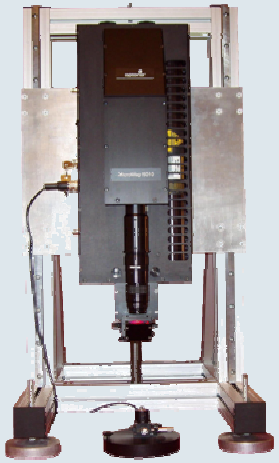
MicroMap 5010

- DC to 500 MHz
- Static deflections
- Profiling
- 3D
- Full field



The all-in-one system for R&D and testing of MEMS

Modeling and designing micro mechanical structures and MEMS is challenging because micro structures behave different from larger structures. As for dynamic devices, vibration modes may suddenly shift from one frequency to another because of thermal effects, air pressure changes or changes in boundary conditions.

Experience shows the importance of having full field and real time information on both static deflections from e.g. thermal effects and vibrations at the same time. When in-plane displacements and surface profile can be measured as well, the MicroMap 5010 represents a complete and powerful tool for research, development and product testing of micro structures.

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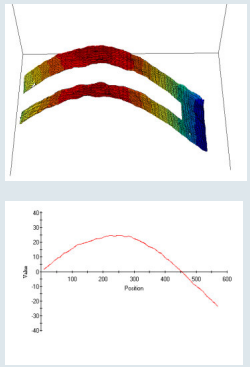
Applications



Vibrating beam

- Research and development
- Product testing

- MEMS and MOEMS
- Micro mechanical structures
- Pressure sensors
- Accelerometers
- Gyroscopes
- Collision sensors

- High temperature measurements
- Vacuum chamber measurements

- Automotive industry
- Sensor industry
- Medical industry
- Aeronautic industry
- Electronic industry

- FFT spectrum by automatic resonance frequency detection
- Vibration mode analysis
- Thermal deflection measurements
- Aging effect analysis

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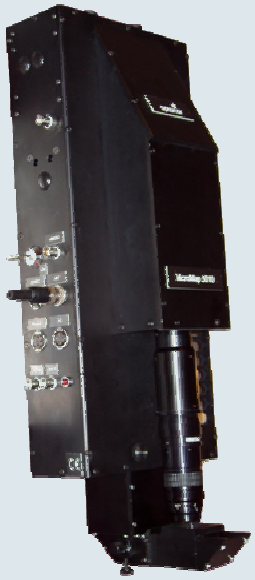
Multi-function 3D system



Out-of-plane module

The MicroMap 5010 is a laser based multi-function system for measurements of dynamic and static displacements of micro mechanical structures in 3 dimensions. The MicroMap 5010 can also do surface profiling measurements.

The MicroMap 5010 can measure both rough and smooth surfaces down to a full field area of 245x330 micrometer, and with spatial resolution better than 3 micrometer. The object is imaged using a microscopic zoom lens. The MicroMap 5010 has long working distance, and measurements can be done through windows, through heat filters and via mirrors.

For ***dynamic measurements*** the MicroMap 5010 uses the so called time average principle, which gives very reliable, full field data for both amplitude and phase of the vibrating object. No scanning performance is required, and the acquisition of data is done at the same time for all points on the surface. Amplitude noise floor (RMS) is down to 0.01 nanometer, and frequencies up to 500 MHz or higher can be measured. Frequency range for standard system is up to 20 MHz for the out-of-plane system and up to 50 kHz for the in-plane system.

For ***semi static deflection measurements*** the MicroMap 5010 measures and displays full field deflection maps, and displacement resolution is approximately one nanometer, depending on the required spatial resolution. Maximum displacement range is several micrometer. With the standard system, the sampling rate for static displacement measurements is 30 Hz, but customized systems can have higher sampling rates.

For ***surface profiling***, the MicroMap 5010 uses a flat mirror as reference object, and the surface of the test object is compared to this flat reference surface. The surface profiling option has some limitations, as only smooth and continuous profiles can be profiled. Profiling across height steps is not possible.

