OEG
Optik
Elektronik
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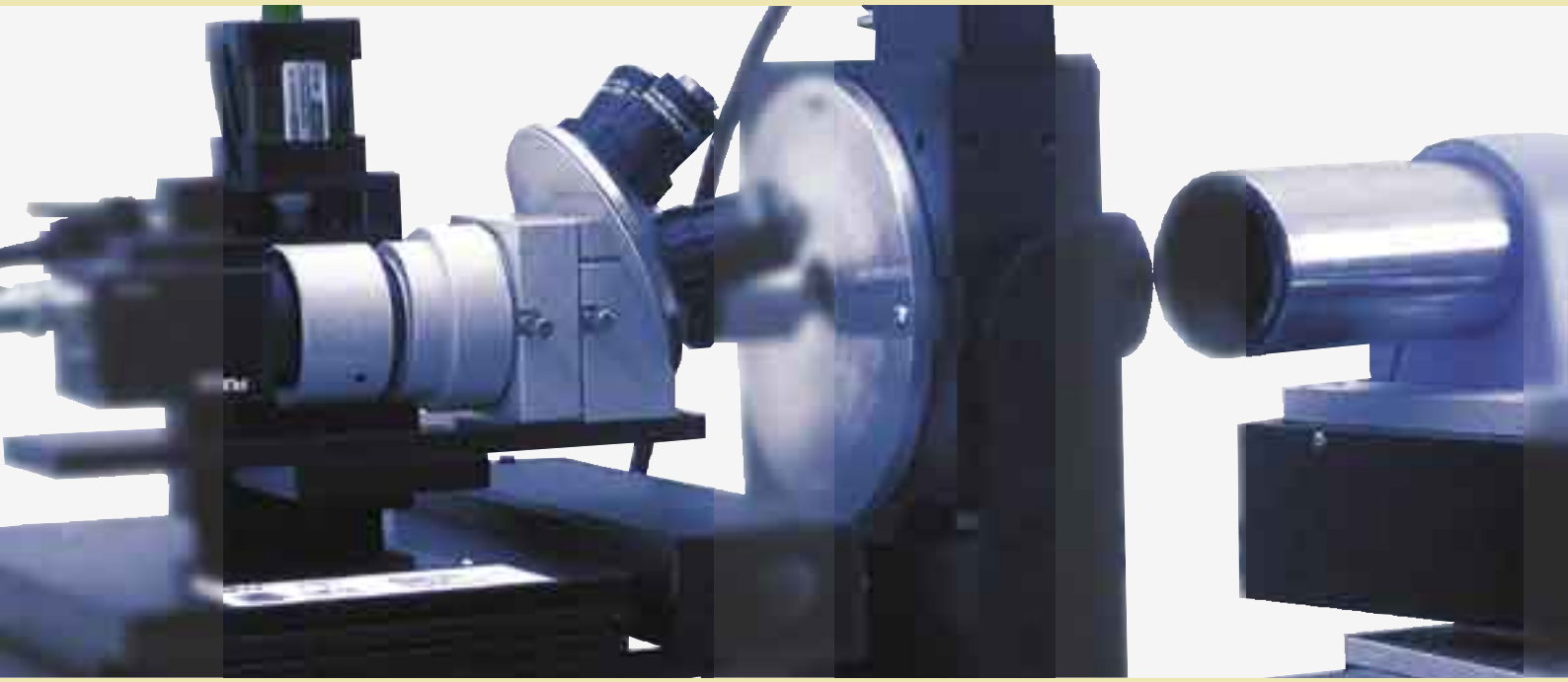


