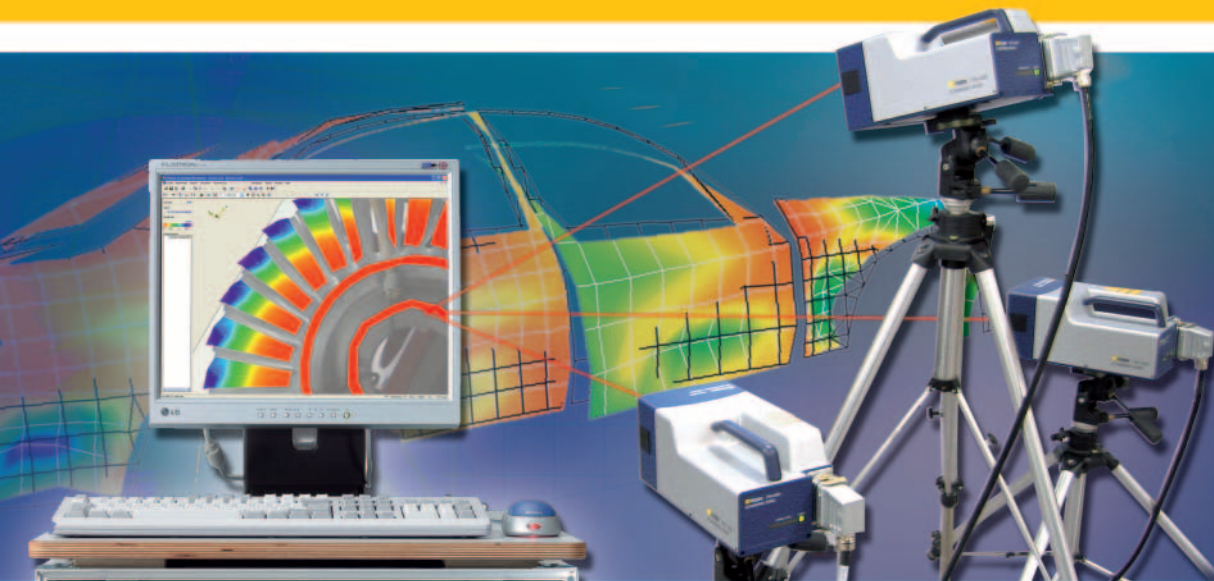**Polytec**

PSV-400-3D Scanning Vibrometer

Polytec Scanning Vibrometer

- ■ PSV-400
  Scanning Vibrometer
- ■ **PSV-400-3D**
  Scanning Vibrometer
- ■ MSA-500
  Micro System Analyzer
- ■ PSV Software
- ■ PSV-A-440
  Optical Derotator
- ■ RoboVib
  Structural Test Station

Acquire and Analyze Vibrations in Three Dimensions

Models to simulate structural vibrations must be validated using reliable experimental data. Three dimensional scanning laser vibrometry is a unique tool for test and simulation engineers to be able to quickly and very accurately determine operating deflection shapes and eigen modes of complex objects across a wide range of frequencies. Measurement data are reliable if they reflect the actual vibration characteristics of the real object. This is precisely what the non-contact method guarantees. With its advanced technology and high performance measurement, analysis and presentation software, the PSV-400-3D allows you to easily investigate solutions to complex structural dynamic issues in research and development.
www.polytec.com/psv3d

Non-contact Optical Technology
The PSV-400-3D extends one of the most revolutionary concepts of surface vibration measurement into the third dimension. Three laser-Doppler vibrometers make up the heart of all 3-D systems – high-precision optical sensors that measure vibrational velocity. They acquire vibrations from changes in the frequency of the light that is scattered back from a vibrating surface (Doppler effect). Apart from giving you the greatest precision, this process offers the security of a measurement method based on physical constants with minimal calibration requirements. More details:
www.polytec.com/vib-university

For Structures Ranging from Small to Large
Originally developed for measuring automobile and airplane structures and components, the 3-D scanning vibrometer has now become a universal measuring instrument. Making measurements on large structures is quick and simple – and can even be automated using robot support. Characterizing 3-D motion of millimeter-sized ultrasonics components is now possible with the new high frequency PSV-400-3D-M. Measurements can even be made on glowing hot, rotating or mechanically sensitive structures. Configurations are available with bandwidths of up to 1 MHz and measurement ranges of up to 10 m/s.