For ***in-plane measurements*** of vibrations and semi static deflections, an optional optical head with dual illumination is used. In-plane measurements can be done on rough surfaces only, and smooth surfaces need to be covered with a layer of light scattering material to be measured with the in-plane module.

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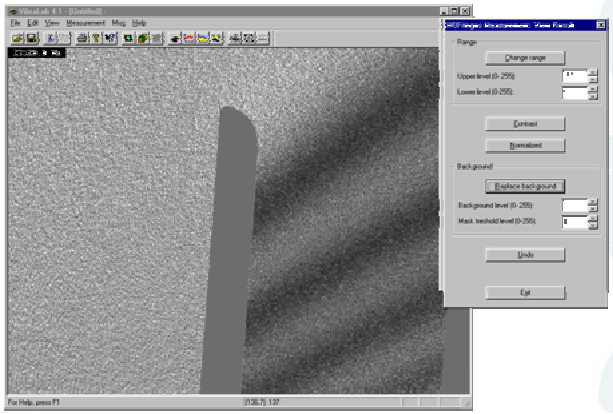
Modern and user friendly technology

Well proven modern technology
When sitting in an airplane, there is a good chance that the turbines in that airplane have been tested with the 'macro' version of the MicroMap 5010, - the VibroMap 1000. Both systems are based on modern interferometric technology which is today being used in a large range of applications within aircraft and space industry, automotive industry, audio, electronic and MEMS industry.

User friendly operation
With the MicroMap 5010 and the VibroMap 1000 systems, there is no need for time consuming preparations or adjustments to start doing measurements and testing. The patented technology has lead to turn-key instrumentation where the operator can physically 'see' the basic information carrying signals 'live' on the video screen, giving very high confidence regarding measurement output validity.

Two basic modes of operation
The ***real time mode*** of operation is being used both for semi static deflection measurements and for dynamic measurement up to GHz or higher. With the real time mode of operation, the measurements are updated 30 times per second (standard), and the displacement map is presented in a semi quantitative way as iso-displacement fringe maps. Any change in



Real time amplitude fringes

displacement in response to changes in excitation frequency, boundary or loading conditions, is immediately seen on the monitor.

The ***numerical mode*** of operation gives detailed numerical information on amplitude and phase distribution (vibration measurements) and static deflections. For vibration measurements, a full field numerical recording covering more than 620x480 measurement points, takes from a few seconds to a couple of minutes to perform. For semi static measurements, the numerical mode of operation find the surface displacement between time t and time (t+dt), where dt can be from a few seconds to several minutes. The semi static displacements can also be monitored and measured continuously over a period of time if the object is moved with a limited velocity during the recording period.

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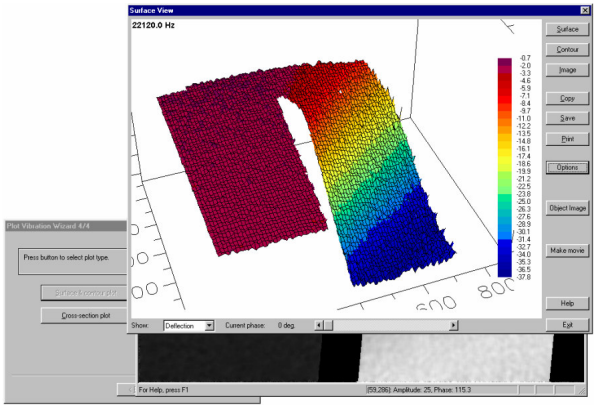
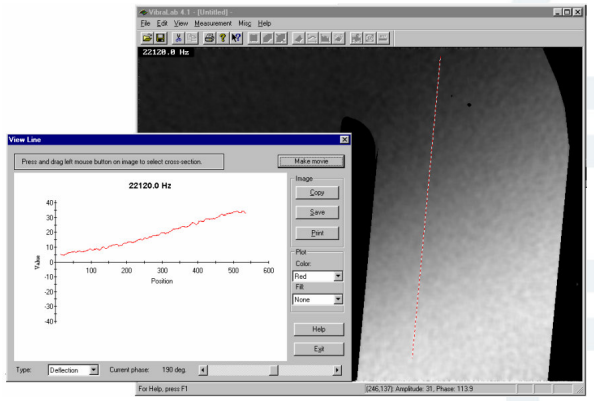
Reliable output
The two modes of operation gives a unique reliability and confidence regarding the validity of the measurement data. Especially when unexpected results are obtained, the two different modes of operation is useful as an extra test. If measurement data was presented with numerical numbers as the only option, then there would be no chance to evaluate the validity of the computer algorithms and calculations. This two modes of operation is one out of many advantages with the MicroMap technology.



