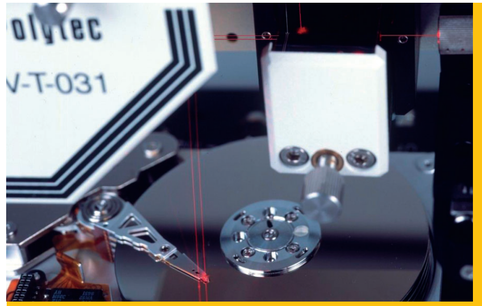
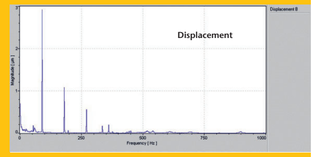


Stable flying heights for a disk drive head are determined with a digital LDV

VibSoft-VDD provides an FFT function for switching from time to frequency domain. The repetitive spindle runout (RRO) is obvious in the frequency domain.



Applications

The VDD PC-Based Digital Vibrometer is an excellent tool to characterize very small dynamic displacements. Both researchers and engineers use the large bandwidth, flat response and fine resolution to measure displacement in applications where traditional analog vibrometers lack sufficient resolution. A few of these situations are described briefly in what follows.

Runout Testing of Precision Spindles

The hard disk drive (HDD) industry requires higher density storage in each successive product generation. With track densities approaching 250,000 TPI, a HDD manufacturer must control spindle runout so that tracking isn't lost. The VDD Digital Vibrometer can measure data that allows the calculation of both the repetitive runout (RRO) and non repetitive runout (NRRO) with the fine precision necessary to verify the tight tolerances needed (NRRO <5 nm). The low noise (high resolution) of the digital LDV between DC and 20 kHz enables this application. The acquired data is easily transferred to a computer for proprietary RRO and NRRO analysis.

Frequency Response Measurement

Frequency response testing on actuators and head gimbal assemblies (HGA's) has traditionally relied on data from a LDV processed by a 2-channel FFT analyzer. With the VDD, Polytec provides a complete solution that eliminates the cost of an external spectrum analyzer and improves the resolution of the measurement. Measuring the resonance response of a part has never been easier.

Slider Displacement Development

HDD researchers are interested in the precise, time-domain displacement history of a slider. The off-track motion of the slider is very small. For real time measurements, a high resolution analog decoder is often the best choice, but when even higher resolution is required, the post processed digital output is the only alternative. A digital vibrometer reduces signal-to-noise by one or two orders of magnitude compared to analog vibrometers and can easily detect the motion.

Using the VDD system, it is possible to make a direct comparison between the time dependent slider position and the position error signal (PES). Using this comparison, contributions to the PES can be identified and minimized.

Head/Media Interface Studies

The high resolution of the digital LDV permits accurate measurements of head/media interface dynamics. Engineers can characterize a given HGA and slider configuration with a particular media product. If not satisfactory, other drive component combinations can be tried until an appropriate solution is found that offers stable flight and minimal registration errors.

Calibration of Transducers and Sensors

The digital LDV does a direct and highly precise mathematical phase demodulation comparable to the international standard ISO 16063-11 (Method 3). The measurement results are referenced to the HeNe laser wavelength due to its accuracy and stability. The digital LDV's performance is so outstanding that it can be used as a reference standard in primary calibration systems for shock and vibration transducers.

VDD Data Acquisition System	
Acquisition board	4 channels (2 for I/Q signal, 2 for reference); 5 MSa/s, 12 bits
Computer (optional)	PC-D Desktop PC or PC-I Industrial PC (from Polytec)
Signal generator (optional)	1 channel, 512 kHz, arbitrary waveforms

VibSoft-VDD Software	
Vib-S-VDD	Digital data acquisition and processing, time & frequency domain displays, time & frequency domain averaging, digital filter program, time domain integration & differentiation. Input channels for vibrometer & reference (VDD-E-600: 2 references)
TTL Gate input software	VIB-S-FFT128
Supports 12,800 FFT lines	VIB-S-VBEng
	Creates Visual Basic® Scripts for automation of measurements and data presentation. Includes User Defined Data Sets (UDDS) for adding external or post processed data
VIB-S-ExpUFF	Converts data to Universal File Format (UFF)

VibSoft-VDD Options	
VIB-S-SIG-M	Internal arbitrary waveform generator
VIB-S-ExtSig	Controls external arbitrary waveform generator via optional adapter
VIB-S-ExpME	Binary data interface for data exchange with ME'scope software
VIB-S-SigPro	Polytec Signal Processor, the user interface to the math library included in the VibSoft Software
VIB-S-VIDEO	Video option for VibSoft and VDD Software

Compliance with Standards	
Electrical safety	IEC/EN 61010
EMC	IEC/EN 61326 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 (CFR 1040.10, CFR 1040.11)

For more information and applications of Polytec's Digital Vibrometers please contact your local Polytec sales engineer or visit our website at **www.polytec.com/vibrometers**

