Lithography

Bonding

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Testing

PRELIMINARY

MANUAL MASK ALIGNER

MJB 4
MASK ALIGNER

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SÜSS MicroTec

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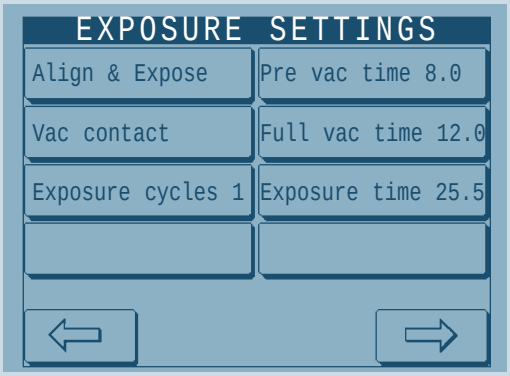
MJB4
MASK ALIGNER

The MJB4 design is based on the highly acclaimed MJB3, which set standards for precision, reliability and high performance. Since its release in 1969 more than 2000 machines have been installed worldwide.

The MJB4 is the next manual mask aligner following the MJB3. It is the ideal, economical tool for laboratories and small series production. In its contact exposure modes, the equipment can achieve a resolution of 0.5 µm, a performance unsurpassed in any other comparable machine.

The machine is widely used for MEMS and opto-electronics applications. It is specially configured for handling nonstandard substrates such as hybrids, high-frequency components or fragile III-V materials, such as GaAs or InP.

The tool can be equipped with either a SUSS Singlefield or a Splitfield microscope enabling fast and highly accurate alignment.



Features and Benefits

- *High resolution printing down to 0.5 µm.*
- *Wafer and substrate handling up to dia. 100 mm (wafers), 4”x4” (substrates)*
- *Special substrate chucks for pieces, III-V materials, thick substrates, hybrids and HF components.*
- *High precision X, Y, Θ alignment stage and microscope manipulator.*
- *High intensity optical configurations for different UV-exposure wavelengths up to 90mW/cm²*
- *Minimum operator training*
- *Ergonomic operation*
- *Touch panel graphical user interface*
- *Easy access to all assembly of the mask aligner*
- *Laser applications on request*

PRELIMINARY

PRINTING MODES

	UV400	UV300	UV250
Soft Contact	2.0µm	<2.0µm	–
Hard Contact	1.0µm	<1.0µm	–
Vacuum Contact	<0.8µm	<0.6µm	<0.5µm
Gap Exposure	>3.0µm		

Resolution achieved in 1µm thick resist (AZ5214E), lines & spaces
Achievable resolution depends on wafer size, wafer flatness, resist type, clean room condition and therefore, might vary for different processes.

The MJB4 is capable of handling several exposure sequences

Soft Contact

In its soft contact exposure mode the MJB4 can achieve a resolution of 2.0 µm. The final data mainly depends on process specifications such as spectral range, the distance between mask and wafer, a function of wafer topography, cleanliness and exposure mode, as well as diffraction reduction.

Hard Contact

With the hard contact exposure mode the gap between mask and wafer is further reduced by purging nitrogen underneath the wafer. Thus the wafer is pushed harder against the mask and achieves a resolution in the 1 micron range.

Vacuum Contact

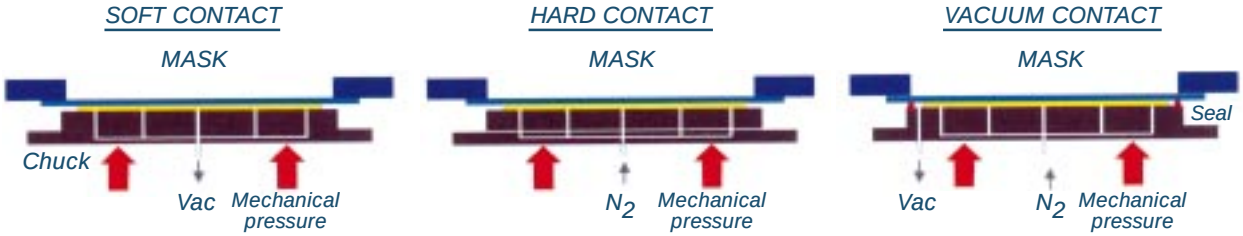
The MBJ4 can perform vacuum contact processes achieving a resolution in submicron range. Vacuum contact yields considerably higher resolution than hard or soft contact, because the gap between mask and wafer is further reduced. To obtain the highest resolution the photoresist thickness also needs to be optimized.

