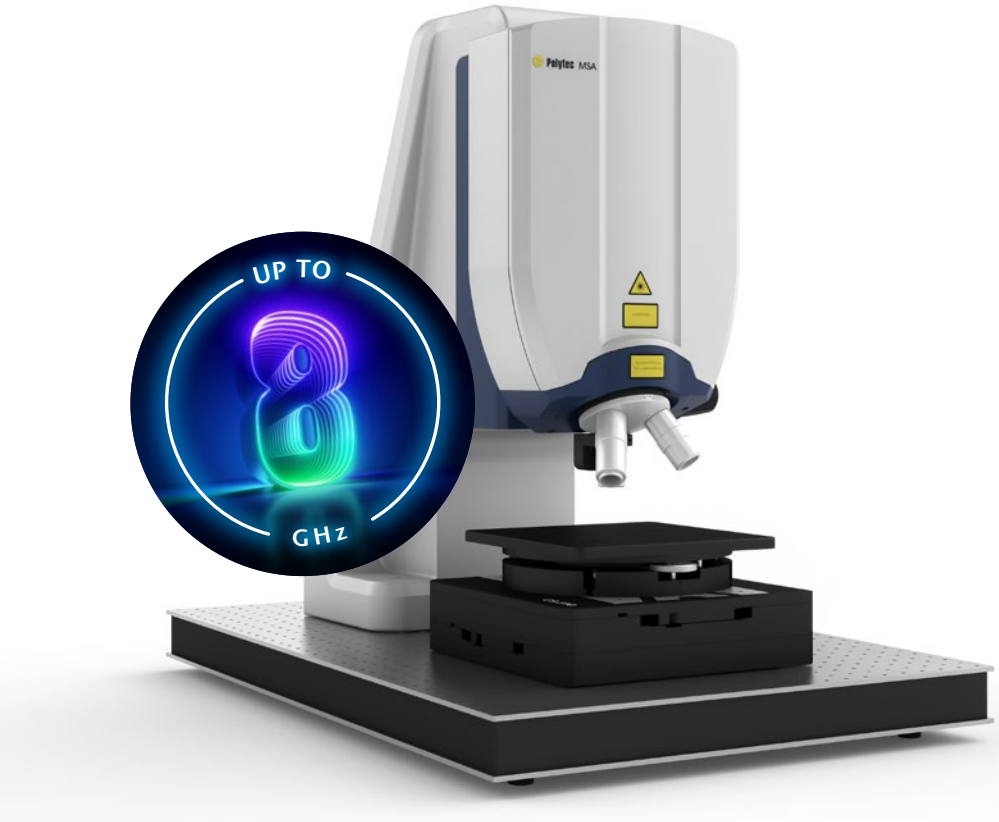
The MSA-600-S Micro System Analyze is a specialized optical measurement workstation designed for 8 GHz frequency vibration analysis and surface characterization. The MSA-600-S system extends the capability for automated scan measurement and visualization of operational deflection shapes to super high frequencies (SHF). This is an indispensable capability for measuring displacement response, mapping deformations, validating FE simulations, and determining leakage to substrates on GHz MEMS (micro electro-mechanical systems).

The high-performance laser Doppler vibrometer delivers fast, real-time response measurement with sub-pm displacement resolution. Additional white-light interferometry provides millions of 3D surface data in seconds.

Use the MSA-600-S for developing GHz devices, for quality control on behalf of form parameter evaluation, device performance and reliability testing. This enables testing of high frequency devices such as FBAR (film bulk acoustic resonators), BAW (bulk acoustic wave) filters and SAW (surface acoustic wave) devices.



Highlights

- Specialized 8 GHz optical measurement workstation
- Real-time response measurements without post-processing
- Unparalleled sub-pm displacement resolution
- Fast measurement and visualization of deflection shapes
- Straightforward and intuitive operation
- Automated system for easy integration into probe stations

MSA-600-S Micro System Analyzer

Measuring dynamic response and topography of GHz micro electro-mechanical devices

Preliminary datasheet

Technical data

MSA-600-S system configurations	
Basic configuration	Out-of-plane vibration measurement up to 8 GHz
Options	
Aquisition memory extentions	Data acquisition memory extention to 200 MSa / channel or 500 MSa / channel
Aquisition channel extention	Data acquisition channel extention to 4 channels
Topography measurement	Topography measurement

Meterological specifications			
Out-of-plane measurement			**Laser Doppler vibrometry**
Frequency resolution f_{RBW}			
		Frequency range setting	
Aquisition memory	200 MHz	500 MHz	1000 MHz
100 MSa/Ch	31.25 Hz (62.5 Hz)[1]	31.25 Hz (62.5 Hz)[1]	31.25 Hz (62.5 Hz)[1]
200 MSa/Ch	15.625 Hz (31.25 Hz)[1]	15.625 Hz (31.25 Hz)[1]	31.25 Hz
500 MSa/Ch	6.25 Hz (12.5 Hz)[1]	15.625 Hz	31.25 Hz
		Frequency range setting	
	2000 MHz	4000 MHz	8000 MHz
all configurations	62.5 Hz	125 Hz	250 Hz