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VDD PC-Based Digital Vibrometer

Modular Vibrometer System

- OFV-5000 Vibrometer Controller
- OFV-505/503 Standard Sensor Heads
- OFV-534 Compact Sensor Head
- OFV-551/552 Fiber Interferometers
- **VDD PC-Based Digital Vibrometer**
- **VibSoft Software**

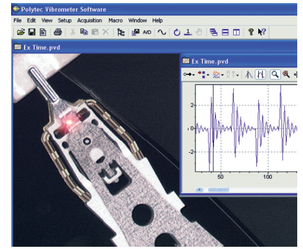
Picometer Displacement Sensitivity

New measurements for data storage, micro-electro-mechanical structures (MEMS) and hearing dynamics push a traditional analog LDV beyond its resolution limits. Polytec offers a choice of either the stand-alone VDD-E-600 Digital Front-End or a DD-600 equipped OFV-5000 Vibrometer Controller with analog and digital capability. The VDD PC-Based Digital Vibrometer utilizes 5 MSa/s, a multi-channel data acquisition and the VibSoft-VDD comprehensive software package for data processing.

Benefits of Digital Vibrometers

The sophisticated design of Polytec's Digital Vibrometers opens the door to many new possibilities. One of the most significant advantages of the digital LDV is the extremely low noise floor and the exceptional sub-picometer displacement resolution on mirror-like surfaces. Digital LDVs are best-suited when extreme accuracy is desired. With a maximum velocity of 810 mm/s and a 2 MHz bandwidth, a wide range of applications can be addressed.

In addition, a digital LDV is an excellent choice when signals are expected to be saved, processed or exported to sophisticated signal processing software. The VibSoft-VDD Software package is cost effective, as it already includes a spectrum analyzer, an arbitrary waveform generator and a data acquisition system.



VDD Digital Vibrometer measurement on a read/write head of a hard disk drive, with video image in VibSoft-VDD Software.

VDD-E-600 Digital Front-End

Alternative Solution: OFV-5000 Vibrometer Controller with DD-600 Digital Decoder

Key Features

- Ultra-precise vibration measurements for data storage, MEMS, hearing dynamics or calibration applications
- True DC capabilities for switches and stages
- 2 MHz bandwidth and cutting-edge, sub-picometer resolution
- Outstanding linearity, accuracy and dynamic range
- Excellent stability, insensitive to drift and ageing effects (all digital)
- Upgrade any OFV-5000 based vibrometer system by adding a DD-600 Decoder Module
- Stand-alone VDD-E-600 Digital Front-End, can be used with any OFV Series Sensor Head
- Comprehensive VibSoft-VDD Software for data acquisition, processing and export, with open software interface (PolyFileAccess)
- Optional integrated arbitrary waveform generator
- Optional upgrade for precision MEMS displacement measurements using the MSV-400 Microscope Scanning Vibrometer and the MSA-500 Micro System Analyzer

VDD System Configuration

Front-Ends

The vibrometer signal from the sensor head can go to one of two basic configurations – the stand-alone VDD-E-600 Front-End or, for the greatest flexibility, the DD-600 Decoder board installed in the OFV-5000 Vibrometer Controller complemented by a VIB-E-400 Junction Box. This configuration enables both digital and analog demodulation, which is preferred by data storage and MEMS applications.

The output from the front-end passes to the data management and acquisition system where displacement, velocity and acceleration can be calculated and displayed. A reference channel input is available for acquiring additional signals for phase and frequency response function (FRF) measurements. The output from an internal arbitrary waveform generator is also available and can be used to drive the device under test.

Sensor Heads

Polytec offers five vibrometer heads – the Dual Fiber OFV-552 Interferometer, the Single Fiber OFV-551 Interferometer, the OFV-534 Compact Sensor Head with optional video camera and the standard OFV-505 and OFV-503 Sensor Heads. The VDD functionality is also available as an option for the MSA-500 Micro System Analyzer.

Principle of Operation

The output signal from the vibrometer sensor head contains information about the velocity (Doppler frequency) and displacement (Doppler phase) of the test object.

OFV-534 Compact Sensor

The VDD decodes the phase of the Doppler signal to measure the dynamic displacement of the test object. In the Front-End a quadrature demodulator generates the I&Q (sine and cosine) components of the sensor signal. They are digitized by a high sampling rate ADC board inside the data management system.