Low Vacuum Contact

For brittle or fragile substrates a low vacuum contact exposure can be performed. The low vacuum contact exposure mode reduces the vacuum impact to the substrate. This feature enables for a better resolution not achievable in soft or hard contact.

Gap Printing

Although the MJB4 is not considered to be a proximity exposure system, the gap printing mode allows exposure at a pre-set gap of up to 50 µm after initial wafer-mask leveling. This reduces mask wear for larger feature sizes.



PRELIMINARY

SPECTRAL RANGES

Range	Wavelength Range	Exposure lamps
Near UV	UV 400 (350 – 450nm)	200/350W Hg
Mid UV	UV 300 (280 – 350nm)	200/350W Hg
Deep UV	UV 250 (240 – 260nm)	500W HgXe

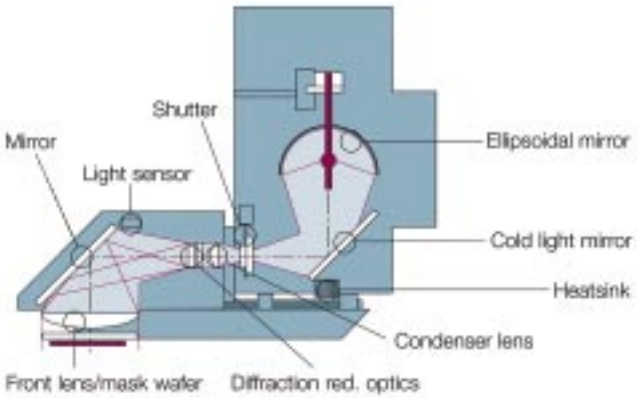
SUSS diffraction reducing exposure optics are incorporated in all MJB4 configurations.

EXPOSURE SYSTEM

High Quality Exposure Optics

SUSS offers a variety of optical configurations designed to compensate diffraction effects for various spectral ranges. Diffractions are a significant factor in the improvement of resolution and yield optimum resist sidewall slopes.

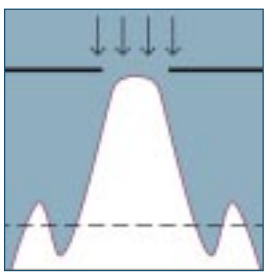
Diffraction effects at the mask pattern edges limit the achievable resolution. They are proportional to the square root of the wavelength. Therefore shorter wavelengths provide less diffraction. SUSS diffraction reducing exposure optics are available for the spectral ranges UV400, UV300 and UV250. All MJB4 configurations incorporate the diffraction reducing SUSS optical system, individually optimized for the particular spectral region and the corresponding desired resolution.



Optical system of MJB4 mask aligner

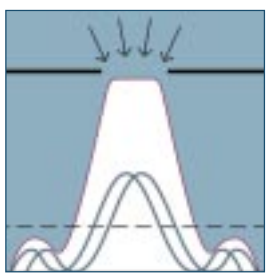
SUSS is the only semiconductor equipment supplier offering diffraction reducing optical setups