Advancing Measurements by Light

www.polytec.com

Faster and Better Product Development:
The 3-D Laser Vibrometer Advantage

Easy and Intuitive to Operate

Start a measurement with the PSV-400-3D in less than a couple of minutes. This is made possible by a quick setup, an intuitive definition of the measurement grid, clear step-by-step user guidance and a fully automated measurement.

Non-contact and Surface Independent

The system is non-contact, so there is no need to attach sensors or run cables. Vibrations are measured exactly as they occur, without any interference caused by the surface features. Measurements can be made accurately from large working distances with ease.

Geometry and Dynamics – The Entire Measurement Task in 3-D

The PSV-400-3D generates measurement grids with 3-D object coordinates imported from existing FE models. Alternatively, 3-D shape can be measured using the integrated Geometry Scan Unit. Measurement values and geometries are stored together in the same coordinate system and may be exported for comparison with FE model simulations. An advantage

over contact transducer methods is that precise correlation with FE node locations is guaranteed.

High Density of Points, High Frequencies – Precise Model Comparison

The sequential approach taken allows a virtually unlimited number of measurement points and thus a dense grid – a particular advantage for model comparison, where higher modes can also be used as reference. Even at high frequencies, it is still possible to get a good resolution of local modes.

Cost-effective and Seamless Integration into the CAE World

Combining fast measurements with process automation, 3-D laser vibrometry can reduce the time and personnel needed for structural analysis. Because it is no longer necessary to mount traditional sensors, up to 90% time savings can be achieved. The open system architecture simplifies data exchange processes, such as when exchanging geometries and measurement values. Thus, the PSV-400-3D fits seamlessly into the CAE world.
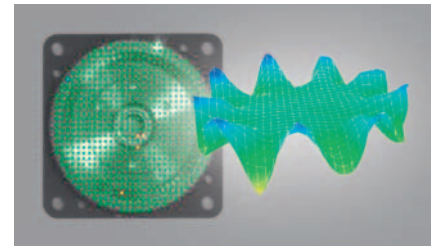
Ultrasonic Technology: Closely Tracking the Smallest Vibrations

Small ultrasonic actuators are being used in everyday devices and in medical technology. The high-frequency PSV-400-3D-M was developed to characterize such systems after the standard version had already established itself as a flexible measurement tool for structural dynamic measurement not only on aerospace and automotive structures, but also with hearing aids and in biology. This system is capable of measuring the dynamic properties of these actuators up to 1 MHz, supplemented by dedicated accessories and an image processing method to ensure a positioning accuracy of the three lasers to ±0.1 mm.

More Info: **www.polytec.com/psv3d**

Automate your Test Results: RoboVib

The RoboVib Structural Test Station combines two cost-effective technologies: the PSV-400-3D Scanning Vibrometer and a high precision industrial robot. RoboVib allows a particularly high level of testing efficiency through integration into the CAE workflow, automation of repeated tests, minimization of costs and time per test, and an overall increase in capacity utilization of the test lab resources. The test sequence is initially set out in the simulation program based on FE geometry data. Then you can really get going: position the object, align the coordinate system, start the measurement – RoboVib will automatically work throughout the entire test process. If desired, it will scan overnight, freeing up the test lab for new tasks the next day.

More Info: **www.polytec.com/robovib**

Applications: Anything that Vibrates

Image: DSTO. Used with permission
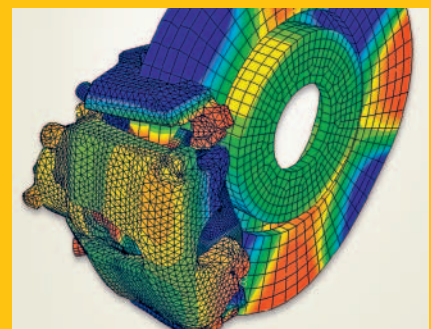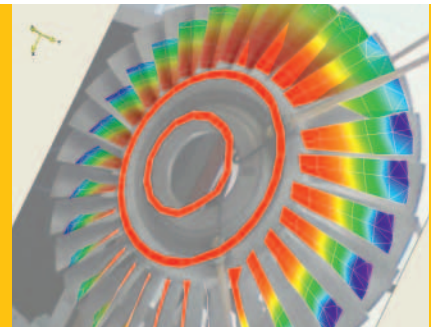
The PSV-400-3D Scanning Vibrometer is the ideal tool for three-dimensional vibration measurement across all industries and areas of research. As a versatile and user-friendly system that can be quickly integrated into design processes, it acquires data for modal analysis on a vehicle chassis just as easily as for non-destructive testing on a fiber composite. The number of applications grows daily as the enabling features and benefits of this non-contact measurement technology are discovered.

