PMA-400 *Planar Motion Analyzer*

POLYTEC MICROSCOPE SYSTEMS

- MSV-050 Manual Microscope Adapter
- MSV-100 Remote Controlled Microscope Adapter
- MSV-400 Microscope Scanning Vibrometer
- **PMA-400 Planar Motion Analyzer**
- MMA-400 Micro Motion Analyzer

MEASURING IN-PLANE MICRO MOTION

The PMA-400 Planar Motion Analyzer is designed for in-plane microstructure vibration and motion analysis. In-plane measurements of microscopic structures such as MEMS or MOEMS require specialized techniques. While Laser Doppler Vibrometry provides superior resolution for out-of-plane measurements, the PMA-400 features in-plane motion analysis using specialized stroboscopic video microscopy.

The PMA-400 System

The PMA-400 Planar Motion Analyzer is a fully integrated, high performance imaging system combining drive electronics, data acquisition and motion analysis software. The system includes high-speed imager, stroboscopic illumination source, Data Management System with data acquisition, and synchronized signal generator.

Both the imager and illumination can be integrated with the optics of the proven MSV Series Microscope Scanning Vibrometer. This setup can be connected to a variety of optical microscopes or probe-stations for wafer level testing.

Motion analysis is performed through convenient, interactive software for measurement control. PMA offers a variety of operation modes. The Live Video Mode provides a slow motion visualization of the moving object.

In the Acquisition Mode, video sequences are sampled and analyzed using proprietary measurement algorithms.

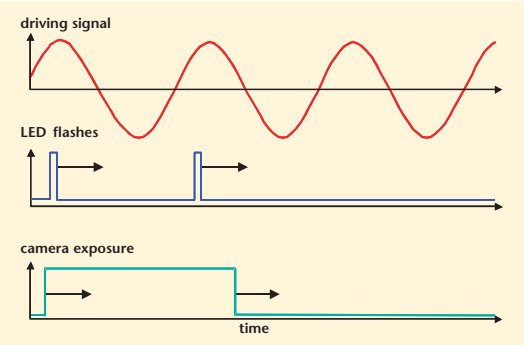
Motion data based on pixel deviations are extracted and displayed as X, Y displacement values. Sub-pixel resolution enables the measurement of vibration amplitudes with resolution better than 10 nm.

Key Features

- Video measurement of in-plane (X, Y) motion of MEMS devices and micro-structures
- Frequency range 0.001 Hz up to 1 MHz
- Time-domain measurements of displacement
- Resolution better than 10 nm
- Measurement of individual structures, or arrays simultaneously with the same video frame
- Modular design that combines with MSV-400 Micro Scanning Vibrometer to MMA-400 Micro Motion Analyzer

Stroboscopic Video Microscopy

Video of fast moving objects will produce blur patterns based on their motion. Using stroboscopic illumination and digital imaging, motion can be sharply frozen in time to capture the objects exact position. Short light pulses synchronized with the objects motion capture the position at precise phase angles. By shifting the timing of these pulses at phase angle increments, the motion of a moving object can be sampled and reconstructed.



The internal signal generator periodically excites the component with a sine or a pulse signal. A so-called "pattern generator" uses a LED to generate ultra-short flashes of light (< 50 ns) synchronously with the phase position of the excitation signal. This means that a high degree of phase accuracy is attained, even with high-frequency excitation. The electronic camera shutter in turn is synchronized with the excitation. It remains open until enough light at the same phase of the periodic motion has been collected. The power of the LED generally allows sufficient illumination with only a few flashes. This procedure guarantees a high degree of measurement accuracy and a visual real-time analysis in live mode.

Applications

- In-plane motion measurement of MEMS
- Ring down measurements to determine actuator settling times
- Microstructure failure analysis and reliability testing
- Wafer-level MEMS motion testing using probe-station
- Measurement of Bode plots

For more information regarding out-of-plane and 3-axis measurement please see also the respective MSV-400 and MMA-400 data sheet.

PMA-400 Technical Data		
System output	– Displacement data – Bode diagrams – Step-response plots	– Ring-down plots
Frequency range	0.001 Hz to 1 MHz	
Resolution/max. amplitude	Displacement resolution (nm)	Peak-to peak motion amplitude (in-plane, µm)
5x microscope magnification	26.8	840
10x microscope magnification	13.5	420
20x microscope magnification	6.7	210
40x microscope magnification	3.4	105
50x microscope magnification	2.7	85
100x microscope magnification	1.3	40
Strobe exposure time (time resolution)	50 ns	
Max. strobe jitter	± 25 ns	
Precision of phase @1 kHz	0.2 mrad (0.01°, resp.)	
Precision of phase @100 kHz	0.02 rad (1.1°, resp.)	
Precision of phase @1 MHz	0.2 rad (11.5°, resp.)	
Maximum velocity	> 0.1 m/s to 10 m/s (magnification dependent)	
Maximum allowed tilt	± 21° (magnification dependent)	
Maximum allowed piston displacement (out-of-plane)	50 µm (magnification dependent)	

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