	2 000	2 000	kHz
Max. acceleration	3200000	6400000	16000000	g
Frequency response[1]				
0.0 Hz…100 kHz	±0.1	±0.1	±0.1	dB
100 kHz…1 MHz	+0.2/–0.5	+0.2/–0.5	+0.2/–0.5	dB
Resolution analog output	95	191	477	µm/s
Resolution[2]				
Frequency-dependent[3]	0.5…1.5	1.0…2.0	3.0…4.0	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	1.0	1.5	3.0	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5]				
T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	0.5	%
Harmonic distortions[7]				
up to 2.5 MHz	< –52	< –52	< –52	dBc
> 2.5 MHz	< –45	< –40	< –40	dBc
Spurious signals (non-harmonic)[8]	< –85	< –85	< –85	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale at a stand-off distance of 0.5 m.

Table 7.10: Metrological properties of the DV-04 decoder for PSV-500-3D Xtra (5 of 5)

Full scale value (peak)	**25 000**	**30 000**	mm/s
Scaling of analog output	6 124	7 349	$\frac{mm}{s}/V$
Frequency range			
f_{min}	0	0	Hz
f_{max}	2 000	100	kHz
Max. acceleration	32 000 000	1 920 000	g
Frequency response[1]			
0.0 Hz…100 kHz	±0.1	±0.1	dB
100 kHz…1 MHz	+0.2/–0.5	–/–	dB
Resolution analog output	954	1 144	µm/s
Resolution[2]			
Frequency-dependent[3]	5.0…8.0	6.0…8.0	$\frac{\mu m}{s}/\sqrt{Hz}$
typically[4]	6.0	7.0	$\frac{\mu m}{s}/\sqrt{Hz}$
Calibration error analog output[5]			
T_a = +5 °C…+40 °C (T_a = 41 °F…104 °F)	±1.0	±1.0	%
Linearity error analog output[6]	0.5	0.5	%
Harmonic distortions[7]			
up to 2.5 MHz	< –52	< –52	dBc
> 2.5 MHz	< –26	–/–	dBc
Spurious signals (non-harmonic)[8]	< –85	< –85	dBFS

[1] The frequency response defines the frequency-dependent amplitude error, referred to the reference frequency of 1 kHz.

[2] The noise-limited resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB with 1 Hz spectral resolution, measured in a distance of 0.5 m on 3M Scotchlite™ Tape (retro-reflective film).

[3] The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz. In the frequency range from 10 Hz to 5 kHz the specified decoder noise is superimposed by the scanner noise. The resolution is then between 0.1 and 1.0 µm/s with 1 Hz spectral resolution.

[4] The typical value refers to the center of the operating frequency range.

[5] Conditions: sinusoidal vibration, f = 1 kHz, amplitude 70% of full scale range, load resistance ≥ 1 MΩ

[6] The linearity error is defined as the amplitude dependent, relative deviation of the scaling factor referred to the scaling factor under calibration conditions (refer to footnote[5]).

[7] Harmonic distortions are specified up to 70% of full scale for the wanted signal.

[8] The maximum amplitude of the distortions refers to the full scale at a stand-off distance of 0.5 m.

7.2.5 Data Acquisition

Components/Properties	PSV-500-3D-M
Data acquisition	PCI-6110
Reference channel	1
Maximum bandwidth	1 MHz (2 MHz)[1]
Function generator	M2i.6030
Output channel	1
Maximum bandwidth	1 MHz (2 MHz)[1]

[1] The specifications in brackets are available as an option.

7.3 Junction Box

Mains Connection

Mains voltage: 100…240 VAC ±10%, 50/60 Hz
Power consumption: 200 VA
Fuses: 3.15 A/slow-blow
Protection class: 1 (protective grounding)

Ambient Conditions

Operating temperature: +5 °C…+40 °C (41 °F … 104 °F)
Storage temperature: −10 °C…+65 °C (14 °F … 149 °F)
Humidity: max. 80%, non-condensing

Housing

Protection rating: IP20
Dimensions (w x h x d): without angle brackets
450 mm x 150 mm x 60 mm (19", 84 HP/3 U)
with angle brackets
485 mm x 50 mm x 60 mm (19", 84 HP/3 U)
Weight: 8 kg

7.4 PC

7.4.1 General Data

Mains Connection

Mains voltage:	100…240 VAC ± 10%, 50/60 Hz
Power consumption:	max. 525 VA
Protection class:	1 (protective grounding)

Ambient Conditions

Operating temperature:	+5 °C…+40 °C (41 °F … 104 °F)
Storage temperature:	-10 °C…+65 °C (14 °F … 149 °F)
Humidity:	max. 80%, non-condensing

Housing Industrial PC

Protection rating:	IP20 (according to EN 60529)
Dimensions (w x h x d):	Without angle brackets: 450 mm x 190 mm x 550 mm (19", 84 HP/4 U) With angle brackets: 485 mm x 190 mm x 550 mm (19", 84 HP/4 U)
Weight:	18 kg

7.4.2 PC Configuration

Basic Set-Up

Processor:	min. Intel® CoreTM i7-2600K
Hard disk drive (HDD):	> 1 TB
Operating system:	Microsoft® Windows® 7 (64-Bit) Ultimate
Network connection:	Ethernet
DVD burner:	refer to manufacturer's documentation

7.5 Scanning Heads

7.5.1 General Data PSV-I-5xx

Ambient Conditions

ATTENTION!

Damage of the scanning head caused by too high ambient temperature!

If the ambient temperature exceeds 35 °C (95 °F), the scanning head may overheat. This could damage it.

» At ambient temperatures above 35 °C (95 °F) you must assemble the scanning head on a tripod (e.g. VIB-A-T02) so that also its bottom side of the scanning head is ventilated sufficiently.