Conventional

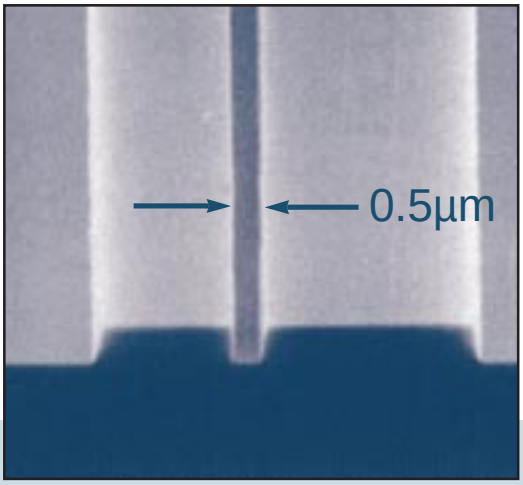


Strong diffraction effects from parallel illumination

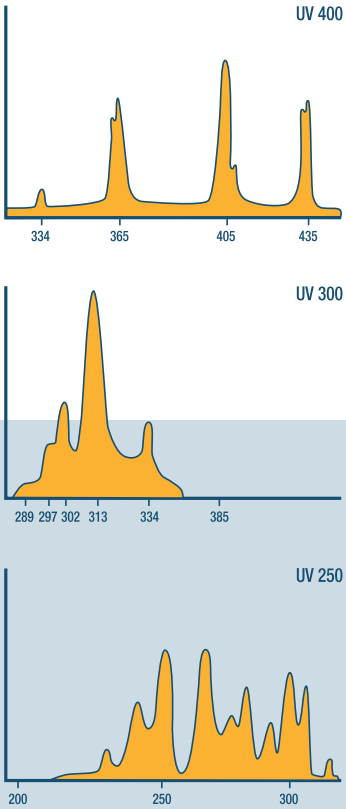
SUSS Optics



SUSS diffraction reducing optics



Reliable submicron printing with SUSS diffraction reducing optics.
(1 micron PMMA, UV250, vacuum contact)



Intensity distribution in the various spectral regions. The intensity scale of the graphics varies, therefore the intensities may not be directly compared.

EXPOSURE OPTICS

UV300/400 Standard Configuration

The basic configuration of the MJB4 achieves its performance with the unfiltered spectrum of a 200W high pressure mercury arc lamp and its associated exposure system with diffraction reduced light path. The MJB4 standard is an excellent, extremely versatile tool for R&D and laboratory applications.

The 200W lamp provides an intensity of more than 40 mW/cm^2 at broadband and more than 20mW/cm^2 at i-line.

The MJB4 exposure systems are manufactured from Herasil and are suitable for processes using near UV (UV400) or mid UV (UV300). Filter elements provide the different spectral ranges of g, h and i-line of the mercury spectrum.