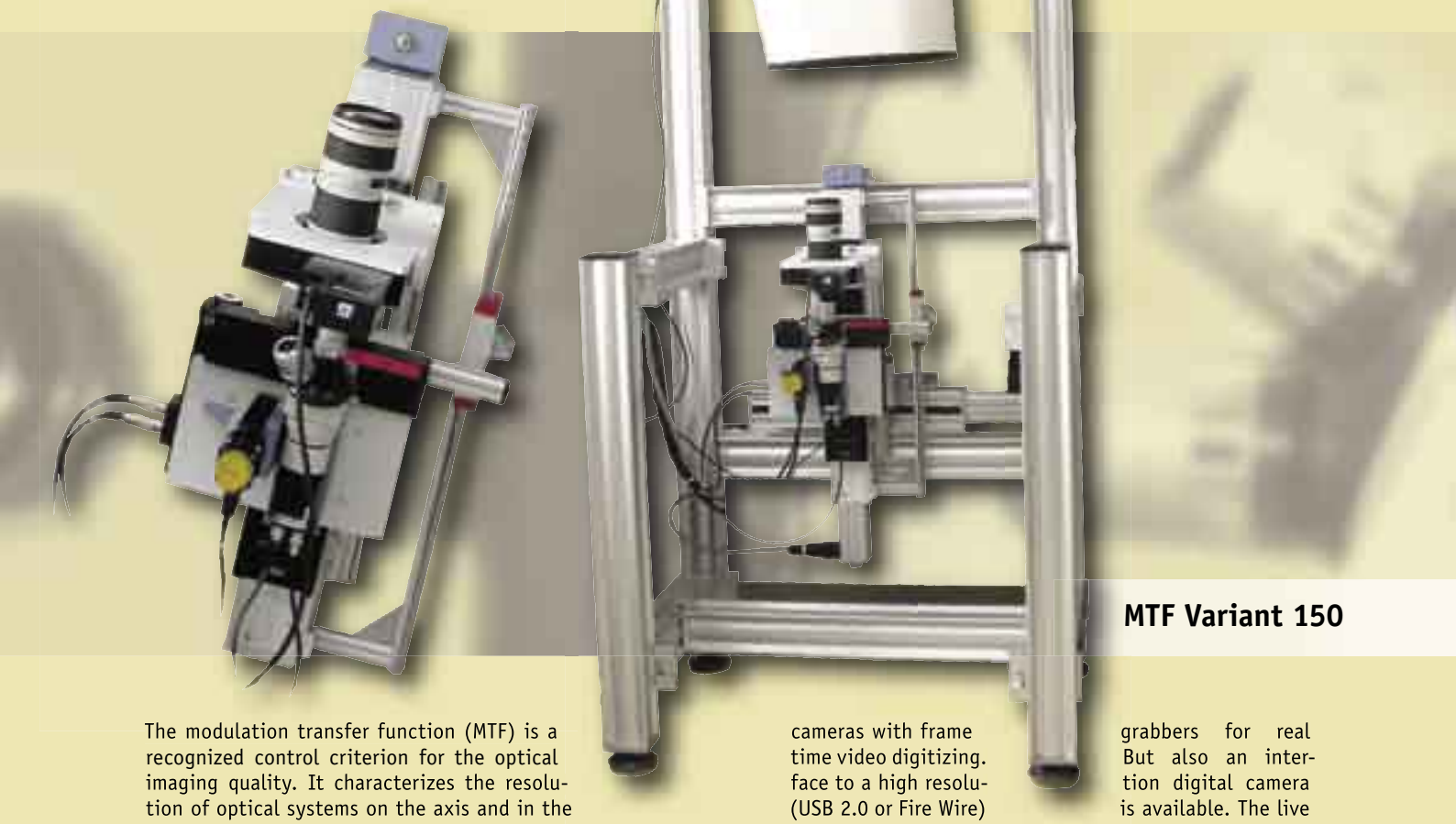
MTF Variant

Computer-controlled fully automatic measurement of the modulation transfer function (MTF) for the quality assurance in the optics manufacturing

A new standard of MTF-measurement

MTF Variant provides the fully automatic characterisation of the imaging quality on the axis and in the field for any azimuths and types of object/image conjugates by measurement of the modulation transfer function.
The operational area covers almost all standard optics for the visible spectral range.