Operating temperature:	+5 °C…+35 °C (41 °F…95 °F) without limitations +35 °C…+40 °C (95 °F…104 °F) with limitations (see above)
Storage temperature:	-10 °C…+65 °C (14 °F…149 °F)
Operating altitude (only Standard):	max. 3048 m (max. 10000 ft)
Humidity:	max. 80%, non-condensing

Dimensions

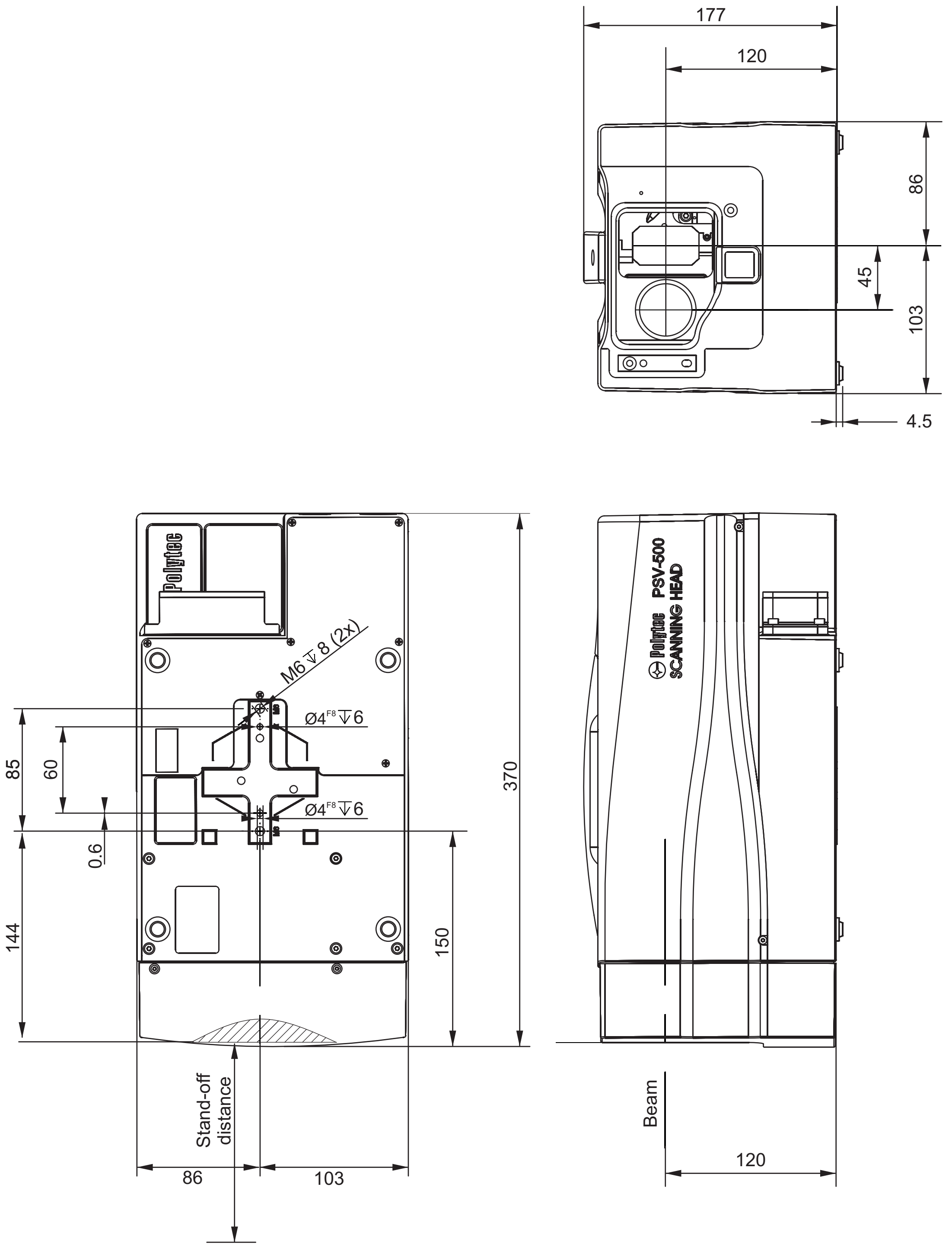


Figure 7.1: Dimensions of the scanning head (Dimensions not specified are given in mm.)

7.5.2 General Data PSV-I-500/PSV-I-520 (Standard)

Laser

Laser type:	Helium-neon
Wavelength:	633 nm
Cavity length:	204 mm ±1 mm
Laser class:	2
Emitted laser power:	< 1 mW

Electrical Data

Power consumption:	approx. 45 W (average value)
Carrier frequency:	40 MHz

Housing

Protection rating:	IP10 (according to EN 60529) IP40 (beam shutter closed or PSV-A-526 protective window mounted)
Dimensions:	refer to FIGURE 7.1
Weight:	9.2 kg (including geometry scan unit and CoherenceOptimizer)

7.5.3 General Data PSV-I-560/PSV-I-570 (Xtra)

Object Laser

Laser type:	Erbium fiber laser
Wavelength:	1 550 nm ± 2.5 nm
Laser class:	1
Emitted laser power:	< 10 mW

Pilot Laser

Laser type:	Laser diode
Wavelength:	520 nm ±10 nm
Laser class:	2
Laser power:	< 1 mW

Electrical Data (Object and Pilot Laser)

Power consumption:	approx. 45 W (average value)
Carrier frequency:	40 MHz

Housing

Protection rating:	IP10 (according to EN 60529) IP40 (beam shutter closed or PSV-A-526 protective window mounted)
Dimensions:	refer to FIGURE 7.1
Weight:	approx. 9.5 kg (including geometry scan unit)

7.5.4 Optics PSV-I-500/PSV-I-520 (Standard)

Focal length (nominal): 70 mm

Minimum stand-off distance: 125 mm

Stand-off distance[1]	Spot diameter (1/e², typ.)	Depth of focus (typ.)[2]	Aperture diameter[3]
[mm]	[µm]	[± mm]	[mm]
141	25	0.48	5.8
345	43	1.4	8.4
549	60	2.8	9.4
753	78	4.6	10
1000	98	7.5	10.4
With each additional meter stand-off distance 85 µm are added to the spot diameter.			