Automotive Development

- Experimental modal analysis for cars and components
- Acoustic optimization on brakes, tires, interior surfaces, etc.

Particular advantages: efficient, can be automated, MIMO-capable, independent of surface, interfaces to CAE and modal analysis.

Materials Research and Engineering Technology

- Measurement of energy harvesting transducers and structures, smart structures
- Structural health monitoring, non-destructive parameter and damage assessment, Lamb wave propagation

Particular advantages: versatile, wide frequency range, high time-resolution and point density.

Ultrasonic Applications

- Characterization and optimization of ultrasound transducers, ultrasonic actuators, sensors, tools, motors, etc.
- In product engineering, medical technology and car construction (e.g. distance sensors)

Particular advantages (PSV-400-3D-M): wide bandwidth, very precise measurement point localization, versatile accessories for small samples.

Aviation and Aerospace Industry

- Construction testing and structural dynamics of airplane and space travel components

- Examination of material fatigue and defects

Particular advantages: no mass influence on light structures, temperature insensitive, measurements in a vacuum possible.

Electronics and Data Storage

- Dynamic testing and vibration analysis, e.g. of read-write heads in hard disk drives
- Environmental testing – analysis of weaknesses on printed circuit boards and components in automobile and airplane electronics
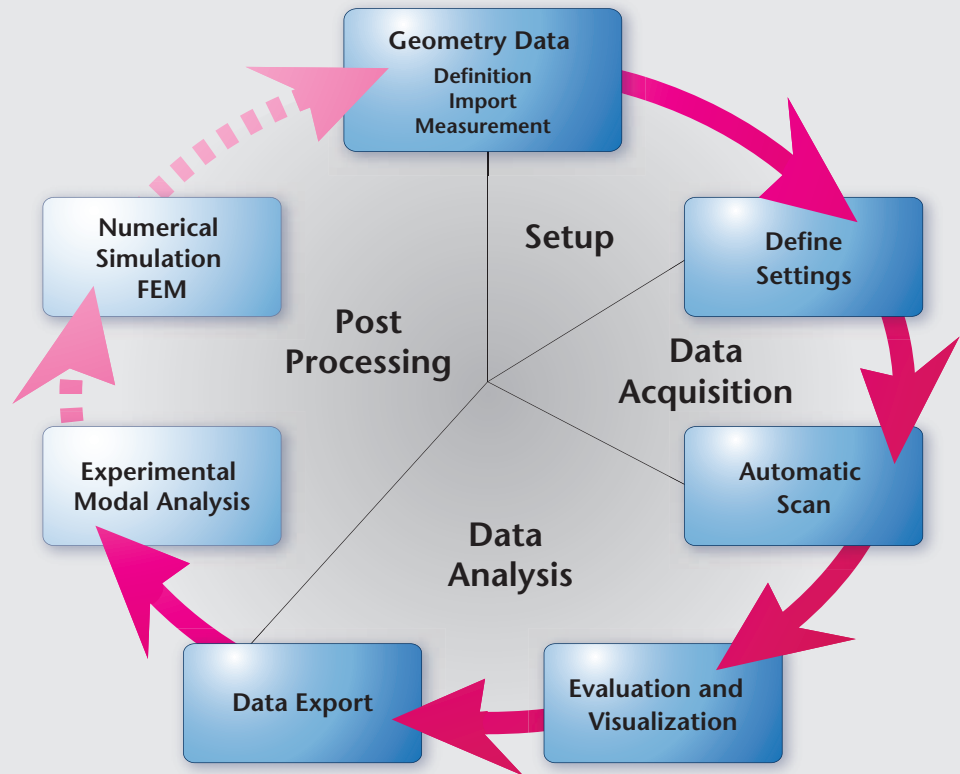
Particular advantages: extremely small measurement volume, separation of relative movement between components, high measurement bandwidth.