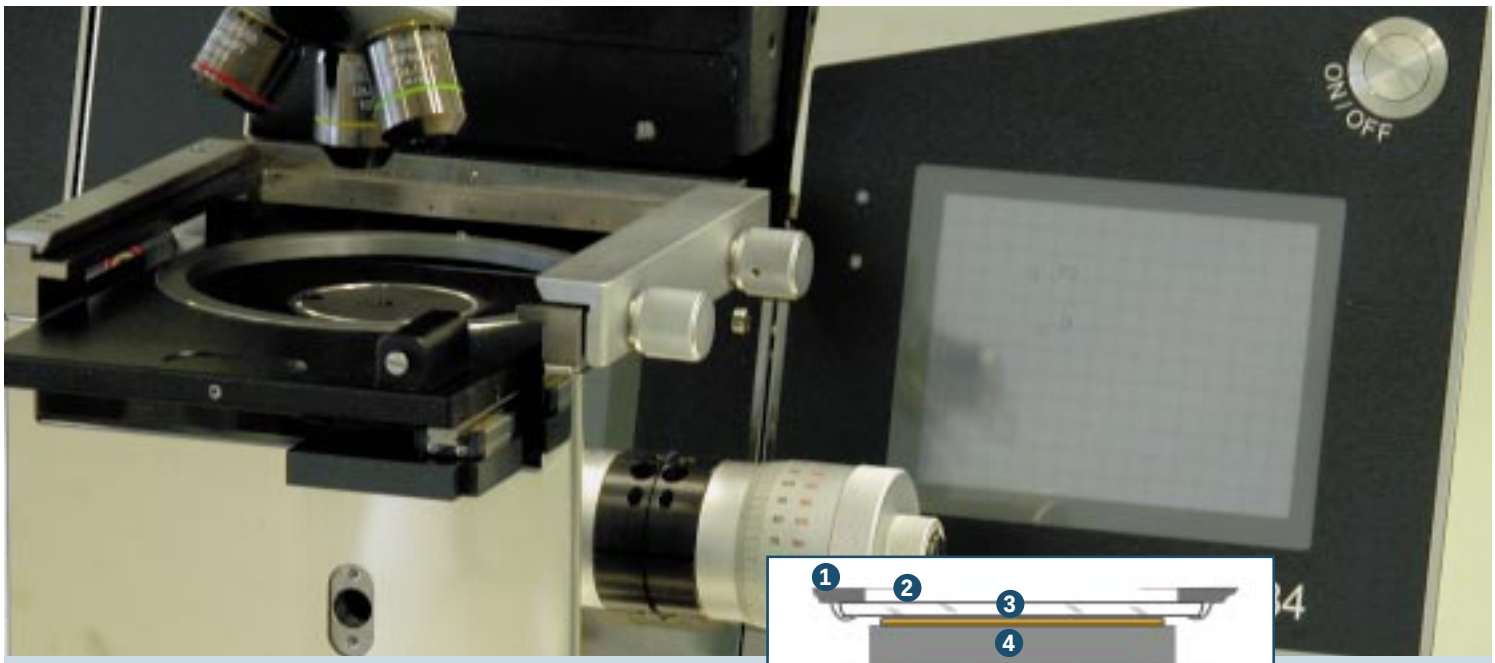
UV250 Submicron Configuration

The UV 250 exposure system incorporates Suprasil lenses for deep UV with corresponding light sources.

For ozone removal the lamphouse can be optionally equipped with an exhaust and cooling system. SUSS recommends the exhaust system when working with DUV.

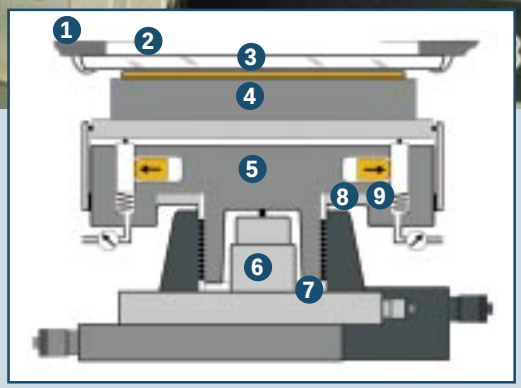
For process techniques in the UV250 spectral range a suitable photoresist such as PMMA must be used. This resist is sensitive below 260nm only.

The Suprasil lens system can also be combined with the 200W or 350 W Hg lamp and associated filter elements for processes in the UV400 or UV300 regions.



ALIGNMENT STAGE

Precise alignment of mask and wafer is crucial for all lithography processes. Alignment is performed by moving the wafer, while keeping the mask stage stationary.



WEC-System in the Alignment Stage.
Soft contact for precise leveling. Inline vertical pneumatic clamping avoids any shifts.

❶ Mask Holder ❷ Mask ❸ Wafer ❹ Chuck
❺ Chuck stage ❻ Spindle
❼ Precise ball-bearing guide
❽ Pneumatic brake ❾ Leveling pistons

XYΘ alignment stage

The MJB4 is equipped with a XYΘ alignment stage using high precision, backlash-free micrometer spindles for X, Y and Θ.

The travel range for X and Y is ±5mm, for Θ±5°.