[1] Measured from the front of the scanning head

[2] For 3dB signal reduction

[3] At the front of the scanning head

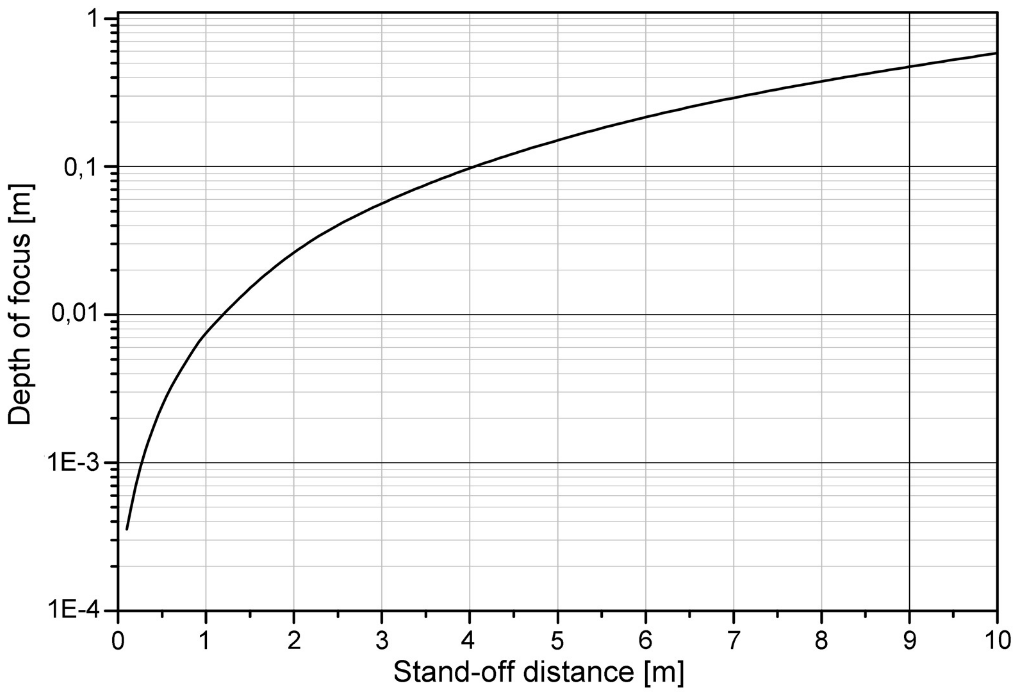


Figure 7.2: Depth of focus subject to the stand-off distance

Signal Level Depending on Surface and Stand-off Distance

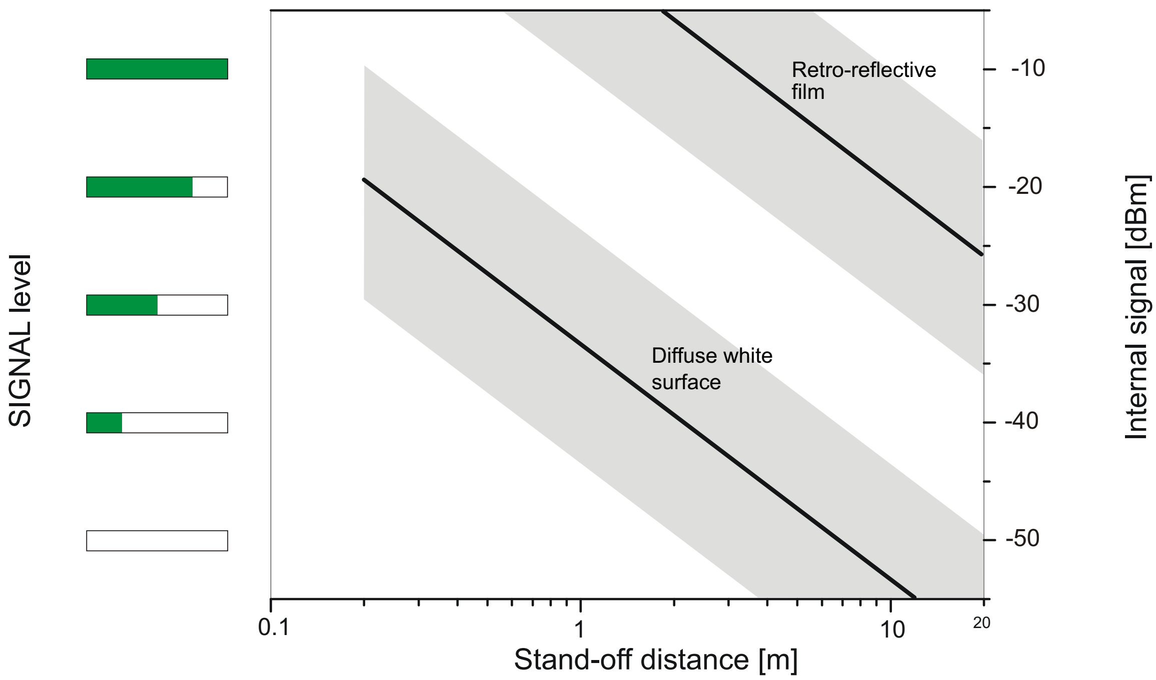


Figure 7.3: Typical signal level range depending on the stand-off distance measured on a diffuse white surface and 3M Scotchlite™ Tape (retro-reflective film)

Table of the Visibility Maxima

Visibility maxima (mm) for l = 204 mm					
141	345	549	753	957	1161
1365	1569	1773	1977	2181	2385
2589	2793	2997	3201	3405	3609
3813	4017	4221	4425	4629	4833
5037	Add 204 mm for every additional visibility maximum.				

7.5.5 Optics PSV-I-560/PSV-I-570 (Xtra)

Focal length (nominal): 70 mm

Minimum stand-off distance: 125 mm

Stand-off distance[1]	Spot diameter (1/e², typ.)	Depth of focus (typ.)[2]	Aperture diameter[3]
[mm]	[µm]	[± mm]	[mm]
150	66	1.5	5.4
200	79	2	6.2
500	148	7	8.3
1000	259	22	9.5
2000	480	75	10.2
5000	1128	413	10.6
With each additional meter stand-off distance 216 µm are added to the spot diameter.			

