PSV-400-3D *Scanning Vibrometer*

POLYTEC SCANNING VIBROMETERS

- PSV-400 Polytec Scanning Vibrometer
- **PSV-400-3D Scanning Vibrometer**
- MSV-400 Microscope Scanning Vibrometer
- PMA-400 Planar Motion Analyzer
- MMA-400 Micro Motion Analyzer

NON CONTACT 3-D VIBRATION MAPPING

The new Polytec PSV-400-3D Scanning Vibrometer is the perfect measurement instrument for gathering 3-dimensional vibration data from both simple and complex structures. The flexibility of the system, the intuitive and highly productive user interface and the short measurement cycle (from planning to presentation of results) contribute significantly to a reduction in product development time and expense.

Key Features

- Rapid setup and fast, non-contact 3-dimensional measurement technique
- Complete acquisition of the optically accessible 3-dimensional vibration vectors
- Scan mesh predefined (after importing geometry data) or interactively created
- Simultaneous measurement using 3 independently oriented sensor heads
- High spatial resolution
- Simple sensor-to-object alignment
- Intuitive 3-D animation of the measurement results
- Clearly displayed separation of Out-of-Plane and In-Plane vector components

Advantages of Laser Scanning Vibrometers

With outstanding bandwidth, high sensitivity, zero mass loading and a sub millimeter-sized probe, Polytec's laser vibrometers have significant technical and tactical advantages over mechanical accelerometers and acoustic microphones.

By integrating a single-point laser vibrometer with a dual-axis scanning mirror, Polytec exploits the advantages of using light as the probe. This device, known as a Scanning Vibrometer, samples a specimen's vibration pattern with a reconfigurable sensor mesh composed of many spots of light.

Polytec's recently developed PSV-400-3D extends the power of scanning vibrometry by measuring the vibration vector's tri-axial components at each sampling point on a structure's surface.

FIELD OF APPLICATION

Long before the first prototypes are built, mechanical and structural engineers rely on mathematical models to predict the vibration characteristics of products in design. Accurate models help produce designs that increase product safety, reduce engineering and manufacturing costs, expedite time-to-market, extend product reliability and simplify construction.

Engineers can use Polytec's PSV-400-3D scanning vibrometer to quickly and easily measure the real vibration characteristics of prototypes and preproduction products. These measurements help refine and adjust the model narrowing the difference between predicted and the experimentally measured outputs and building confidence in the model for future predictions.

Principle of Operation

A single laser vibrometer measures the projection of the sampling point's velocity vector along the vibrometer's optic axis. By using three independent vibrometers co-aligned to the same sampling point but at different interrogation angles, the complete 3-D velocity vector at that point can be determined.

Polytec has extended this principle in the design of a new scanning 3-D laser vibrometer, the PSV-400-3D. By using three PSV Scanning Vibrometers, vibration velocity measurements are made simultaneously from three different directions at each respective sampling point. The three sensors are controlled centrally by Polytec's PSV measurement and control software.

Performing a typical measurement involves these simple steps:

- Position the sensor heads in front of the object to be measured
- Align (train) to the target
- Define the sample points on the object
- Set the data acquisition parameters
- Start the scan
- Evaluate and/or export the data

Performing a Measurement

The following section demonstrates the procedure using a brake disk as the test structure.

Aligning to the target

The PSV-400-3D needs to know the position and orientation of the three sensor heads relative to the target. This is done by the operator targeting the three PSV-400-3D probe beams on to between four to seven known points on the target object, and then entering the corresponding coordinate values.
Once entered, the PSV-400-3D calculates the position and orientation of each sensor head.

Defining the sample points

The PSV-400-3D allows individual sample points to be defined directly from the live video image. Alternatively, the operator can import an externally created geometry model that has been saved in Universal File Format. Once defined, the scan grid can be superimposed on the test sample as shown in Fig. 1.