Numerical 3D plot



Numerical line plot

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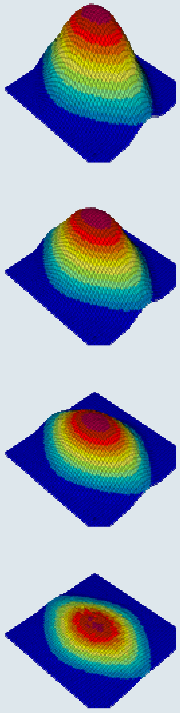
Features and benefits



Pressure sensor

- Non contact laser based multi-function instrument: vibrations - static deflections - surface profiling
- 3D measurement: out-of-plane and in-plane measurements
- Both rough and smooth surfaces can be measured
- High resolution for both rough and smooth surfaces
- Two modes of operation both for vibration analysis and static deflection analysis
- Full field measurements with no scanning functions
- The physical laser speckle noise from rough surfaces is reduced or eliminated

- Full field static or semi static deflection measurements with animated display
- Surface profiling

- Vibration measurement with reliable data for both amplitude and phase, and animated deflection displays
- High frequency measurements up to 500 MHz or higher for both out-of-plane and in-plane measurements
- High amplitude resolution for both rough and smooth surfaces – noise level (RMS) down to 0.01 nanometer
- Easy operation – no stroboscopic functions necessary

- Long working distance
- Measurements through windows, heating filters and via mirrors possible
- Microscopic zoom lens for easy operation
- Small and larger surfaces
- Animated displays
- User friendly technology and instrumentation
- Long life time and long warranty period
- Cost effective
- Customized systems available

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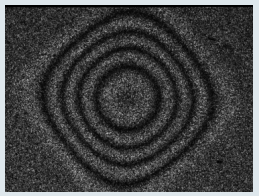
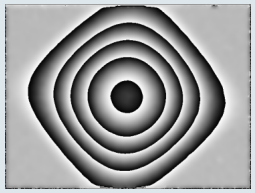
MicroMap system description

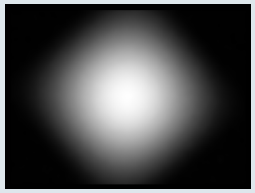
Static deflection



Real time fringes



Deflection phase map



Numerical map

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Standard system units

- **Optical head for out-of-plane measurements and/or optical head for in-plane measurements**
- **Mounting stage for optical head, including height adjustment**
- **Computer**
- **Signal generators**
- **Software for vibration measurements**
- **Software for static deflection measurements and surface profiling**
- **Object holders and excitation units**

How it works

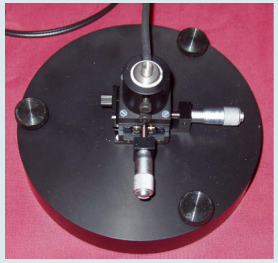
The full object field is illuminated by an expanded laser beam, and the object is imaged by a microscopic zoom lens onto a ccd array. For out-of-plane measurements, an internal reference beam is used to interfere with the object light. For in-plane-measurements with the optional in-plane optical head, two laser beams are being used for object illumination.