[1] Measured from the front of the scanning head

[2] For 3 dB signal reduction

[3] At the front of the scanning head

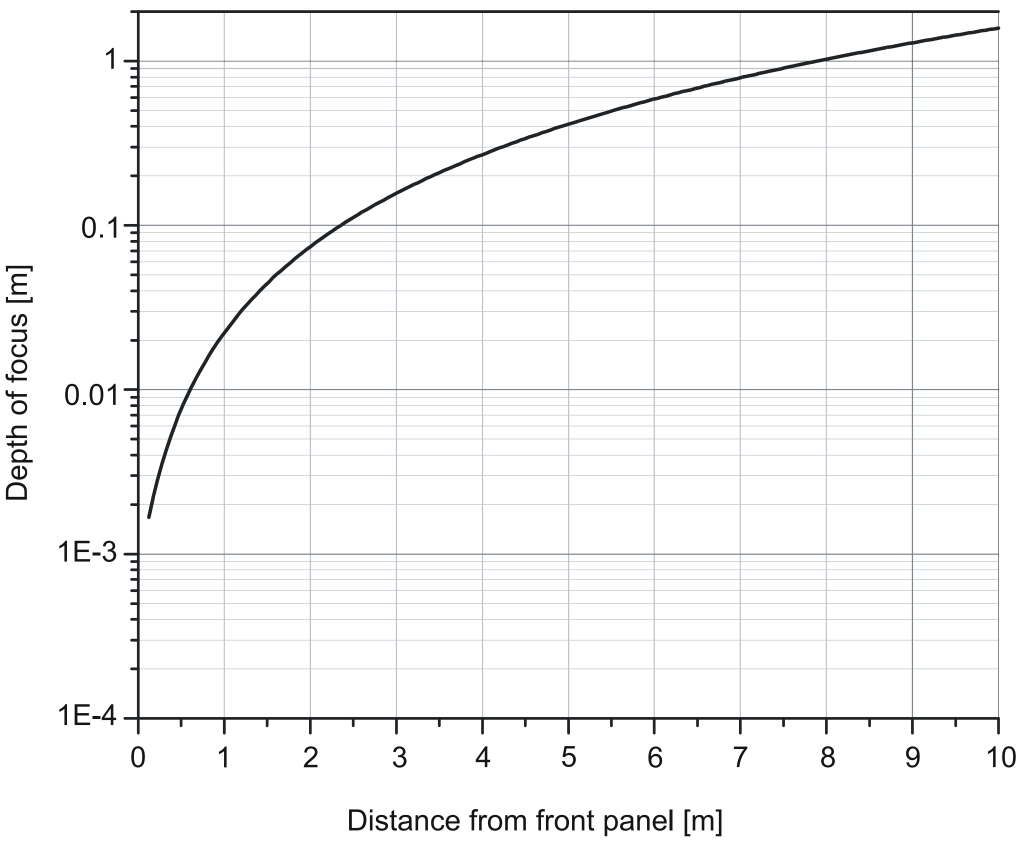


Figure 7.4: Depth of focus subject to the stand-off distance (PSV-500-3D Standard)

Signal Level Depending on Surface and Stand-off Distance

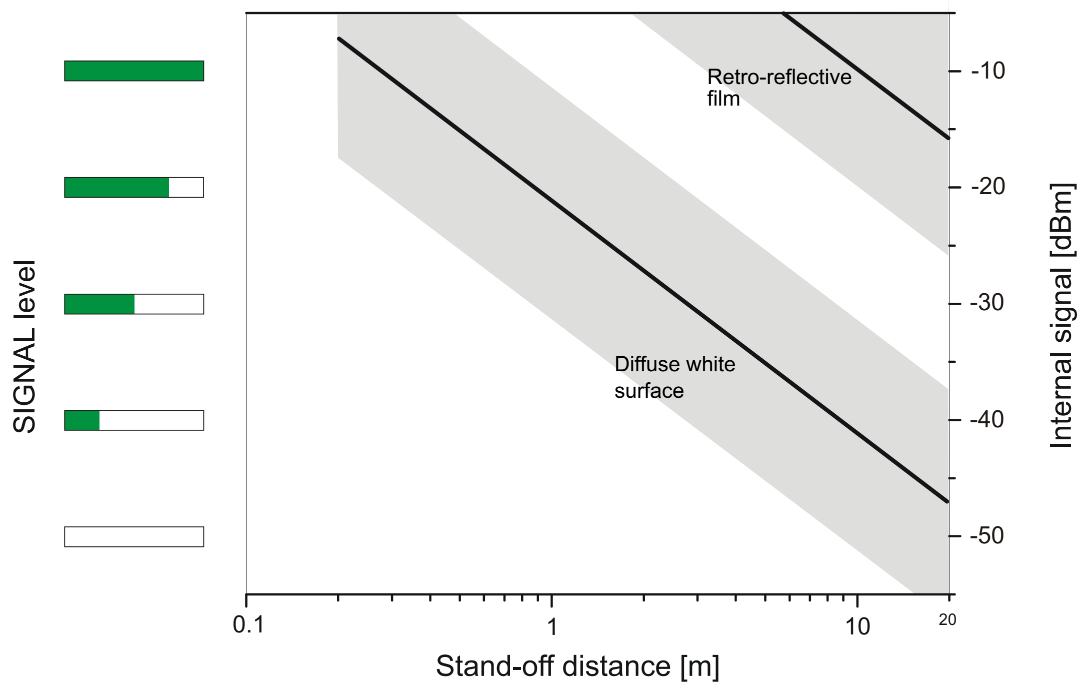


Figure 7.5: Typical signal level range depending on the stand-off distance measured on a diffuse white surface and 3M Scotchlite™ Tape (retro-reflective film)

7.5.6 Scanner PSV-I-5xx

Type:	Servo-controlled Galvo scanner
Maximum deflection:	horizontal: ±25° vertical: ±20°
Angular resolution:	16-Bit
Point stability:	< 0.001°/hour (after 2 h warm-up period, with constant ambient temperature)

7.5.7 Video Camera (Only PSV-I-500/PSV-I-560)

Video system:	full HD	
Image sensor:	1/2.8-type CMOS	
Signal-to-noise ratio:	> 50 dB	
Zoom:	20x optical zoom	
Lens:	F1.6 to F3.5/f = 4.7…94 mm	
Active pixels (HxV):	@ wide end:	ca. 55° x 32°
	@ tele end:	ca. 3° x 2°
Minimum stand-off distance:	@ wide end:	10 mm
	@ tele end:	1000 mm
Minimum illumination:	1.5 Lux	

7.5.8 Geometry Scan Unit (Only PSV-I-500/PSV-I-560)

Laser

Laser type:	Laser diode
Wavelength:	670 nm ± 5 nm
Laser class:	2
Laser power:	< 1 mW
Accuracy of the distance measurement:	typ. ±2,5 mm, depends on the signal level, for stand-off distances ≥1,5 m

7.6 System Cabinet

Mains Connection

Mains voltage:	100…240 VAC ±10%, 50/60 Hz
Power consumption:	600 VA

Housing

Dimensions (w x h x d):	580 mm x 1330 mm x 845 mm
Weight:	186 kg (incl. front-end, PC, monitor, scanning head and cables)

Appendix A: Optional Accessories

A.1 PSV-A-430 Acoustic Gate Unit

With the acoustic gate unit you can start or stop a measurement depending on a characteristic noise (e.g. start measuring with brakes squealing). Connect up the acoustic gate unit using a BNC cable to the AUX IN jack on the front of the front-end.