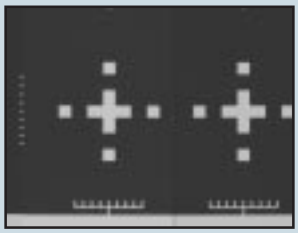
Substrate thickness compensation is easily adjustable allowing for a shift-free separation/contact movement.

The manual Z-movement allows a maximum substrate thickness of up to 4mm.

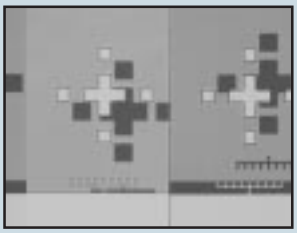
The mechanically clamped mask holder is designed for quartz, glass or film masks. It is equipped with vacuum clamping for the mask. Mask holders and chucks are easily exchangeable. Existing MJB3 equipment can be used on the MJB4 with a special mask holder frame.

Fast and safe substrate loading/unloading is possible without removing mask holder or mask.

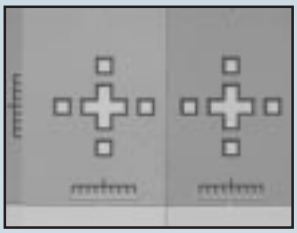
Direct Alignment by Eye



Mask targets



Misaligned mask and wafer targets



Perfectly aligned targets

■ Color image ■ Large field of view ■ Life-images, no risk of shift ■ Cost effective
■ Limited to depth of focus of respective objective

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Topside alignment with M500 microscope

MANUAL OPTICAL ALIGNMENT

The human eye possesses a remarkable ability to recognize symmetry. The task to produce suitable alignment keys therefore consists of finding high contrast figures where symmetry can be recognized. A simple example is placing a small cross within a large cross. The line width of the large cross is not significant, if both sides of the cross can be observed.

For best alignment the gap between the edges of the small and the large crosses is critical. The minimum distance is approximately 2µm. Typical values lie between 3 and 5µm, depending on contrast and edge quality. If the gap between the small and large alignment target is 3µm, a misalignment of 0.5µm causes a 40 percent intensity difference.

SUSS has designed a range of alignment crosses meeting all important requirements.

20µm

Examples of 2µm Misalignment

Competition:
Optical misperception by simple crosshair alignment (recognition of misalignment hardly possible)

SUSS:
The combination of microscopes with a large depths of focus DOF and wide range of advanced alignment marks enable highest alignment accuracy (immediate recognition of misalignment)

M604 Splitfield microscope

MICROSCOPES

The high alignment accuracy is obtained through the use of high resolution microsopes.

In addition alignment accuracy can be checked before exposure in all exposure modes especially in vacuum contact.

Standard topside alignment is performed with the M604 Splitfield microscope. Equipped with 10x objectives it offers a simultaneous viewing of mask and wafer. For small substrate alignment the SUSS single field microscope M500 might be a cost-effective solution. With both, the M604 and M500 an alignment accuracy of 1µm or better is achievable.

For manual alignment the full objectives depth of focus is normally used. The line and space resolution is approximately 1µm. It is not necessary to recognize submicron features in order to achieve submicron alignment accuracy.

M604Splitfield microscope

Objective	2,5x	5x	10x	20x
Resolution (µm)	4,2	2,2	1,1	0,9
Depth of focus (µm)	195	51	13	4,5
Field of view ø (mm)	4,65	2,33	1,16	0,58
Magnification	47,3	94,6	189,2	378,3

The MJB4 can be equipped with the M604 Splitfield microscope and the M500 Singlefield microscope

M500 Singlefield microscope

Objective	2,5x	5x	10x	20x
Resolution (µm)	4,2	2,2	1,1	0,9
Depth of focus (µm)	518	132	33	10
Field of view ø (mm)	8,80	4,40	2,20	1,10
Magnification	25	50	100	200

The high alignment accuracy is obtained through the use of special 20x high resolution microscope objectives. They are optically compensated for observation through the mask.