More Info: **www.polytec.com/applications**

3-D Scanning Vibrometer Technology – Measurements for Today and Tomorrow

The PSV-400-3D Scanning Vibro-meter comprises three scanning heads, each with an integrated laser interferometer, scanner and video camera, an instrumentation cabinet with a central computer and three data acquisition and control units, one for each scanning head. The scanners and data acquisition are controlled and synchronized by the high performance PSV software. State-of-the-art 3-D graphics are used to visualize the dynamic pro-cesses, even allowing 3-D animated solids with textured surfaces.

Geometry Data
Definition
Import
Measurement

Numerical
Simulation
FEM

Setup

Define
Settings

Post
Processing

Data
Acquisition

Experimental
Modal Analysis

Data
Analysis

Automatic
Scan

Data Export

Evaluation and
Visualization

Open-Minded

Due to its open system architecture, the PSV-400-3D Scanning Vibrometer is a powerful data acquisition platform that can be seamlessly integrated into engi-neering workflows and the IT environ-ments. The system provides input inter-faces for geometry data from CAE and FEM packages or from the convenient Geometry Scan Unit. All data are avail-able to third party applications through various export filters and PolytecFile-Access, an open data interface.

PSV Software includes a high perfor-mance signal analysis module which allows post processing of the measure-ment data with numerous mathemati-cal operations. With the aid of the inte-grated Visual Basic® compatible Scripting

Engine, it is possible to program and control the PSV system using external applications or process control systems.

Optimally Configured for Current and Future Tasks

Your intended application determines the requirements for frequency band-width, measurement range and number of measurement channels. The 3-D Scan-ning Vibrometer can be configured in two versions: one suitable for the acoustic and low ultrasonic range (PSV-400-3D)

and the other suitable for the high ultra-sonic range (PSV-400-3D-M). High per-formance data acquisition boards, signal generators and software functions can be individually configured to suit every task. Frequencies from near DC to 1 MHz and vibrational velocities of <0.01 µm/s to 10 m/s can be measured. With the right hardware and software accessories, measurements with the PSV-400-3D Scanning Vibrometer are even easier and more effective (p. 7).

PSV-400-3D Configurations				
Model	Description	Number of channels	Frequency range	Max. velocity
PSV-400-3D	For structural dynamics and acoustics	8	80 kHz	10 m/s
PSV-400-3D-M	For high frequency (ultrasonic) dynamics	4	1000 kHz	10 m/s

Making Measurements
with the PSV-400-3D is Simple

Operating the PSV-400-3D is intuitive and simple to use in comparison with traditional multi-channel contact transducer methods. Set up the system, define geometry and measurement grid – and you are all ready to make your measurement. More Info: www.polytec.com/psv3d

Interactive Setup

User-friendly drawing tools help you define the shape, orientation and point density of the grid on the video image of the object. Absolute geometry can either be read in from CAE/FEM files or can be measured directly on the object under investigation using the Geometry Scan Unit. The preferences for bandwidth, frequency resolution, vibration excitation and channels are simply defined in a dialog. The PSV only requires one setup for all measurement points. Settings that have been saved from previous measurements can be loaded by a simple mouse click from the project browser. The signal generator controlled by the PSV software ensures precisely defined vibration excitation.

Quick Scan

The laser beam automatically scans the whole grid and makes a vibration measurement at each of the predefined points. While doing so, the laser is always optimally focused; the signal-to-noise ratio is permanently monitored and optimized. During the scan, the time responses and frequency spectra of the vibrometer and reference signals are displayed.

In the case of broadband excitation, the PSV-400-3D records the complete spectrum for every measurement point and all deflection shapes of the measurement surface.

The FastScan mode enables deflection shapes to be determined in the shortest possible time (hundreds of measurement points in a few seconds).

Perfect Visualization

The PSV software package provides an informative animation of the vibrations measured. The deflection shapes can be color-coded as 2-D or 3-D graphics for display purposes. Frequencies of interest can be easily selected from the spectra using a cursor. The video image itself can be animated in 3-D to show exaggerated, lifelike motion of the structure. Animated profile slices also help you to understand the vibration in detail. Response to transient events can be shown in high resolution slow motion by using time domain animation*. For every individual measurement point, the pertinent spectra, transmission functions, coherence and time signals* are available for analysis. The graphics and animations can be easily used in impressive reports and presentations.