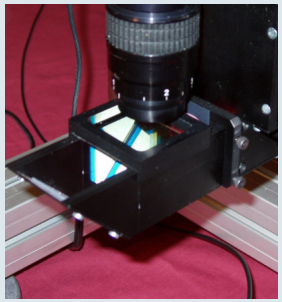
For vibration measurements the MicroMap 5010 computer uses a signal generator for object excitation, meaning the object is vibrating with one frequency at a time. The object can be vibrated by sources like e.g. pzt based shakers, or the object may have its own deflection function. Vibration amplitude fringes can be displayed real time, while a unique recording algorithm is used to calculate numerical amplitude and phase maps within a few seconds or up to a couple of minutes, depending on the averaging level selected. For numerical measurements, the object is excited steady state with constant frequency and amplitude during the recording period.

For static deflection measurements the MicroMap 5010 computer uses phase shifting technology to record and calculate (semi) static deflections of the object under investigation.

For surface profiling, a flat mirror is used as reference plane, and by use of phase shifting, the surface profile is calculated. A separate profiling object holder is used, with the flat reference mirror included.

Accessories





Out-of-plane

Part #	Unit	Description
MM-01A	Out-of-plane optical head	Including 0.7 – 4.5 X zoom lens
MM-02-A	Out-of-plane mounting stage	With height adjustment for optical head
MM-03-A	Computer	Lap top or desk top
MM-04-A	DAC coupling unit	DC signal transmission to optical head
MM-05-A	Signal generator (2)	Two Agilent signal generators
MM-06-xxx-A	Out-of-plane high frequency module	xxx = 080: 80 MHz xxx = 500: 500 MHz
MM-07-AA	Out-of-plane object excitation unit	Up to 50 kHz, 3 gram objects max, X-Y adjustment
MM-07-AB	Out-of-plane object excitation unit	Up to 50 kHz, 3 gram objects max, X-Y adjustment + tilt adjustment (goniometers). For shiny objects.
MM-07-AC	Customized out-of-plane object holder	User specified
MM-08-A	Out-of-plane object deformation unit	For demonstration purposes
MM-09-A	Profiling object holder	Used for object profiling, includes a flat reference mirror X-Y translation + X-Y tilt adjustments
MM-12-2.0	Attachment lens +2	To be used with standard 0.7 – 4.5 X zoom lens
MM-12-1.5	Attachment lens +1.5	To be used with standard 0.7 – 4.5 X zoom lens
MM-12-0.75	Attachment lens +0.75	To be used with standard 0.7 – 4.5 X zoom lens
MM-14	20X fixed microscope objective	
MM-15-A	Polarizer	Object polarizer
MM-16-AA	Illumination beam splitter	25x25x25 mm
MM-17-AB	Illumination beam splitter	15x15x15 mm
MM-18-A	Illumination diffuser	
MM-19-A	Out-of-plane expansion lens	For object illumination
MM-25-A	Dust cover	For out-of-plane optical head

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Accessories

In-plane module

In-plane

Product #	Unit	Description
MM-01-B	In-plane optical head	Including 0.7 – 4.5 X zoom lens
MM-02-BA	In-plane mounting stage	Including base plate
MM-02-BB	In-plane mounting stage	With z-adjustment
MM-03-xxx-B	In-plane high frequency module	xxx = 020: 20 MHz xxx = 080: 80 MHz xxx = 500: 500 MHz
MM-05-BA	In-plane object excitation unit	Up to 50 kHz, 3 gram objects max X-Y translation adjustment
MM-05-BB	In-plane object excitation unit	Up to 50 kHz, 3 gram objects max X-Y-Z translation adjustment
MM-05-BC	Customized in-plane object excitation unit	User specified
MM-06-B	In-plane expansion lens (2)	For object illumination
MM-07-B	In-plane Intensity adjustment filter (2)	For object illumination
MM-25-B	Dust cover	For in-plane optical head

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Imaging specifications

The tables below shows full field image size and working distance for different objectives.