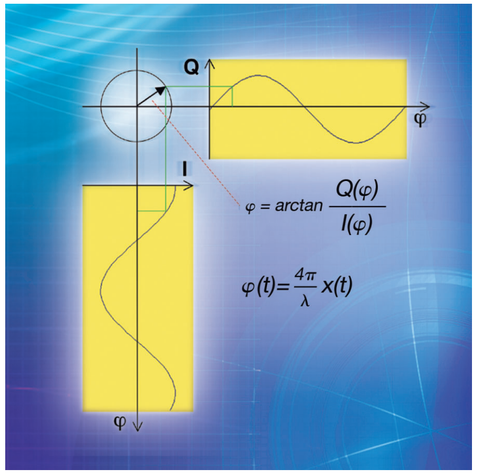
These two signals can be represented as a rotating vector whose phase is directly related to the displacement of the test object and the laser wavelength. By numerically decoding the phase with an arctan function, high displacement accuracy and resolution is achieved. Velocity and acceleration data are available through VibSoft-VDD Software by differentiation of the displacement signal.

To learn more about digital vibrometry, please read our tutorial "Basics of Digital Vibrometry" at **www.polytec.com/usa/vib-university**.

VibSoft-VDD Software Features

The VibSoft-VDD Software package manages the data acquisition, signal decoding, arbitrary waveform generator and data display. Measurements can be presented in both time and frequency domains. Included with the software are an extensive number of functions including FRF, auto power spectra, cross power spectra, coherence and phase.

- Controls acquisition, signal processing, display and export of all data
- Calculates FRFs, coherence and other signal properties
- Applies digital high, low and band pass filters; User can load custom ASCII format filters



The I&Q Signal Format

- Differentiates and integrates in time and frequency domain
- Averages the input signal in the time domain
- Calculates FFT with 12,800 lines (optional up to 204,800 lines)
- Controls integrated arbitrary waveform generator with common and user defined excitation waveforms
- Program automatic test routines and interface with other software using Visual Basic scripting (VBS)
- Export data in ASCII format, Universal file UFF, direct data access to binary data using Poly File Access software and optional binary ME'scope interface
- Access all settings of the OFV-5000 Controller via RS-232 interface
- Access live video images of the test object and laser beam position when using a sensor head equipped with an internal video camera, or an MSV-050/100 Microscope Adapter

OFV-505 Sensor Head

OFV-551 Fiber Interferometer

Technical Data

Front-End Specifications				
VDD-E-600 Stand-Alone Front-End				
Power	100 VAC ... 240 VAC, max. 75 W			
Dimensions [W x L x H]	235 mm x 320 mm x 150 mm			
Weight	5.7 kg			
Signal inputs REF1/REF2	±200 mV ... ±10 V, into 1 MΩ			
Input coupling	AC or DC, adjustable by software			
Inputs TRIG, GATE, AUX	TTL/CMOS			
Output signal	Internal generator output, max. ±10 V			
Outputs SYNC, AUX	TTL/CMOS			
VDD-Option for OFV-5000 Vibrometer Controller				
Hardware	DD-600 Decoder Board for OFV-5000 Auxiliary Slot and VIB-E-400 Junction Box			
Power	VIB-E-400 Junction Box: USB-powered			
Dimensions [W x L x H]	VIB-E-400 Junction Box: 260 mm x 208 mm x 88 mm			
Weight	VIB-E-400 Junction Box: 2 kg			
Signal inputs REF1, REF2	±200 mV ... ±10 V, into 1 MΩ			
Input coupling	AC or DC, adjustable by software			
Inputs TRIG, AUX	TTL/CMOS			
Output signal	Internal generator output, max. ±10 V			
Outputs SYNC, AUX	TTL/CMOS			

VDD Performance Specifications				
Frequency range	0 Hz ... 2 MHz			
Max. number of FFT lines	12,800 (optional 204,800)			
Maximum number of samples	■ Time mode: 64 MSa ■ FFT mode: 32,768			
Max. velocity for frequency, f, and sample time, t	Frequency f ≤ 51.2 kHz		Frequency f > 51.2 kHz	
t < 1 s	810 mm/s		810 mm/s	
t = 1 s ... 2 s	810 mm/s		405 mm/s	
t > 2 s	405 mm/s		405 mm/s	
Velocity resolution[1], depending on the vibration frequency f	f = 2 kHz 0.001 μm s^{-1}/√Hz	f = 20 kHz 0.01 μm s^{-1}/√Hz	f = 200 kHz 0.1 μm s^{-1}/√Hz	f = 2 MHz 1 μm s^{-1}/√Hz
Max. displacement	unlimited			
Displacement resolution[1]	<0.1 pm s^{-1}			
Measurement error for displacement	■ ±(1 % of RMS reading) for 1 nm ... 100 nm ■ ±(0.2 % of RMS reading + 1 nm) for ≥ 100 nm			
Total harmonic distortions	<0.1 % up to 50 kHz (sinusoidal vibration)			
Amplitude frequency response	■ Displacement: typ. ±0.1 % ■ Velocity: typ. ±0.2 % ■ Acceleration: typ. ±0.2 %			
Spurious signals	< 20 pm			

[1] Resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0 dB in a 1 Hz resolution bandwidth (RBW), measured on 3M Scotchlite Tape™ (reflective film). The velocity resolution values refer to the settings for a maximum velocity of 810 mm/s.