Flexible Analysis

The Polytec signal processor is a high performance analysis tool similar to a spreadsheet which makes numerous mathematical and statistical operations available for individual pieces of data or whole data sets. Data from other sensors can be simply imported and linked to the vibrometer data. Using standardized export filters or the Polytec-FileAccess open interface, external software packages or your company's internal software can access the measurement data for modal analysis, sound field or power flow calculations.
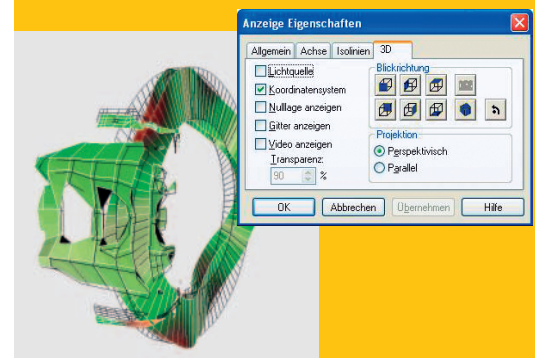
*As an option/with optional accessories
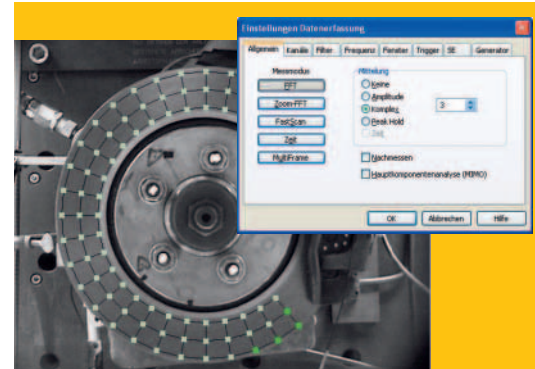
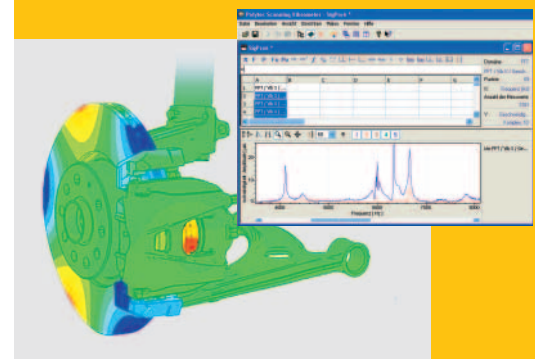**Measurement grid in live video image**
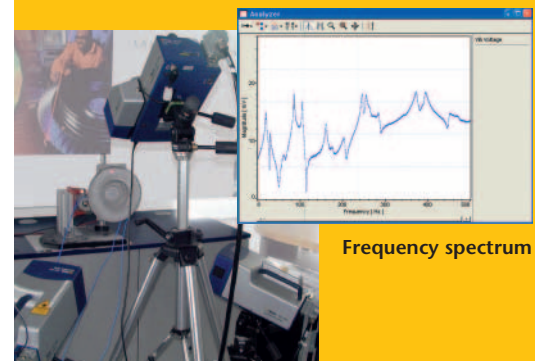
Frequency spectrum

Measurement on a brake disk

3-D Animation

Signal Processor

Simulated mode

Technical Data

Delivery Contents	
Vibrometer system	■ Three OFV-5000 Vibrometer Controllers, equipped with digital velocity decoders ■ Three PSV-I-400 Sensor Heads. Each head is composed of an OFV-505 Vibrometer Sensor, a precision scanner and a color video camera with autofocus and 72X zoom, and comes with a transportation case ■ PSV-E-401-3D/PSV-E-408 Junction Box with 3 PSV-CL-10 main cables, 10 m
Computer	■ PSV-W-402 Data Management System ■ Industrial PC with Windows® XP or Vista 64, Gigabit Ethernet, data acquisition hardware ■ 24" Wide screen monitor, DVD writer, optical mouse and keyboard
Accessories	■ VIB-A-T02 Tripod with tip-tilt adapter ■ PSV-Z-051 Handheld remote for control of the scanners ■ Mobile 19" rack mount cabinet for electronics with worktop and cable storage

Additional components depend upon PSV model and configuration.