Microscope Options

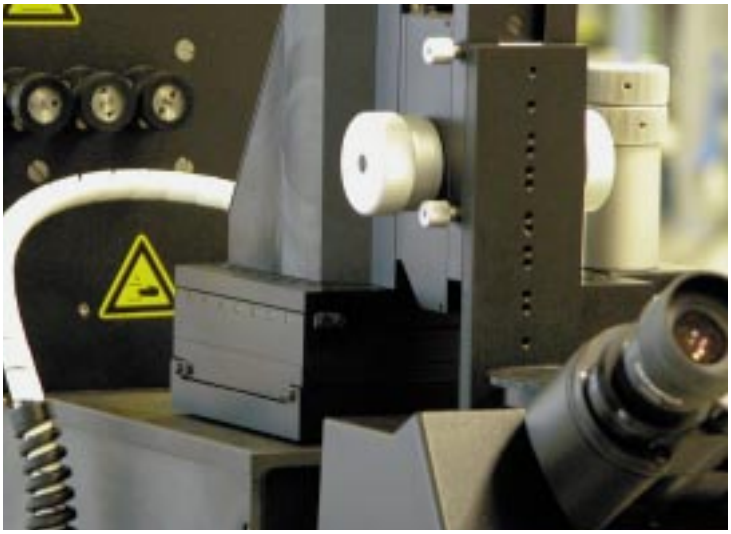
For demonstration and educational purposes both microscopes can be optionally equipped with CCD camera and monitor.

Microscope Manipulator

For fast microscope scanning of mask and wafer a microscope manipulator is standard. It is equipped with precise pneumatic brakes, vibration-, shift- and backlash-free positioning. A travel range of ±40mm in X, +30mm in Y, and -50mm allows for flat alignment of a four inch wafer/substrate.

In case of working with a Singlefield microscope a fast X scanning movement is available. A rotation adjustment for the SUSS Splitfield microscope in a range of ±4° is normal.

Coarse and fine focus can be done with a conveniently combined control. An automatic microscope lift protects the high magnification objectives with short working distance, if the exposure cycle is initiated or if the mask had to be loaded or unloaded.



SUSS Singlefield microscope and TSA manipulator

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SUSS INFRARED SYSTEMS

For backside or buried layers feature alignment the SUSS MJB4 can be optionally equipped with an infrared system. There are two principles of IR alignment possible: The SUSS IR transmitted illumination system and the SUSS IR incident illumination system. Both are applicable to materials transparent to wavelengths in the range from 400 to 1200nm. Both methods were incorporated for the handling of IR transparent materials like GaAs, InP, Silicon etc. Infrared alignment can also be used to align to buried diffusion layers.

For IR alignment both microscopes, the M500 Singlefield and the M604 Splitfield, can be employed.

Alignment Accuracy with IR

Due to the specific design in most IR applications an alignment accuracy of ± 5µm (± 2µm under optimal process conditions) is achievable.

SUSS IR Alignment System

- *Infrared light source to be positioned manually*
- *Special IR chucks available*
- *One (M500) or two (M604) video cameras sensitive to wavelengths in the range from 400 to 1200nm*
- *Video monitor*
- *Dedicated IR light source*
- *Dedicated IR objectives*

MJB4 CONFIGURATIONS

The SUSS MJB4 submicron aligners are designed for the highest demands on resolution and alignment accuracy. They incorporate the highest SUSS quality in mechanics (alignment stage) and exposure optics. For specific applications SUSS offers optical set ups for UV250, UV300 and UV400.

For Top Side / IR Aligment there are two microscopes available, the M500 Singlefield and the M604 Splitfield microscope. As a special advantage the MJB4 allows for an alignment check in all contact exposure modes.

Exposure Lamp Power Supply

There are two options available. The standard power supply for the 200W mercury lamp equipped with a smooth lamp ignition system to prolong lamp life time. The lamps runs at constant power supply only and is adjustable between 150 and 250W.