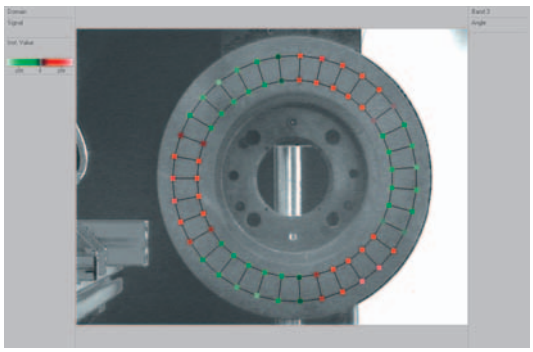


Figure 1:
Scan points on the test object. All points are accessible from a single sensor position.

Scanning the sample

Prior to the measurement, the object being characterized must be stimulated to establish sufficient vibration in the specimen. In the present example, a hammer was used to strike periodically at the brake disk. Following each strike, the vibrations of one sample point at a time are measured by the sensor heads.
In combination with the reference signal reflecting the excitation force, the full frequency response is revealed.

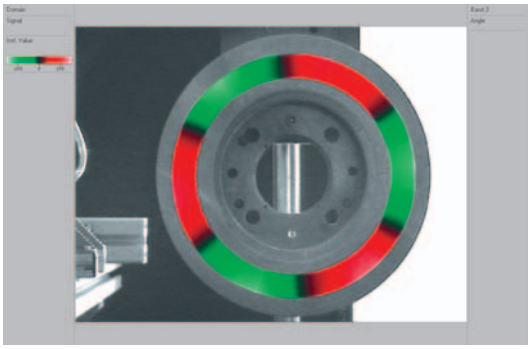


Figure 2:
2-D color representation of deflection in the Z-axis direction at 2063 Hz.

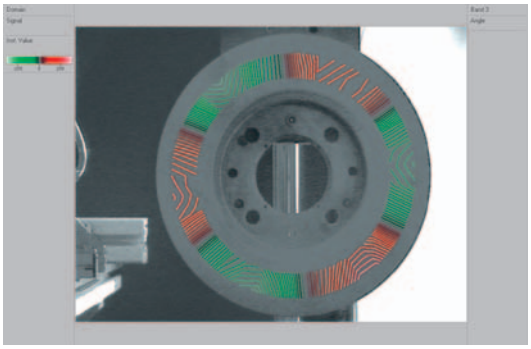


Figure 3:
Isoline representation of deflection in the Z-axis direction at 2063 Hz.