The use of CCD-cameras in connection with image processing systems provides real time data of the line- or edge-intensity distribution. From this data the MTF can be computed. The MTF-data can be stored or shown on the PC screen.
Additionally CCD-cameras provide the advantage, that both directions of MTF (sagittal, tangential) can be measured nearly at the same time. The MTF Variant uses analogue-CCD-cameras with frame grabbers for real time video digitizing. But also an interface to a high resolution digital camera (USB 2.0 or Fire Wire) is available. The live video of the edge or gap is shown on the PC screen. The measuring field is freely selectable. The efficient evaluation software adjusts the measuring window with automated measuring expirations according to the movement of the object. For interactive measurements the measuring field can be defined by the operator. The real time evaluation refers both to the MTF measurement and to line and edge display functions.



MTF Variant 150

The modulation transfer function (MTF) is a recognized control criterion for the optical imaging quality. It characterizes the resolution of optical systems on the axis and in the image field. Beside the MTF with MTF Variant can be measured e.g. also the focal length, chromatic aberrations or the distorsion.
MTF Variant is the result of research and development for many years in the field of MTF measurement and worked satisfactorily with many considerable optics manufacturers in the production control. In addition it is also outstanding suitable for the employment in teachings, research, laboratory as well as goods in and outgoing inspection.

Real time MTF-measurement offers new possibilities

The classical MTF measurement principle, with which the picture of an edge or a gap, produced by the test specimen, is photo-metrically scanned by a mechanical scanning movement, can be realized meanwhile more simply by the use of CCD cameras.

Special requirements require adapted solutions

The MTF test bench is adapted in coordination with the user to special setting of tasks.
The adaptions refer e.g. to the test specimen focal lengths and its f-number, the measuring wavelengths or the object and image plane situations.
A measurement setup for an optics for the path of rays finite/finite differs from the structure from a measuring

instrument for the path of rays infinite/finite.
For test specimens with long focal lengths and large free aperture the focal length of the measuring collimator is differently to measure (as evident in the fig. MTF Variant 150) than for test specimen with very short focal length. For the conception of the equipment of the MTF test bench, necessary for the different measuring tasks, the OEG GmbH is available as competent partner with experience for many years.

Reasons for MTF measurement

Despite the presence of sophisticated design and manufacturing techniques, lenses can still vary considerably in imaging quality because of manufacturing errors. Because of the growing demands in imaging performance of lenses their characterisation by help of the Modulation Transfer Function (MTF) as the premier parameter for objectively evaluating is more and more used.
The optical industry uses this parameter as meaningful quality function for the objective evaluation of optical systems.
The MTF describes how the image contrast varies with spatial frequencies. It is expressed as the ratio of contrast in the image to contrast in the object as a function of spatial frequency of a line grid with cosinus functional transmission. Spatial frequency is expressed in terms of line-pairs per millimeter (lp/mm). The MTF combines image resolution and contrast into a common representation.
Another feature of an MTF measuring instrument is, that it allows system testing in situations similar to actual applications. Field angle positions, spectral ranges, distances between object- and image plane can be replicated or simulated in the test of an optical system.
MTF measuring instruments are characterised by large versatility, there apart from the MTF numerous further parameters can be derived, e.g. field curvature, chromatic aberrations, effective focal length, back focal length or line spread function. The MTF measurement offers a method to engineer or test technician for the direct measurement of the picture characteristics and permits thereby conclusions on error causes in the manufacturing process. MTF measurement results can be compared with the associated optics calculation.