Time domain measurement [2]	
Aquisition memory	Max. sampling time
100 MSa/Ch	32 ms (16 ms)[1]
200 MSa/Ch	64 ms (32 ms)[1]
500 MSa/Ch	160 ms (80 ms)[1]

Maximum object velocity	
Frequency range	Max. velocity
up to 300 MHz	150 m/s
300...600 MHz	80...150 m/s [3]
600...1300 MHz	38...80 m/s [3 4]
1300...2500 MHz	80...150 m/s [3 4]
2500...8000 MHz	150...490 m/s [3 4]

Displacement resolution	
Frequency range	Resolution [5 6]
up to 1 MHz	100 fm/√Hz
100...1300 MHz	50 fm/√Hz
1300...8000 MHz	30 fm/√Hz

[1] Values in brackets apply to the 4 channel data acquisition mode
[2] Time domain acquisition and animation restricted to frequencies up to 600 MHz
[3] Frequency-dependent
[4] Maximum displacement amplitude ≤ 10 nm
[5] The noise-limited resolution is defined as the signal amplitude (rms) at a signal-to-noise ratio of 0 dB and a spectral resolution of 1 Hz.
[6] The attainable resolution is frequency-dependent. The specified values are average values across the given bandwidth.

Topography measurement				**White-light interferometry**
Configuration	MSA-600 with topography measurement option			
Vertical measurement range	250 µm			
Method of evaluation	smooth surface [1]	rough surface [2]		
Z performance				
Measurement noise [3]	0.09 nm	6 nm		
Vertical resolution [4]	<1 nm	<37 nm		
Flatness measurement				
Average flatness deviation [5]	4.5 nm	45 nm		
Repeatability [6]	0.25 nm	14 nm		
Step height measurement on a calibrated depth setting standard [2 7]				
Nominal step height	0.24 µm	0.75 µm	7.5 µm	75 µm
Repeatability [8]	0.02 µm	0.04 µm	0.05 µm	0.06 µm
Maximum deviation [9]	0.05 µm	0.12 µm	0.16 µm	0.18 µm

[1] Analysis of the correlogram phase, can be used on flat surfaces.

[2] Analysis of the correlogram envelope, for usage on unsteady/rough surfaces

[3] RMS value of the signal amplitude for an averaged measurement on a parallelly aligned plane mirror (R ≈ 4%, λ/20), calculated from 25 single measurements, under repeatability conditions.

[4] Measurement noise (N = 1) · √8

[5] Mean value of measured flatness values (according to ISO 1101) of 50 measurements on a parallelly aligned plane mirror (R ≈ 4%, λ/20) under repeatability conditions.

[6] Standard deviation of the measured flatness values (according to ISO 1101) of 50 measurements on a parallelly aligned plane mirror (R ≈ 4%, λ/20) under repeatability conditions.

[7] 15 measurements per step on a calibrated depth setting standard, type KNT 4080/30 (ISO 5436-1)

[8] Standard deviation of the measured deviation of the calibrated step height under repeatability conditions.

[9] Largest measured deviation in relation to the calibrated step height out of 15 measurements per step under reproducibility conditions.

Optical specifications	
MSA-I-630 Sensor Head	
Laser wavelength	532 nm
Laser safety class	class 3R (< 5 mW visible output)
Light source wavelength	470 nm
Light source safety class	class 2 LED product (< 20 mW visible output)
Camera	Full-field progressive scan camera
Camera resolution	1732 x 1200 pixel

Bright field objectives	Magnification	Working distance (WD) mm	Spot diameter ($1/e^2$) µm	Field of view mm x mm
A-MOB-001X	1	13	46	10.0 x 7.0
A-MOB-002X	2	34	23	5.1 x 3.5
A-MOB-005X	5	36.5	9.3	2.0 x 1.4
A-MOB-010X	10	33.5	4.6	1.0 x 0.7
A-MOB-010B-LD	10	48.9	4.6	1.0 x 0.7
A-MOB-020X	20	20	2.3	0.51 x 0.35
A-MOB-050X	50	13	1.4	0.20 x 0.14
A-MOB-100X	100	6	0.8	0.10 x 0.07