Technical Specifications

Optics		
Component	PSV-I-400 Sensor Head	PSV-A-420 Geometry Scan Unit with PSV-I-400
Dimensions [W x L x H]	190 mm x 376 mm x 163 mm (7.5 in x 14.8 in x 6.4 in)	238 mm x 382 mm x 163 mm (9.4 in x 15 in x 6.4 in)
Weight	7 kg (15.4 lbs)	7.6 kg (16.8 lbs)
Laser type	HeNe laser (633 nm)	Laser diode (620…690 nm)
Laser safety class	Class 2 (<1 mW visible output)	Class 2 (<1 mW output)
Working distance	0.35 m … ~5 m	
Sample size	from few mm² to several m²	
Camera	Color video camera, CCD 1/4", 752 x 582 pixels, with Auto Focus and 72X zoom (4X digital, 18X optical). Optional: External digital camera, 1034 x 779 pixels, monochrome, with 1/3" C-mount macro zoom, 8.5 mm … 90 mm, minimal working distance: 178 mm; minimum field-of-view: 6 mm x 8 mm	
Scanner	High precision scan unit (scanning range ±20° about X,Y); angular resolution <0.002°, angular stability <0.01°/hr	
Scan speed	30 points/s (typical)	

Data Acquisition/Data Processing			
Component	OFV-5000 Vibrometer Controller	PSV-E-401-3D Junction Box	PSV-E-408 Junction Box (not for PSV-400-3D-M)	PSV-W-402 Data Management System
Dimensions [W x L x H]	450 mm x 360 mm x 150 mm (17.7 in x 14.0 in x 5.9 in)	450 mm × 360 mm × 135 mm (17.7 in x 14.0 in x 5.3 in)	482 mm × 303 mm × 23 mm (19.0 in x 11.9 in x 0.9 in)	450 mm x 550 mm x 190 mm (17.7 in x 21.7 in x 7.5 in)
Weight	10 kg (22.0 lbs)	9 kg (19.8 lbs)	1.5 kg (3.3 lbs)	18 kg (39.7 lbs)

General Specifications	
Power	100 VAC …240 VAC ±10 %, 50/60 Hz; overall max. 800 W
Environmental conditions	Operating temperature: +5 °C … +40 °C (41 °F … 104 °F); storage temperature –10 °C … +65 °C (14 °F … 149 °F); relative humidity: max. 80%, non-condensing
Calibration	Every 24 months

PSV-400-3D Decoder/Performance Specifications						
Model	Decoder[1]	Number of ranges	Ranges mm s^{-1}/V	Full scale (p) m/s	Max. decoder frequency	Resolution[2] µm s^{-1} /√Hz
PSV-400-3D	VD-08	8	0.2 … 50	0.002 … 0.5	5 kHz … 25 kHz	<0.01 … 0.2
	VD-09	8	5 ... 1000	0.05 ... 10	100 kHz ... 2.5 MHz	0.01 ... 4
PSV-400-3D-M	VD-07	6	1 ... 50	0.01 ... 0.5	20 kHz ... 350 kHz	<0.02 ... 0.2
	VD-09	8	5 ... 1000	0.05 ... 10	100 kHz ... 2.5 MHz	0.01 ... 4

1) Modular system: more decoder combinations and additional decoders on request

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 on 3M Scotchlite Tape® (reflective film). The attainable resolution is frequency-dependent and is specified for frequencies above 10 Hz

PSV-400-3D Data Management System		
Version	PSV-400-3D	PSV-400-3D-M
Number of channels	■ 3 Vibrometer channels ■ 5 Reference channels	■ 3 Vibrometer channels ■ 1 Reference channel
Acquisition bandwidth	80 kHz	1000 kHz
Resolution	24 bit	12 …16 bit (depends on bandwidth)
Sensor supply	4 mA /24 V IEPE compatible	4 mA /24 V IEPE compatible
Signal generator channels	4 (uncorrelated for MIMO measurements)	1
Bandwidth	80 kHz	500 kHz
Resolution	12 bit	16 bit

Compliance with Standards	
Electrical safety	IEC/EN 61010-1: 2002-08
EMC	IEC/EN 61326-1:2006-10; Emission: FCC Class B, 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
Laser safety	IEC/EN 60825-1:2003-10 (CFR 1040.10, CFR 1040.11)