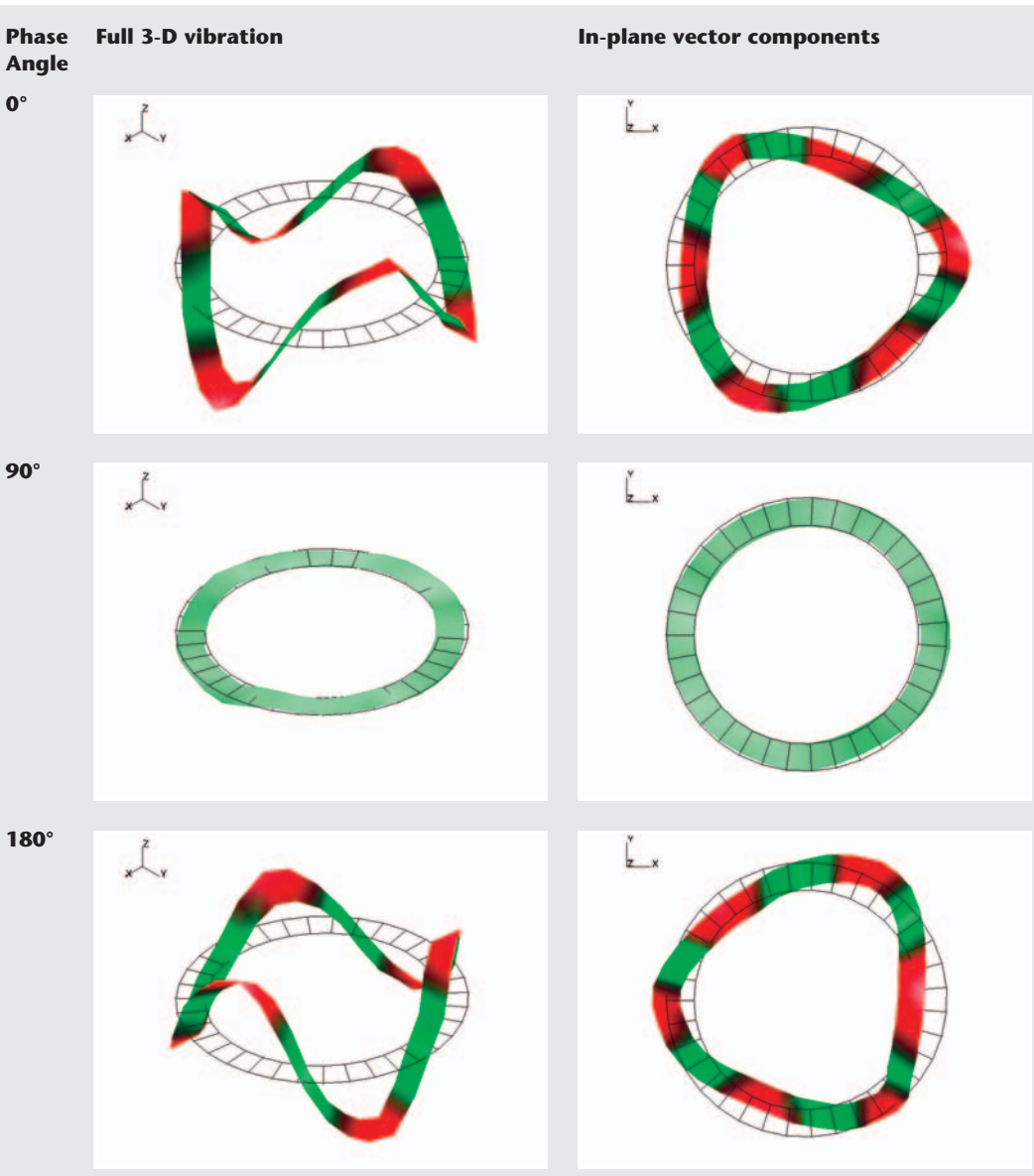


Figure 4:
Frames at different phase angles of the data animation sequence show the 3-D representation of vibration data measured on the brake disk at 2063 Hz.

Evaluating and exporting data

After the measurements have been made, the data can be evaluated in the PSV presentation mode. Operating deflection shapes (ODS) of the vibrating object can be presented as an animation with several viewing options. Each component of the vibration vectors can be simply represented as a two-dimensional color map (Fig. 2) or a set of isolines (Fig. 3). A particularly powerful feature is the 3-D representation where the vibration data along the X, Y, and Z axes are presented either simultaneously or seperately (Fig. 4).

Additional presentation and analysis options are made available by exporting the structure geometry and the measurement data in the Universal File Format (UFF) for further processing by popular third-party software packages like ME Scope, LMS and IDEAS.

SUMMARY

Polytec's PSV-400-3D offers engineers many new and exciting options for vibration measurement and modal analysis. It is a vital diagnostic tool for structural and mechanical engineers using FEM to develop new products.

Based on the outstanding PSV-400 1-D Scanning Vibrometer, the new instrument acquires and displays 3-D modal data while retaining the proven reliability of its predecessor. Designed for convenience and ease of use, the PSV-400-3D has the ability to scan predefined measurement grids and to simultaneously record vibration vector components at each sample point.

The geometry model import feature and the UFF measurement data export feature combine to simplify and enhance the relationship between product design, finite element modeling and actual structural measurements.

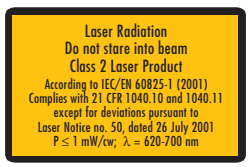
PSV-400-3D Technical Data

System Specifications	
Frequency range	0 kHz … 80 kHz
Velocity range	0 m/s … 10 m/s
Working distance	> 0.4 m
Laser wavelength	633 nm (red)
Laser protection class	Class II He-Ne laser, 1 mW per sensor, eye-safe
Sample size	1 mm^2 to several m^2
Scan grid	Multiple grid densities and coordinate systems (polar, cartesian and hexagonal) each with up to 512 x 512 points combined in one scan