Interference objectives	Magnification	Working distance (WD) mm	Type	Field of view mm x mm
A-IOB-02X5-B	2.5	10.3	Michelson	4.0 x 2.8
A-IOB-005X-B	5	9.3		2.0 x 1.4
A-IOB-010X-B	10	7.4	Mirau	1.0 x 0.7
A-IOB-020X-B	20	4.7		0.51 x 0.35
A-IOB-050X-B	50	3.4		0.20 x 0.14
A-IOB-100X-B	100	2		0.10 x 0.07

General specifications

Component	MSA-I-630 Sensor Head	MSA-F-630 Front-End	MSA-W-630 Data Management System	MSA-E-600 Controller
Power	via MSA-F-600 Front End	100 ... 240 VAC ± 10%, 50/60 Hz max. 100 VA	100... 240 VAC ± 10%, 50/60 Hz max. 525 VA	100... 240 VAC ± 10%, 50/60 Hz max. 450 VA
Dimensions [W x L x H]	see figure	485 x 150 x 380 mm (19", 84 TE/3 HE)	485 x 190 x 550 mm (19", 84 TE/4 HE)	499 x 177 x 373 mm (19", 98 TE/4 HE)
Weight	12.6 kg	9.0 kg	18.0 kg	12.0 kg
Operating temperature	18 ... 30 °C (64.4 ... 86 °F)	+5...+40 °C (41...104 °F)		
Storage temperature	–10 ... + 65 °C (14 ... 149 °F)	–10 ... + 65 °C (14 ... 149 °F)		
Relative humidity	max. 80%, non-condensing			

Component	MSA-A-630 Data Aquisition	A-ESG-004 Signal Generator
Model	Rohde & Schwarz RTP 064	Rohde & Schwarz SMB100B
Bandwidth	8 GHz	8 kHz ... 12.75 GHz
Max. sampling rate	40 GSa/s	N.A.
Channels	up to 4	1
Power	100 ... 240 VAC, ± 10%, 50/60 Hz, max. 1000 W	100 ... 240 VAC, ± 10%, 50/60 Hz, max. 160 W
Dimensions [W x L x H]	463 x 349 x 285 mm	344 x 372 x 153 mm
Weight	18 kg	10.5 kg
Operating temperature	+5 ... +45 °C	0 ... +55 °C
Storage temperature	-40 ... +70 °C	-40 ... +70 °C
Relative humidity	max. 80%, non-condensing	

Software features

Out-of-plane measurement	
Data acquisition	
Video display	Live, full field, black & white video image of test object directly incorporated into user interface for interactive scan set up and beam positioning. Digital zoom into live video image.
Laser positioning	Visible laser moves with cursor on live video image by clicking or dragging the mouse.
Defining scan geometry	Utilizing APS Professional mode for up to 512 x 512 points per object of any shape. Measurement points are defined graphically over the live video image using a mouse. User can draw individual objects using polar, cartesian or hexagonal grids, or define single points. Define single points (optional): Single point geometry can be optimized by refining or coarsening the grid. Automatic generation of surface elements to connect scan points.
Scan geometry import	Geometry import from UFF or ME'scope format.
Autofocus option	Automatic focusing of the laser at the current position of the specimen or during the scan; allowing for an optimized signal level at every scan position [1].
Sample positioning	Interactive control of X-Y positioning stage (optional) by using the mouse and absolute or relative displacements by precisely defined distances. Measurements at different positions can be acquired separately and combined for analysis and presentation.
Vibrometer control	All vibrometer parameters such as velocity range and tracking filter are software controlled.
Display	Simultaneous display of live video showing actual laser spot, entire scan area including scan points, and multiple analyzer displays of various signals (time traces and spectra).
Specimen excitation	Wide range of waveforms including sine, periodic chirp, white noise, random signals, sweep and arbitrary signals.
Acquired scan data	Entire spectrum acquired for all channels at all scan points
FastScan	Fast acquisition mode (up to 50 points/s) for measurements at a single frequency. Bandwidth is definable. Complex and magnitude averaging and signal enhancement are available.
Time domain data (optional)	Time domain acquisition, time domain averaging, time domain animation.
Gate input	Gate input for intermittent scan control.
Scan data validity check	Data quality check at all scanned points in Signal Enhancement (SE) mode. MSA-600 checks the quality of data in each spectrum. The averaged spectrum is weighted toward those spectra with the best signal to noise ratio. Measured points are labeled: optimal (SE only), valid, or A/D overload.
Trigger	Auto or manual threshold, rising or falling edge, source: external or any measurement signal
Averaging	Complex or magnitude averaging of spectra, peak hold, time
FFT lines	Calculation with up to 32 million FFT lines, display resolution with up to 8 million FFT lines.
Window functions	Rectangular, Hamming, Hanning, Flat top, Blackman Harris, Bartlett, Exponential

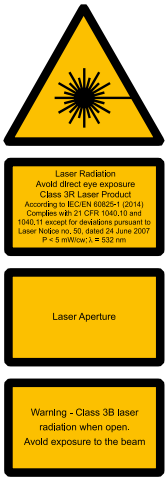
[1] Requires portal stand with automatic z-stage.

