

# OPO test station

Tester of telescopic sights



Fig. 1. Photo of exemplary telescopic sight



Fig. 2. Photo of OPO test station

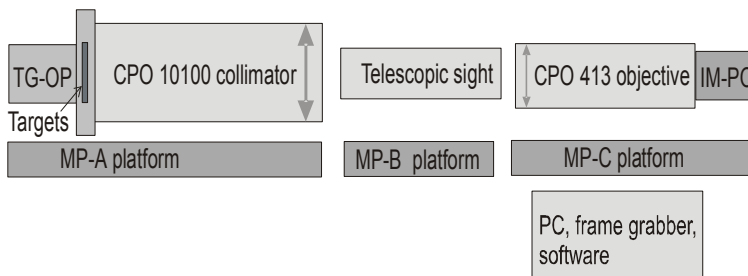


Fig. 3. Simplified block diagram of OPO test station

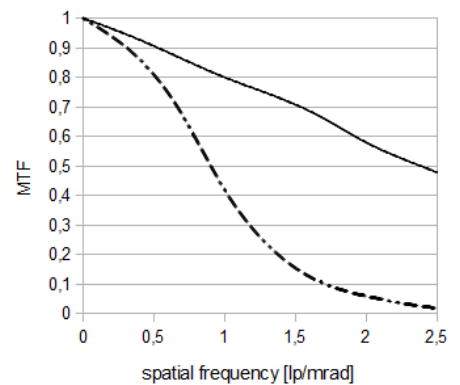


Fig. 4. MTF of two exemplary telescopic sights of different quality

## BASIC INFORMATION:

Telescopic sights is a group of afocal optical systems (focal length equals to infinity) working in visible spectral range built using telescope design concept. This group can be divided into aiming scopes, binoculars, spotting scopes, and astronomical telescopes. The astronomical telescopes group is excluded from further analysis.

Main task of telescopic sights is to generate high quality image of observed scenery that could be later evaluated by human observer. It is critical that image generated by a telescopic sight should be perceived as sharp by human observer.

There are many telescopic sights offered on international market of very different quality and price. There are many myths on quality of telescopic sights often supported only by brand of manufacturer.

OPO test station is a modular, quasi universal station for testing optical sights. This station enables measurement of a series of important parameters of optical sights: resolution, MTF (on axis, off axis), magnification, distortion, FOV, transmission, vignetting, eye relief distance, exit pupil diameter, diopter range, parallax error. Tested optical sights can be accurately evaluated on basis of these parameters. OPO is a perfect tool for manufacturers, big buyers or repair workshops of telescopic sights.

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### HOW OPO IS BUILT

OPO is built using a concept of computerized system that carries out analysis of reference images generated by tested telescopic sight.

OPO test station is built from a series of modules: TG-OP target generator, CTG controller, set of targets, set of pinholes, CPO10100 refractive collimator, MP-A mechanical platform, MP-B mechanical platform, set of two refractive objectives (CPO413 refractive objective, CPO25), set of two imagers (IM-PO imager, IM-TR imager), MP-C platform, PC, frame grabber, set of aperture reductions, and TOPO test software.

TG-OP is a light source integrated with a reference movable targets that generate reference images. CPO10100 collimator is a high resolution refractive collimator that projects reference images into direction of tested telescopic sight.

MP-A is a mechanical platform that enables precision rotation of CPO10100 collimator in order to simulate off axis targets. MP-B enables positioning of tested sight, MP-B enables positioning of IM imagers, IM-PO is an ultra sensitive high-res imager, IM-TR is a linearized radiometric imager.

### RANGE OF TESTED SIGHTS

Table. 1. Range of tested sights

Parameter	Value
max input aperture	60mm
min input aperture	10 mm
max output aperture	30 mm
min output aperture	2 mm
maximal magnification	30
minimal magnification	1

### TEST RANGE AND ACCURACY

Parameter	Value
Maximal frequency of resolution target	226 lp/mrad (target space)
Off-axis angle range	from 0° to 30°
Uncertainty of resolution measurement	10%
Spatial frequency range for MTF measurement	0- 2.5 lp/mrad (measurement at imaging plane) 0- 2.5xM lp/mrad (measurement at object plane where M is magnification)
MTF measurement uncertainty	+/-0.02 (at MTF >0.2) for on axis +/-0.03 (at MTF >0.2) for off axis
MTF measurement repeatability	+/-0.01 (when MTF >0.2)
Magnification measurement range	1 to 30
Magnification measurement uncertainty	Not worse than 2%
Distortion measurement range	Up to 20%
Distortion measurement relative uncertainty	Not worse than 4%
FOV measurement range	0.2° to 20°
FOV measurement relative uncertainty	Not worse than 3%
Vignetting measurement range	0 to 2
Vignetting measurement relative uncertainty	Not worse than 3%
Transmittance measurement range	0.2 to 1

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Transmittance measurement uncertainty	Not worse than 0.01
Range of eye relief distance	4-150 mm
Exit pupil distance measurement uncertainty	1 mm
Range of exit pupil diameter	2-12 mm
Exit pupil diameter measurement uncertainty	0.4 mm
Range of diopter range	-6 to +6 diopter
Diopter range measurement uncertainty	0.2 diopter at range -6 to +3 diopter 0.5 diopter at range >+3 diopter
Range of parallax error	0 to 10 mrad
Uncertainty of parallax error	0.1 mrad

### VERSIONS

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

Table. 2. Definition of codes used to describe versions of OPO test system

Code	Test capabilities	List of measured parameters
OPO-X	Basic	resolution, exit pupil distance, exit pupil diameter, diopter range
OPO-Y	Medium	Resolution, MTF (on axis, off axis), magnification, FOV exit pupil distance, exit pupil diameter, diopter range
OPO-Z	Expanded	Resolution, MTF (on axis, off axis), magnification, distortion, FOV, transmission, vignetting, exit pupil distance, exit pupil diameter, diopter range, parallax error

### Options:

OPO test station is basically optimized for testing aiming sights and small scopes. However, it can be modified to enable also measurement of parameters typical for binoculars like: Binocular collimation error, Relative Diopter Difference, Defocus between optical channels, Image rotation between optical channels. Please add additional letter B in OPO code.

### WHY OPO?

There are many telescopic sights offered on international market of very different quality and price. There are many myths on quality of telescopic sights often supported only by brand of manufacturer. Only by measurement of a series of important parameters claims about quality of telescopic sights can be verified. Such verification can be extremely important in some applications of telescopic sights (military/security application, search and rescue operations, astronomy, etc).

It should be emphasized that at present OPO station is the only commercially available station optimized for testing telescopic sights offered at international market.

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