Laser Radiation
Do not stare into beam
Class 2 Laser Product
According to EN 60825-1 (2001)
P ≤ 1 mW/cw; λ = 620-700 nm

PSV-400 Hardware Accessories	
PSV-A-MIR / PSV-A-MIR+ Mirror Set	Mirror set for measurements in difficult to access areas. The mirror set comprises 4 (MIR+: 5) high-quality coated mirrors plus magnetic base mirror holders
PSV-A-PDA Remote Control Unit	Wireless remote control unit for beam positioning, focus adjustments, teaching of scan points and others
PSV-A-430 Acoustic Gate Unit	Activates the gate input if a noise exceeds a certain threshold (e.g. for enabling brake squeal measurements)
PSV-A-T31 Tripod System	For quick and easy positioning of the three PSV-I-400 Sensor Heads

PSV-400-3D-M Accessories for Ultrasonic Measurements	
A-CAZ-1000 External Video Camera	External digital camera with macro zoom lens allows high-precision measurement point definition on small samples
PSV-S-TRIA Optimizing 3-D Geometry	Image processing software option to optimize the point geometry and the accuracy of measurements
PSV-A-450 Alignment Sample	Reference object supporting a precise 3-D alignment of the sensor heads. Precisely machined and marked reference points with known coordinates and a well balanced distribution of these marks in 3-D space allow a well defined basic alignment of the PSV measurement system. Thus spatial accuracy is well improved
PSV-A-T34 Near-field PSV-3D Stand	Rigid support for 3 PSV-I-400 scan heads. The angle between the scan heads is optimized and balanced for resolution of all vibrational components (in-plane and out-of-plane). Support for A-CAZ-1000 central digital camera
A-MIR-2030 Mirror Set	Special front coated mirror, includes a magnetic stand for flexible positioning. Allows measurements on areas with no direct optical access. Combined with the PSV-A-T34 Near-field Stand the mirror enables vertical measurements

RoboVib Structural Test Station – typical examples of sample size and measurement area			
Robot	Linear Axis	Max. Object Size (L x D x H)	Measurement
KUKA KR-140	KL1500 (5.0 m)	6.0 m x 1.1 m x 2.2 m	of front, top, laterals (approx. half of a passenger car)
KUKA KR-60	none	0.5 m x 0.5 m x 0.5 m 3.0 m x 0.5 m x 0.5 m	from 5 sides from one side and top

Please find more detailed information about the RoboVib Structural Test Station on www.polytec.com/robovib

Software Features and Options

Setup		● Standard ○ Option
APS Professional	For arbitrary definition of measurement points and individual object properties	●
Geometry Data Import	Geometry Module for importing geometry data to the PSV software for defining the scan points	●
Signal Generator	Signal generator for vibration excitation	●
Measurement		
High Resolution Scan	Software extension to allow a high-resolution 512 x 512 point density for each object	●
FastScan	Fast scan routine (up to 30 scan points/s) for analyzing the response of structures at a single frequency	●
Time Domain Data	Time domain data are acquired while scanning The data can be averaged and animated during acquisition	○
Zoom FFT	Significantly increases frequency resolution for selected frequency bands	○
Extended FFT Lines	Various options to extend the number of FFT lines up to 819,200	○
Multi Frame	For triggered measurements on combustion engines	○
Analyze		
Signal Processor	The user interface to the math library included in the PSV software, designed as an easy-to-use spreadsheet	●
Principle Component Analysis	For MIMO measurements. Not available for PSV-400-3D-M	○
Data Export to ME'scope	Data export to Vibrant's ME'scope modal analysis software	○
ME'scope Modal Software	Software package for modal analysis by Vibrant. For extracting of modes and modal parameters from PSV data, including data interface	○
Desktop Analysis Version	Desktop version of PSV Software for post processing and presentation of measurement results, without data acquisition feature. Available as single or network license	○
Maintenance Packages		
Software Maintenance Basic	Basic software maintenance included in the system for a duration of 1 year	●
Extendend Software Maintenance	New releases of the software are provided free of charge for an additional period of 12 months	○
University Program	This special software maintenance for universities and colleges entitles to a constant update of the software package purchased with the measurement system. New releases of the software are provided free of charge during the lifetime of the system	○

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For more technical information and applications of the PSV-400-3D Scanning Vibrometer please contact your local Polytec sales engineer or visit our website at **www.polytec.com/psv3d**

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