A.2 External Digital PSV-A-515 Video Camera

A.2.1 Introduction

The video camera is a digital high-resolution video camera that can be used instead of the video camera installed in the scanning head. The external video camera allows a higher accuracy in the positioning of the laser beams for VideoTriangulation. The video camera is monochrome, to get the best possible resolution for this application.

By default, the video camera is provided with a prime lens (standard lens). As an option, there is a 10x zoom lens available that is set up manually. For short stand-off distances (180 – 300 mm) the zoom lens contains a close-up lens that has to be removed for larger stand-off distances.

The zoom lens is delivered with the PSV-A-455 helium-neon block filter. If the intensity of the laser light is still too high, it can be mounted additionally. The block filter reduces the intensity of the laser light scattered back to the video camera by 98%.

INFORMATION

With PSV-500 Xtra, the block filter has no effect. When required, reduce the brightness of the pilot laser in the PSV software.

To position and align the external video camera you can optionally use the VIB-A-T05 tripod with geared head.

ATTENTION!

Damage to the camera chip caused by skin contact!

The acidic protection layer of the skin consists of a hydrolipid film. If the camera chip gets into contact with this film, i. e. if you touch it with bare fingers, the chip becomes unusable.

» Do not touch the camera chip during assembly.

» Refer to the listing of the possible cleaning agents in SECTION 1.2.5.

A.2.2 Control Elements of the Video Camera with Standard Lens

Back view The back view of the video camera with standard lens is shown in the following figure.

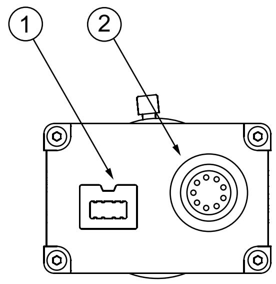


Figure A.1: Back view of the video camera

1 IEEE interface
Connection for the IEEE-1394 cable (FireWire®) to the PC to transmit the video signal, for mains supply and to control of the video camera.

2 I/O port connection (12-pin circular jack)
This connection is not used!

Side view The side view of the video camera with standard lens is shown in the following figure.

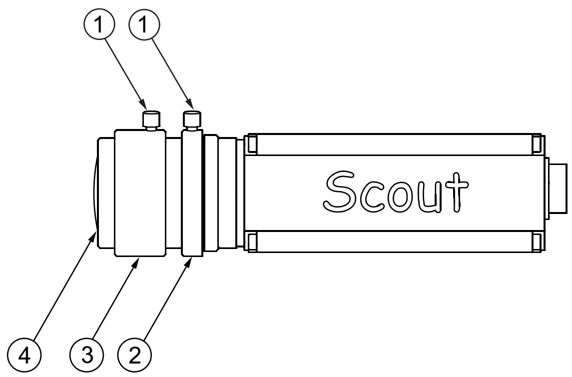


Figure A.2: Side view of the video camera

1 Locking screws
Screws to lock the required settings for focus and aperture

2 Aperture ring
Ring for manual setting of the aperture

3 Focusing ring
Ring for manual focusing

4 Front lens

A.2.3 Control Elements of the Video Camera with Zoom Lens

Back view

The back view of the video camera with zoom lens is shown in the following figure.

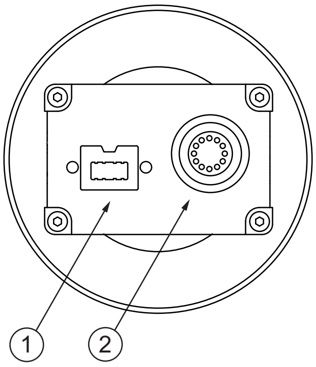


Figure A.3: Back view of the video camera

1 IEEE interface
Connection for the IEEE-1394 cable (FireWire®) to the PC to transmit the video signal, for mains supply and to control of the video camera.

2 I/O port connection (12-pin circular jack)
Not used

Side view

The side view of the video camera with zoom lens is shown in the following figure.

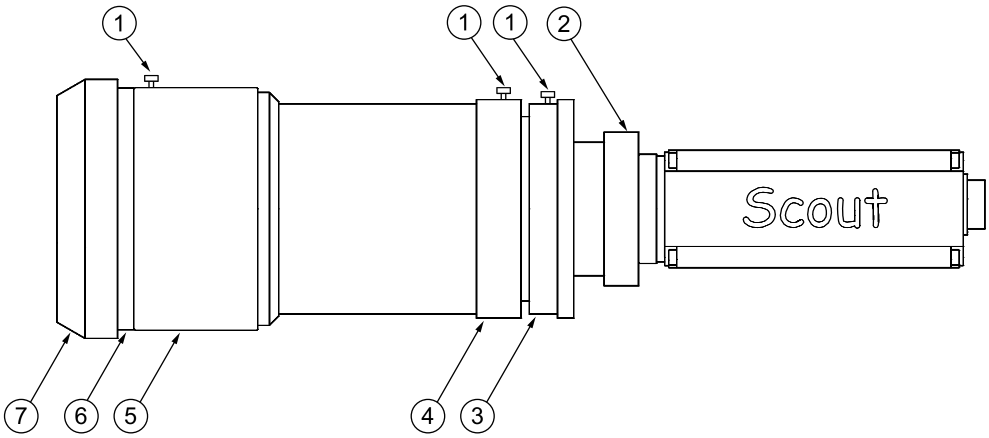


Figure A.4: Side view of the video camera

1 Locking screws
Screws to lock the required settings for focus, zoom and aperture

2 Locking ring
Ring for setting the orientation of the zoom lens

3 Aperture ring
Ring for manual setting of the aperture

4 Zooming ring
Ring for manual setting of the focal length

5 Focusing ring
Ring for manual focusing

6 Close-up lens and front lens
Close-up lens for stand-off distances from 180 to 300 mm (refer also to SECTION A.2.5.2)

7 PSV-A-445 helium-neon block filter
The filter reduces the intensity of the laser light scattered back to the video camera by 98%.

A.2.4 Installation

INFORMATION
Keep the assembly instructions for all components in a safe place.

A.2.4.1 Assembly

To mount the video camera on a VIB-A-T05 tripod with geared head, proceed as follows:

1. Assemble the tripod as described in the assembly instructions provided by the manufacturer.
2. Mount the geared head onto the tripod as described in the assembly instructions providing by the manufacturer.

