ORIS

Station for precision testing small VIS-NIR optical objectives

Fig. 1. Photo of ORIS test station

1 Basic information:

ORIS is a test station for testing short focal length optical objectives. This station enables measurement of all important parameters of optical objectives (MTF, resolution, effective focal length, distortion, vignetting, transmission, back focal length, flange focal length, depth of focus, field curvature, chromatic aberration) of optical objectives working in spectral bands: VIS and NIR.

2 How is built?

ORIS test station differs significantly comparing to typical test stations offered on international market. The main reason is that the station uses a concept of inverse imaging for testing optical objectives. This means that the tested objective projects image of a reference target located at its focal plane instead of creating an image at its focal plane. In detail, a target generator module (high intensity light source combined with a reference target) is located at the focal plane of the tested objective that projects target image into direction of a reflective collimator combined with an imaging camera. The collimator creates image of the reference target at its focal plane where imaging camera captures and digitizes this image. Quality of this output image of reference target projected by tested objective is evaluated using specialized software that calculates parameters of the objective.

ORIS is build using a set of blocks: CRI off-axis collimator, CROL refractive collimators, ORIS base block, set of spectral filters, IM-V imager, PC set, TAS-Ov computer program.

3 Measurement range and accuracy

Measurement range and measurement accuracy depend on version of ORIS station. Precision data is delivered when ORIS version is determined. Below is presented general data.

Table. 1. Acceptable parameters of tested objectives

Parameter	VIS and VIS/NIR optical objectives
Range of acceptable focal length[1]	4 – 75 mm
Minimal acceptable flange focal length[2]	0.5mm
Acceptable Optics length	4 – 100 mm
Range of acceptable aperture of tested objectives	4 – 40 mm
Range of acceptable F-number	0.7 – 10
Maximal simulated sensor (can be extended)	15 × 15 mm
Spatial frequency range for MTF measurement	0 – 450 lp/mm

[1]Minimal focal length can be extended – special version for ultra short focal length optics
[2]Minimal flange focal length can be shortened. Version for negative FFL possible too.
(flange plane in the same point as last surface of the optical objective)

Maximal spatial frequency of resolution target	456 lp/mm
Off-axis angle range[3] (can be extended)	from -60^0 to $+60^0$

Table. 2. Measurement range and measurement relative uncertainty

Parameter	VIS and VIS/NIR optical objectives
MTF measurement uncertainty	± 0.02 (at MTF >0.2)
MTF measurement repeatability	± 0.01 (when MTF >0.2)
Focal length measurement relative uncertainty[4]	≤1%
Distortion measurement relative uncertainty[5]	≤ 4%
Distortion measurement sensitivity	≤ 0.6%
Vignetting measurement relative uncertainty	≤ 3%
Relative transmission measurement relative uncertainty	≤ 3%
Absolute transmission measurement relative uncertainty	≤ 4%
Back focal length measurement relative uncertainty	≤ 1%
Working focal length measurement relative uncertainty	≤ 1%
Depth of focus measurement relative uncertainty	≤ 4%
Field curvature measurement relative uncertainty	≤ 6%
Chromatic aberration measurement relative uncertainty	≤ 5%

Attention: Measurement uncertainties presented in table above should be treated as approximate values. Uncertainties of some of parameters (focal length, back focal length, distortion, depth of focus, field curvature) do depend not only on quality of ORIS test station but even more on quality of image projected by tested objective. Better image quality better measurement. This relationship occurs because measurement of these parameters requires to mark edges of image of reference target. More blurred edges means that measurement errors are higher.

VERSIONS

ORIS stations can be delivered in many different versions. The version is described using one letter code presented in the table below.

Table. 3. Definition of codes used to describe versions of ORIS test system

1	2
Code	**Test capabilities**
A	MTF (on – axis)
B	MTF (on – axis, off – axis, sagittal, tangential), effective focal length, and resolution
C	As in point B but additionally: distortion, vignetting, relative transmission
D	As in point C but additionally: absolute transmission
E	As in point D but additionally: back focal length, flange focal length, depth of focus, field curvature
F	As in point E but additionally: chromatic aberration, MTF through–focus

Example: ORIS-B means the following ORIS test system: 1) test station capable to measure MTF (on – axis, off – axis, sagital, tangential), effective focal length, and resolution.

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[3]Maximal FOV of tested objective is equal to two times of off-axis angle range

[4]Uncertainty of measurement of focal length is typically better than 1%. Value in data sheet is conservative value for a case of poor quality objective when image is blurred.

[5]But not better than indicated by sensitivity value