The spatial resolution of details within an image, is better than 1/100 x 1/100 of image size

For instance, imaged area 525x700 micrometer means that smallest resolvable detail is < 5.25 x 7 micrometer

Out-of-plane and in-plane systems have same imaged area, but different working distances

Fixed microscopic objectives

Microscope objective	*Image area*	*Working distance Out-of-plane*	*Working distance In-plane*
20 X	245 x 330 um	4 mm or longer	30 mm

Microscopic zoom lens 0.7 – 4.5 X with different attachment lenses

Attachment lens	*Minimum image area*	*Maximum image area*	*Working distance Out-of-plane*	*Working distance In-plane*
+ 2	525 x 700 um	3040 x 4050 um *	20 mm or 30 mm	45 mm
+ 1.5	700 x 930 um	4500 x 6000 um *	30 mm or 40 mm	55 mm
No attachm. lens	1050 x 1400 um	6975 x 9300 um *	75 mm or 85 mm	100 mm
+ 0.75	1400 x 1850 um *	9000 x 12000 um *	100 mm	125 mm

*** For shiny objects, maximum effective area may be less, due to geometric illumination/reflection effects**

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Specifications

Note:

- ***Real time mode*** **means semi numerical recordings with iso-deflection fringe display**
- ***Numerical mode*** **means with numerical recordings with numerical amplitude and phase maps**

Out-of-plane system

Maximum spatial resolution with 20X objective	3 um
Amplitude noise level (RMS) rough objects numerical mode	0.04 nanometer
Amplitude noise level (RMS) shiny objects numerical mode	0.01 nanometer
Maximum amplitude numerical mode	40 nanometer
Maximum frequency for numerical mode (standard)	20 MHz
Maximum frequency for numerical mode non-standard	80 - 500 MHz (or higher)
Minimum frequency for numerical mode and real time mode	30 Hz
Amplitude resolution for real time vibration fringe measurements	Approximately 100 nanometer
Maximum amplitude for real time vibration fringe measurements	> 5 um
Maximum frequency real time mode	GHz (unlimited)
Noise level (RMS) static deflection measurement (typical)	1 nanometer
Maximum static deflection	> 10 um

In-plane system

Maximum spatial resolution with 20X objective	3 um
Amplitude resolution rough objects numerical mode	0.04 nanometer
Amplitude resolution shiny objects numerical mode	Not available
Maximum amplitude numerical mode	> 40 nanometer
Maximum frequency for numerical mode (standard)	50 kHz
Maximum frequency for numerical mode non-standard	20 - 80 - 500 MHz (or higher)
Minimum frequency for numerical mode and real time mode	30 Hz
Amplitude resolution for real time vibration fringe measurements	Approximately 100 nanometer
Maximum amplitude for real time vibration fringe measurements	> 5 um
Maximum frequency real time mode	GHz (unlimited)
Noise level (RMS) static deflection measurement (typical)	1 nanometer
Maximum static deflection	> 10 um

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Specifications

Laser class	IIIa
Laser	5 mW HeNe
Data export formats	Standard export formats for vibration amplitude data, vibration phase data, static deflection data and surface profile data.
Animations	Available for both vibration displays and semi static deflection displays
Graphics displays	3D plots – line plots – contour plots – image displays
FFT-spectrum	Available
Speckle averaging module	Included with both out-of-plane and in-plane modules
Phase shifting	Included with both out-of-plane and in-plane modules

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Dimensions

Out-of-plane system

Dimensions optical head	550 x 90 x 135 mm (H x W x D)
Weight optical head	7.2 kg
Dimensions mounting stage	900 x 400 x 530 mm (H x W x D)
Weight mounting stage	20.7 kg
Total dimensions optical head on mounting stage	900 x 400 x 530 mm (H x W x D)
Total weight optical head on mounting stage	27.9 kg

In-plane system

Dimensions optical head	460 x 230 x 274 mm (H x W x D)
Weight optical head	7.5 kg
Dimensions mounting stage	460 x 300 mm mounting plate + Ø38 x 350 mm posts (2)
Weight mounting stage	8 kg
Dimensions optical head on mounting stage	550 x 460 x 300 mm (H x W x D)
Total weight optical head on mounting stage	15.5 kg

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