ATTENTION!
Damage to the camera chip caused by skin contact!
The acidic protection layer of the skin consists of a hydrolipid film. If the camera chip gets into contact with this film, i. e. if you touch it with bare fingers, the chip becomes unusable.
» Do not touch the camera chip during assembly.
» Refer to the listing of the possible cleaning agents in SECTION 1.2.5.

---

3. Remove the protective caps from the video camera and from the lens.
4. Mount the lens on the video camera.
5. Screw the tripod adapter angle provided onto the video camera housing. To do so, use the four M3 x8 Allen screws provided as well as a size 2.5 mm Allen key.

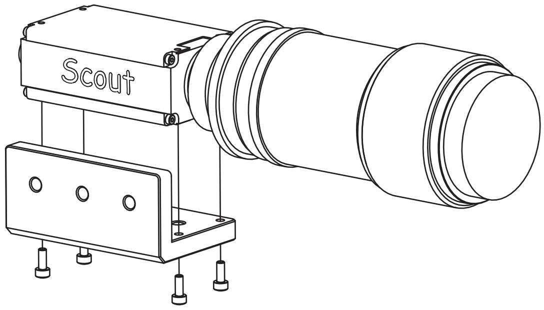


Figure A.5: Assembly of the tripod adapter angle

6. Remove the quick release plate from the geared head by simultaneously pressing the safety knob on the bottom side and moving the safety lever counterclockwise to the end position.
7. Screw the quick release plate onto the tripod adapter angle with the 1/4" camera screw.

INFORMATION

With the aid of the tripod adapter angle you can mount the video camera in different positions in portrait or landscape.

8. Use the quick release plate to position the video camera onto the geared head.

   The safety lever clicks into place automatically.

CAUTION!

Damage caused by unsecured quick release plate!

» Snap the quick release plate all the way round. Press the safety lever to the end position. Only then you can use the scanning head.

9. Ensure that the quick release plate is attached all the way around. Only then you can use the video camera.

A.2.4.2 Cabling

To connect the video camera, plug the IEEE-1394 cable (FireWire®) into the IEEE-1394 interface on the back of the video camera and into a free IEEE-1394 interface on the back of the PC.

A.2.5 Technical Specifications

A.2.5.1 General Data

Power Supply

Supply voltage:	8 V…36 VDC (via the IEEE-1394 interface)
Power consumption:	max. 2.5 W (@ 12 VDC)

Ambient Conditions

Operating temperature:	+5 °C…+40 °C (41 °F…104 °F)
Storage temperature:	−10° C…+65 °C (14 °F…149 °F)
Humidity:	max. 80%, non-condensing

Housing

Protection rating:	IP30
Dimensions (w x h x d):	Video camera without tripod adapter angle: 29 mm x 44 mm x 86 mm Video camera with tripod adapter angle: 37 mm x 53 mm x 88 mm
Weight:	Video camera without tripod adapter angle: 0.15 kg Video camera with tripod adapter angle: 0.28 kg

A.2.5.2 Optics

Video Camera

Sensor type:	Basler Scout scA1000-30fm - 1/3 inch, progressive scan CCD camera
Pixels:	1034 (H) x 779 (V)
Pixel size:	4.65 µm x 4.65 µm
Frame rate (at full resolution):	max. 30 frames/second
Video output signal:	Mono: 8 bit/pixel, IEEE-1394 compatible

Standard Lens

Lens:	F 1.4/f = 4.5 mm, (focus, iris; manually adjustable)
Angle of view (horizontal):	52°
Stand-off distance	approx. 200 mm…infinite
Weight:	54 g
Dimensions (w x h x d):	31 mm x 36 mm x 38 mm

Zoom Lens

Lens:	F 2.5/f = 8.5 ... 90 mm, (zoom, focus, iris; manually adjustable)	
Angle of view (horizontal):	@ wide end:	approx. 28°
	@ tele end:	approx. 2.8°
Stand-off distance with close-up lens:	approx. 180 mm ... 300 mm	
Stand-off distance without close-up lens:	approx. 300 mm ... infinite	
Weight:	504 g (with PSV-A-455 helium-neon block filter)	
Dimensions (w x h x d):	66 mm x 68 mm x 148 mm (with PSV-A-455 helium-neon block filter)	

A.3 PSV-A-HNeBF Block Filter (Only for PSV-500 Standard)

If the intensity of the laser light is too high the supplied helium-neon block filter should be mounted additionally. The block filter is screwed directly on the video camera aperture of the scanning head and reduces the intensity of the laser light back scattered to the video camera by 98%.

A.4 PSV-A-526 Protective Window

A.4.1 Introduction

The protective window covers the laser beam exit as well as the aperture of the video camera on the scanning head. Furthermore the protective window dampens the acoustic excitation of the scanner mirrors.

Metrological limitations

The protective window is not suitable for default use, because the use entail the following limitations:

- In the case of perpendicularly incidence of the laser beam to the protective window, the direct reflection of the protective window is mirrored to the detector of the vibrometer. Instead of the object under investigation, the vibration of the protective window is measured.
- The disturbed scan range depends on the focused stand-off distance. At a stand-off distance with less than 1 m, because of the direct reflection a centralized scan range of up to ±3° must be precluded from the measurement. For measurements with a stand-off distance of more than 1 m, the disturbed scan range is limited to ≤ ±1°. In this disturbed scan range, it is possible that also the autofocus is not working properly.
- Geometry measurements are not possible with mounted protective window.
- The scan area is limited to ±15°.
- When using the wide angle setting of the video camera a shading of the video image on the right edge occurs. The specified scan range of ±15° is visible in all stand-off distances on the video image.
- Depending on the scanning angle of the laser beam, a lateral displacement of the beam occurs. This can be widely compensated by carrying out the alignment with the mounted protective window.

INFORMATION

Soiling on the protective window will taint the measurement results. Thus the protective window has to be free of dirt and dust. Remove dust only with compressed air from an air duster. Remove dirt with a lint-free cellulose cloth and only use water-based or alcohol-based glass cleaner if necessary. Do not use any acidic or ammoniacal detergents.