A more sophisticated power supply is the SUSS constant intensity controller (CIC 1200). It enables you to run lamps at constant intensity as well as in constant power. Each lamp can be adjusted to a specific intensity or power level.

For UV250 applications the CIC1200 is mandatory.

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SUSS MJB4 MASK ALIGNER STANDARDS

Mask and Wafer / Substrate	
Substrate Size	Round: 1” up to 100 mm / 4”
	Square: 5x5 mm up to 100x100 / 4”x4”
Wafer/substrate thickness	Up to 4mm
Mask Size	2”x2” up to 5”x5”
Mask thickness	Up to 4.8 mm / 190 mil

Exposure System		
Lamp House	350W	
Lamp Power	200W; 350W; 500W (DUV with HG-XE lamp)	
Intensity	200W	45mW/cm2 at 405nm
(over dia. 100mm area)		30mW/cm^2 at 365 nm
	350W	90mW/cm^2 at 405nm
		45m/Wcm^2 at 365nm
	500W	20mW/cm^2 at 250nm
Uniformity	≤3%	
Spectrum	UV400 : 350 – 450nm (g, h, i-line)	
	UV300 : 280 – 350nm	
	UV250 : 240 – 260nm	

Print Resolution	Lines and Spaces; Resist AZ 5214E, 1µm, Wafer 100mm		
	UV400	UV300	UV250
Soft Contact	2.0µm	<2.0µm	–
Hard Contact	1.0µm	<1.0µm	–
Vacuum Contact	<0.8µm	<0.6µm	<0.5µm
Gap Exposure	>3.0µm		

Lamp Power Supply	
CPC (Standard)	Constant Power Controller for HG200W
CIC1200	Constant Intensity Controller for HG200, HG350W and HG-XE500W

Alignment System	
Top Side Alignment	M500 Singlefield microscope
	M604 Splitfield microscope
IR Alignment	Double Transmitted Illumination / M500 / one IR camera
	Single Incident Illumination / M500 / one IR camera
	Double Transmitted Illumination / M604 / two IR cameras
	Double Incident Illumination / M604 / two IR cameras
M604 Illumation options	Brightfield (standard); Dark Field; Interference contrast

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Top Side Microscope Manipulator	
Travel Range X	± 40mm
Travel Range Y	+ 30mm / -50mm
Travel Range θ	± 4°

Alignment Stage	
Travel Range X	± 5mm
Travel Range Y	± 5mm
Travel Range θ	± 5°
Mechanical resolution X,Y	0.1 µm
Mechanical resolution 0	$4x10^{-5°}$

Utilities		
Vacuum	Pressure	< -0.8 bar (<200hPa absolute) / 150mm or 6” Hg
	Consumption	0.25 m^3/h (0.5 ft^3/h)
Compressed dry air	Pressure	> 5.5 bar (81 psi)
	Consumption	0.5 m^3/h
Nitrogen	Pressure	>1.5 bar (22 psi)
	Consumption	200W lamp: 0.2 m^3/h, 350W lamp: 0.35 m^3/h
		500W lamp: 0.7 m^3/h
Electrical Power	Input	95V – 260V, 50/60Hz
	Consumption	200W lamp: 500 VA, 350W lamp: 1650 VA
		500W lamp: 2250 VA
Physical	Width x Depth x Height	600 x 800 x 650mm (24 x 31 x 28”)
	Weight	Up to 150 kg (331 pds)

Data depends on individual process conditions and can vary according to equipment configurations. Not all specifications may be valid simultaneously. Illustrations in this brochure are not legally binding. Design and specification of custom built machines depends on individual conditions and can vary according to equipment configurations.

Small footprint:

Width	600mm	24”
Depth	800mm	31”
Height	650mm	28”

= 0.5 m^2 (5ft^2)

PRELIMINARY

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