PSV-400-3D Software Features	
3-D Alignment	▪ The laser beams are matched to 4 to 7 known points of the object geometry ▪ Using the above information, the system calculates the sensor head positions relative to the coordinate system of the test object
Scan grid definition	Two methods available: ▪ Manual, interactive definition in the live video image by the Advanced Point Selection (APS) Professional utility ▪ Data import from CAD and FEM systems via Universal File Format (UFF)
Sensor control	Simultaneous control of all three sensor scanning units
Controller operation	Parallel operation of all three Vibrometer Controllers with identical parameters
Data acquisition	▪ Simultaneous data acquisition from 4 channels (3 vibrometer signals, 1 reference signal) ▪ Digital filtering and averaging ▪ Triggers: external, analog, pre- and post trigger
Data quality	Speckle Tracking and continuous assessment of the S/N ratio in order to improve data quality by Signal Enhancement (number of samples used for averaging depends on signal quality)
Target data	▪ Vibration components in Cartesian coordinates in the coordinate system of the test object ▪ Raw vibration signal from each respective vibrometer ▪ Velocity (measured), displacement (calculated) and acceleration (calculated) can be displayed ▪ Digital filtering and averaging ▪ Data saved as frequency spectra (standard) or time signal (optional) ▪ Calculation of the transfer functions between reference signal and primary signal
Data representation	▪ Perspective view of the test sample's 3-D geometry: zero position of the object represented by a wire frame; sample motion represented by a colored 3-D surface model of all three vibration vectors simultaneously ▪ Animated representation of the vibration data as deflection from zero position and color code; provides a three-dimensional impression of the vibration ▪ 2-D or 3-D representation of each vibration component (X, Y, Z) ▪ Display of spectra or time signals for single measurement points
Data export	▪ Windows Automation Interface: Polytec File Access (enables data access utilizing Visual Basic® or C++) ▪ Export of geometry data, spectra, time signals and deflection shapes as ASCII files (Microsoft Excel compatible), UFF (both standard) or ME'Scope format (optional) ▪ Export of animated 2D- and 3D-models and profiles as an AVI file
Data import	Import of geometry data from UFF or ME'Scope files

PSV-400-3D Hardware	
PSV-I-400 Sensor Head	▪ Three independent sensor heads are used for 3-D mode ▪ High precision dual-axis scan unit (scanning ranges ± 20°); angular resolution < 0.002°, angular stability < 0.01°/hr ▪ High sensitivity OFV-505 vibrometer sensor ▪ Color video camera with Auto Focus and 72X Zoom (4X digital, 18X optical) ▪ Working distance > 0.4 m
OFV-5000 Vibrometer Controller	▪ Three Controllers are used in the system (one for each measurement head) ▪ 8 velocity ranges: 0.2, 0.5, 1, 2, 5, 10, 20, 50 (mm/s/V) ▪ 3-D Mode bandwidth: 0 kHz … 80 kHz; OFV-5000 output bandwidth: 1.5 MHz ▪ Four analog low pass filters: 5 kHz, 20 kHz, 100 kHz and 1.5 MHz (3dB point) ▪ RS-232 interface for remote control by the Data Management System
PSV-E-400 Junction Box	Interface between PSV-I-400 Sensor Heads, OFV-5000 Vibrometer Controllers and PSV-W-400-3D Data Management System ▪ Input for 4 analog signals, triggers and gate available on BNC connectors, ICP® compatible ▪ Output for signal generator available via BNC connectors
Central video camera	Monitors along the measurement axis (optional)
PSV-W-400-3D Data Management System	State-of-the-art rack-mountable industrial PC equipped with: ▪ DVD Recorder ▪ 17" LCD Display ▪ 100 MB Ethernet network connection ▪ Four-channel data acquisition card for vibration frequencies up to 80 kHz ▪ Internal signal generator providing various excitation signals according to current PSV software ▪ Communication with the Vibrometer Controllers via Junction Box using USB interface ▪ Operating system Windows® 2000 or Windows® XP Professional (German, English and Japanese versions available)
Tripod	On request
Systems cabinet	Integrates Vibrometer Controllers, Junction Box and Data Management System Includes castors and lockable covers for transport/storage
Cable set	Connects Sensor Heads, Vibrometer Controllers, Junction Box and Data Management System

For more information, please contact your local Polytec application/sales engineer.



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