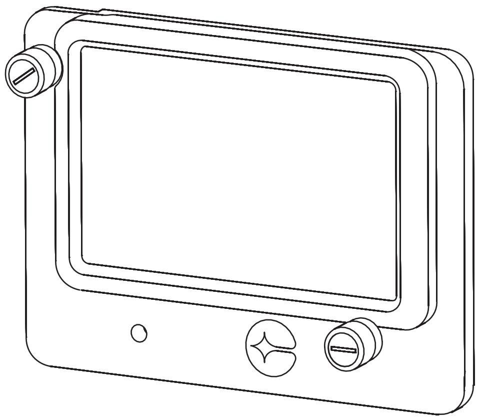


Figure A.6: Protective window

A.4.2 Assembly

For transport, the protective window is protected by a protective cover on the front side and with a plastic plate on the back side. To mount the protective window, proceed as follows:

1. Remove the plastic plate from the back of the protective window by undoing the two knurled screws (refer to the following figure, picture 1). Keep the plastic plate in a safe place.

ATTENTION!

Thread damage caused by overtightening the screws!

If you tighten the screws too firmly, you could damage the thread.

» Only hand-tighten the screws.

» Hand-tighten means: Tighten the screw firmly so that it can not undo itself. Do not use excessive force and avoid damaging the thread.

---

2. Fix the protective window on the front of the scanning head (using the two knurled screws (refer to the following figure, picture 2).

3. Remove the protective cover from the front of the protective window by undoing the knurled screws (refer to the following figure, picture 3). Keep the protective cover in a safe place.

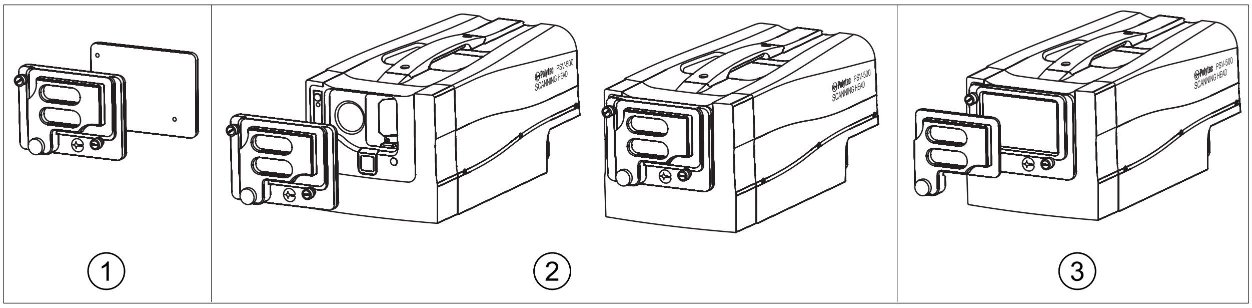


Figure A.7: Assembly of the protective window

A.4.3 Technical Specifications

Dimensions (w x h x d):	145 mm x 107 mm x 22 mm
Weight:	0.285 kg (without plastic plate and protective cover)
Max. scanning angle in y-direction:	± 15°
Max. scanning angle in x-direction:	± 15°
Stand-off distances:	from 0.5 m to 2 m
Suitable for wavelengths:	632.8 nm (PSV-500 Standard) 1 550 nm (PSV-500 Xtra)

A.5 Reference Object

The reference object allows high-precision 3D alignment of small objects. 30 reference points are marked with crosshairs on the reference object. Eight of these reference points are elevated on columns. For a high-precision 3D alignment, at least four points on the level as well as at least one point on one of the four columns have to be used. The reference object can be placed vertically or horizontally on a flat surface. Assembly on a tripod, which is available as an option, is possible using the hexagonal adapter plate. Refer to your software manual on how to carry out a 3D alignment using the reference object.

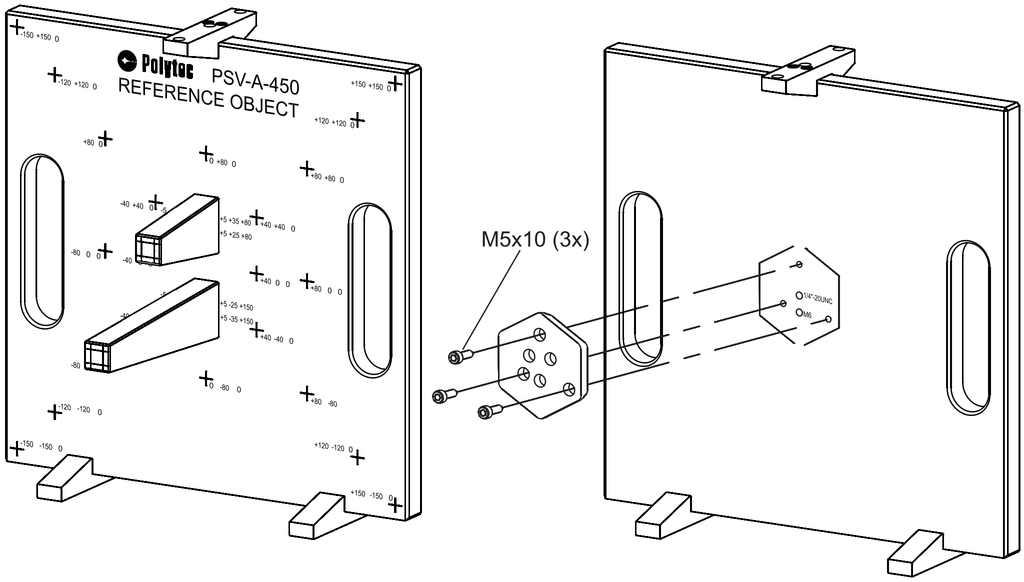


Figure A.8: Front view (on the left) and back view (on the right) of the reference object

A.6 EXT External Scanner Control

By default, in the scanning head the DAC output signals are connected directly to the control inputs of the scanners. If the scanning head is provided with the EXT option (external scanner control), the DAC output signals and the control inputs of the scanners are available at the OPTION jack. In this case the scanners only move if a voltage is created at the control inputs. The scanning angles are deflected according to the voltage applied to the control inputs. The voltages must be within the range of ±5 V. The relationship between applied voltage and the deflection angles is:

X-direction: ±5V correspond to ±26°

Y-direction: ±5V correspond to ±21°

Cabling

You have to assemble the provided 8-pin DIN circular plug before you can use the external scanner control. Plug the 8-pin DIN circular plug into the OPTION 8-pin circular jacks on the back of the scanning head.

If you want to operate the scanning head with EXT option (external scanner control) via the internal scanner control, plug the PSV-A-523 bridging plug into the OPTION 8-pin circular jack on the back of the scanning head.