The solution for many measuring tasks

MTF Variant

Measuring principle

The MTF measurement is based on the picture (provided by the lens under test) of an edge or a gap almost at the same time in meridional and sagittal direction.
The picture of the edge or line produced by the test specimen is seized and evaluated over an image processing system. In the case of use of the edge picture first the line spread function is computed through to differentiate the edge picture.
From the fourier transformation of of the line spread function the complex optical transfer function results. The MTF is the amount of the fourier transformation of the line spread function.

Measuring procedure

For the measurement the interactive real time mode and the fully automatic measuring mode stand for order.
In the interactive real time mode can be represented the MTF as well as the edge- and the line spread function as

live image on the PC screen. Thus MTF Variant can be used e. g. during the fine tuning with the objective assembly. The results of interactive measurements can be stored and represented together in diagrams. On the basis of the freely selectable designation of the curves these can be identified in the diagram.
In the fully automatic measuring mode measuring templates are processed automatically. These are programmed and stored generally once by the user. A measuring template contains information about the object angles (or field points) and azimuths which have to be measured. One or more templates can be assigned to a certain type of objective.
After the start the complete measurement runs off fully automatic.
As result first a quick report is generated. The quick report contains the focus curve as well as all measurements with clear marking, made in the measuring expiration. Additionally the numeric measured values are available for as many as desired freely selectable spatial frequencies.
The diagram contains the option to draw in expected values for the contrast as function of the spatial frequency, so that a comparison between measured value and desired value is very easy and fast possible.

On a view
• real time representation of MTF, ESF (edge spread function) and LSF (line spread function) on the PC screen
• fast switching between tangential and sagital MTF measurement
• comparison with freely selectable desired MTF-values in the diagram
• real time MTF for fine tuning during the objective assembly
• simple change between different measuring wavelengths
• fast change between measurement on the axis and in the image field
• alternatively manual or automatic azimuth-dependent measurement
• software controlled rotation of the specimen around 360° with automatic measurement of the contrast values for a given spatial frequency and a freely selectable number of azimuths
• operation and controlling of the hardware by joystick, mouse and PC keyboard
• graphic and numeric representation of the measured values with drawn in desired values (optional)
• small space requirement
• automatic production of meaningful metrology records (quick report)
• diagram of the focus curve (contrast for given spatial frequency)
• software controlled or manual focusing
• automatic focusing with a user selected spatial frequency
• alternatively fully automatic or manual procedure for measuring functions up to 7 axis
• measurement of chromatic aberrations
• measuring procedure very easily programmable by user
• measurement of focal length (infinity/finite) or magnification (finite/finite)
• easy to adapt to different measuring tasks
• software interface for digital cameras and frame grabber for analogue cameras
• objective data base

Technical parameters

Parameter	MTF Variant
MTF accuracy	±0.02
MTF repeatability	±0.02
frequency range	0 ... 200 c/mm
object height	< 100 mm, automatically adjustable
image height	< 30 mm, software controlled adjustment
azimuthal measurements	360°, manually/automatically
focal length range	0 ... 200 mm
object/image conjugates types	finity/finity infinity/finity
optical length	200 ... 800 mm
spectral range	360 ... 1,000 nm
spectral measurements	with filters possible
maximum field angle sin(w)*	60°
maximum free aperture	50 mm (MTF Variant Standard) 150 mm (MTF Variant 150)
autofocus	yes, for freely selectable spatial frequency
automatic measuring procedure	yes, for up to 7 axis
maximum specimen diameter	85 mm
measuring principle	image evaluation of an edge or a line tangential/sagital
manual measuring procedure	yes, by joystick
operating system	Windows 2000/XP
software	32 Bit
PC	Pentium IV, 256 MB RAM, 32 MB VGA
PC-screen	19" flat panel monitor*

*The indication refers to the mechanically maximally attainable field angle. The optically maximally meaningful field angle depends on the test specimen. The parameters refer to the standard equipment and can be adapted to special measuring tasks.

OEG

Measuring instruments for optical parameters
MTF-measuring instruments
Autocollimation-applications
Special optical measuring instruments

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