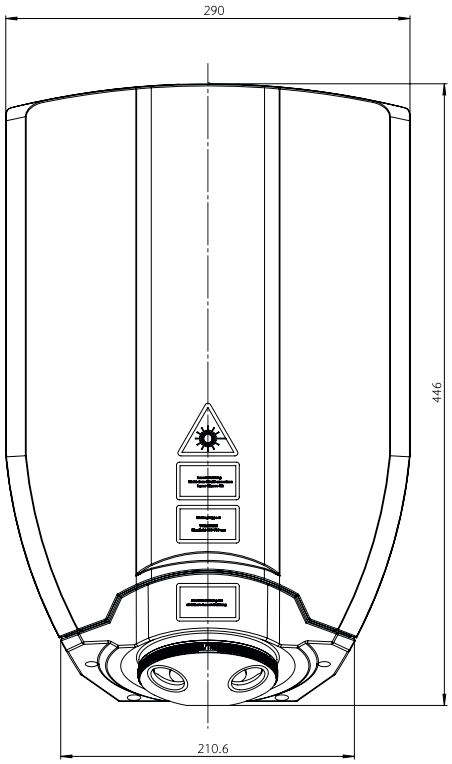
Data processing and analysis	
Data organisation	Support for project oriented workflow by a tree-style file browser for measurements, settings, macros, user defined waveforms, amplitude correction files. Context based actions on different file types.
Display	Color/gray, filled/unfilled contours and 3-D relief maps over stored video image (static or animated), averaged spectra over all scan points, individual spectra at each point as Bode or Nyquist plots, line profiles. Animation of video image for easy visualization of results. Data are scaled in velocity, acceleration or displacement. Logarithmic/linear axes
Data transfer	ASCII, Universal File Format (UFF), ME'scope and PolyWave binary data interface (optional). UFF and ME'scope data can be imported, analyzed and processed as user defined datasets and combined with measured data.
Graphics transfer	Graphic formats AVI (for animations), JPEG, BMP, TIFF, PNG, GIF.
Data processing	Complex spectral analysis provides the following quantities and functions for area and/or single-point data: magnitude, magnitude dB(A), phase, real, imaginary, frequency response function (FRF), H1, H2, auto power, cross power, coherence, averaged RMS over frequency. 3rd octave analysis, ESD, PSD.
Polytec Signal Processor	The Polytec Signal Processor is the user interface to the PolyMath library included in the PSV software. Easy-to-use spreadsheet for post processing of scan data.
Automated processing	Software can be fully automated.

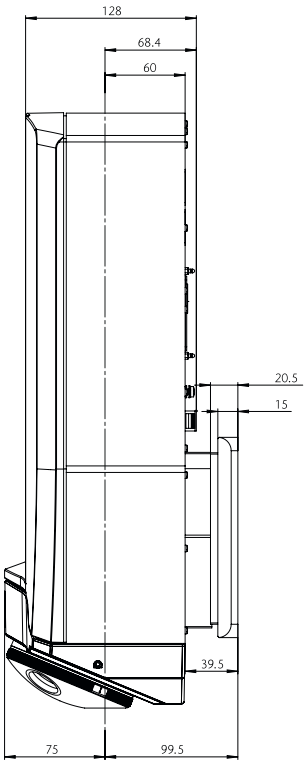
Topography measurements	
Data acquisition	
Working principle	By shifting an interference objective with respect to the sample, a high resolution X-Y-Z mapping is generated. The interference pattern is captured with the video camera.
Measurement modes	■ Short coherent measurement ■ Smart Surface Scanning technique for extended contrast range
Data processing and analysis	
Data organization	Support for project oriented workflow by a tree-style file browser for measurements and settings.
Post-processing	Envelope or phase evaluation
Data evaluation	Linear regression; polynomial fit; subtracting; averaging; filters like median, erosion, high pass and low pass filter; masking functions
Data display	■ Surface view: 2D, 3D presentation and isolines view, with video overlay ■ Profile view: profile sections; correlogram; roughness/waviness parameters; graphs/diagrams, geometrical data like angle, heights, radius etc.
Data transfer	Graphs can be exported in various common image graphic formats; measurement data can be exported as ASCII file.
Automated processing	Software can be fully automated.

Options and accessories
Please refer to the document “Accessories for stand-based instruments”

Compliance with standards	
Electrical safety	IEC/EN 61010-1
EMC	IEC/EN 61326-1 Emission: Limit Class A, 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)
Expanded uncertaintyof measurement	SEMI MS4-0416 and MS2-113







All dimensions given in mm

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