The pin configuration of the provided 8-pin DIN circular plug is shown in the following figure as well as in the following table.

8-Pin DIN Circular Plug

Socket type: 8-Pin DIN Circular Plug
Manufacturer: Amphenol-Tuchel
Series: C 091 D

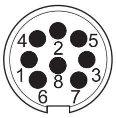


Figure A.9: Pin configuration of the 8-pin DIN circular plug (view: solder side)

Pin	Signal	Function
1	DAC GND Y	Reference potential, DAC output Y
2	DAC GND X	Reference potential, DAC output X
3	DAC OUT X	DAC X output signal (±5V DC)
4	- COMMAND Y	Differential control input –Y
5	- COMMAND X	Differential control input –X
6	+ COMMAND Y	Differential control input+ Y
7	+ COMMAND X	Differential control input + X
8	DAC OUT Y	DAC Y output signal (±5VDC)

PSV-A-523 Bridging Plug

You can use the internal scanner control with the scanning head with the EXT option. To do so, plug the PSV-A-523 bridging plug into the OPTION jack. The bridging plug connects the DAC output signals to the control inputs of the scanners. The wiring of the bridging plug is shown in the following figure.

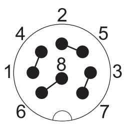


Figure A.10: Wiring of the bridging plug

Appendix B: Basics of the Measurement Procedure

B.1 Theory of Interferometric Velocity and Displacement Acquisition

Optical interference can be observed when two coherent light beams are made to coincide. The resulting intensity fluctuation, e.g. on a photodetector, varies with the phase difference φ between the two beams according to the equation

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

The phase difference φ is a function of the optical 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 equation f_D (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

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

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

B.2 Optical Configuration in the Scanning Head

In vibrometers from Polytec, velocity and displacement acquisition are carried out using a modified Mach-Zehnder interferometer.

The optical configuration in the scanning head is shown schematically in the following figure.

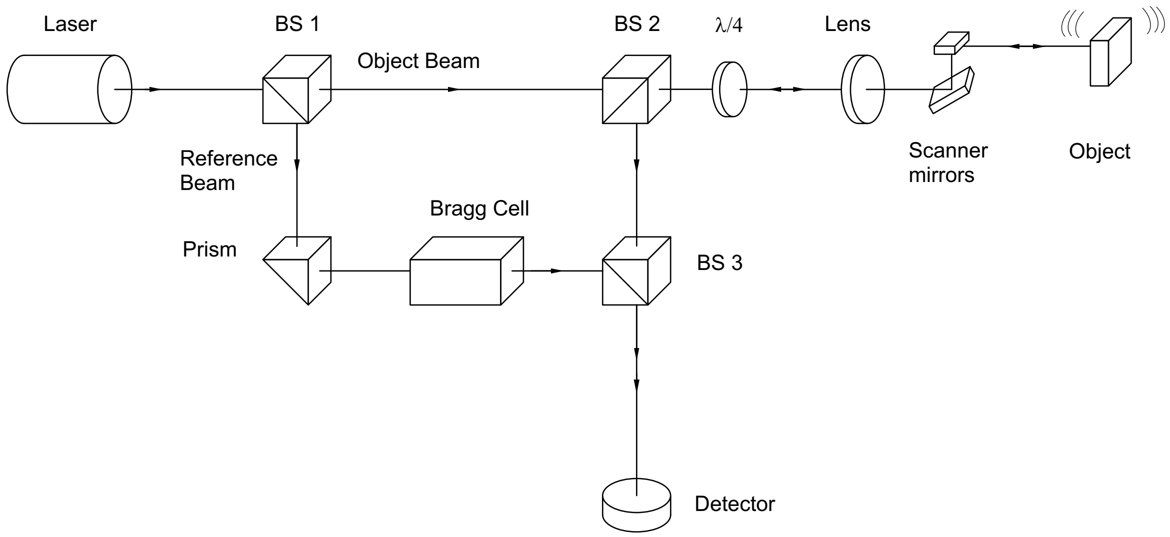


Figure B.1: Optical configuration of the interferometer in the scanning head

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

The object beam passes through the polarizing BS2 beam splitter as well as a $\lambda/4$ plate, is then focused by the lens on the object and scattered back from there. The polarizing BS2 beam splitter then functions as an optical directional coupler together with the $\lambda/4$ plate, and deflects the object beam to the BS3 beam splitter. The interference signal is created from the optical path difference between reference and laser beam. The distance to the object goes into the optical path difference with a factor of 2. As an option the objective displays the object on the camera. If the spot diameter on the object is minimal, the video image is sharply focused.

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

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

Appendix C: Declaration of Conformity

CE

Konformitätsbescheinigung / Declaration of Conformity

für / for

Gegenstand / Object :	**Scanning Vibrometer** **PSV-500-3D-H / PSV-500-3D-M** **PSV-500-3D-H Xtra / PSV-500-3D-M Xtra**
Frond-End Typ / Model :	**PSV-F-500-3D**
Junction Box Typ / Model :	**PSV-E-500**
Scanning Heads Typ / Model :	**PSV-I-500 / PSV-I-520 / PSV-I-560 / PSV-I-570**
Data Management System :	**PSV-W-500**

Der Hersteller / The manufacturer

Polytec GmbH
Polytec Platz 1-7
76337 Waldbronn / Germany

bestätigt das Einhalten der Richtlinien 2014/30/EU und 2014/35/EU
confirms the compliance with the directives 2014/30/EC and 2014/35/EC.

Das Gerät stimmt überein mit den folgenden Normen / The unit complies to the following standards:

EN 60825-1:2008-05	Sicherheit von Laser-Einrichtungen / Safety of laser products
EN 61010-1:2011-07	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte / Safety requirements for electrical equipment for measurement, control and laboratory use
EN 61326-1:2013-07	EMV-Anforderungen an die Störaussendung und Störfestigkeit – Elektrische Betriebsmittel für Messtechnik, Leittechnik und Laboreinsatz / EMC requirements on the Emission and Immunity – Electrical equipment for measurement, control and laboratory use Störaussendung / Emission : - **Grenzwertklasse: Klasse A / Class A** - **EN 61000-3-2, EN 61000-3-3** Störfestigkeit / Immunity : - **EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11**

Ausgestellt von / Issued by

Dr. Dietmar Gnaß
Managing Director
Polytec GmbH

Datum / Date
20.04.2016

Figure C.1: Declaration of conformity for the PSV-500-3D

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Numerics

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E

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