OPO

Tester of telescopic sights

Fig. 1. Photo of exemplary telescopic sight

Fig. 2. Photo of OPO test station

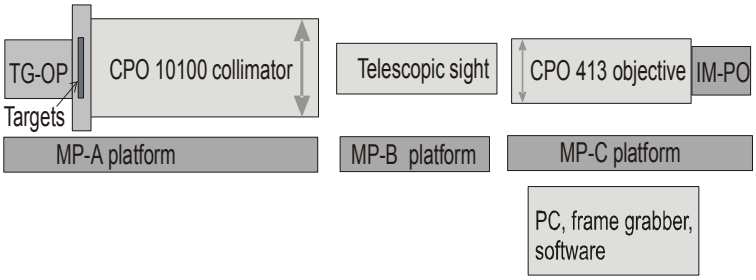

Fig. 3. Simplified block diagram of OPO test station

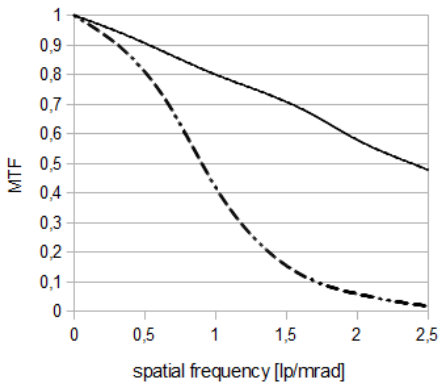

Fig. 4. MTF of two exemplary telescopic sights of different quality

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 computerized 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 manually operated computerized system that carries out analysis of reference images generated by tested telescopic sight. Simple design concept based on manual operation and modularity ensures high reliability and long life time.

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 0^0 to 30^0
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	0.2º to 20º
FOV measurement relative uncertainty	Not worse than 3%
Vignetting measurement range	0 to 2
Vignetting measurement relative uncertainty	Not worse than 3%

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Transmittance measurement range	0.2 to 1
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, and image rotation between optical channels. Please add additional letter B in OPO code.

WHY OPO?

Inframet does not claim that OPO is the best test station for testing optical sights available on the market because of unique test capabilities or test automation. There are other test stations of similar test capabilities or even stations that offer measurement of several more parameters. Next, OPO does not offer automatic testing at all. However, OPO is the oldest specialized station for testing telescopic sights commercially available on international market. The station is based on highly reliable design and easy to operate by technicians of minimal optical education. So far Inframet has not got no even a single report of technical problems with OPO station from its customers. Next, the station offers high test speed when used by well trained technicians.

It is true that there are on the market more sophisticated test stations comparing to the OPO station. These stations offer automation of testing and apparently can reduce requirements on technician education and cost of work force. However, practically automatic testing means sophisticated mechanical design of movable parts that finally brings reduced reliability. This factor is of particular importance as station warranty is short. Next, automatic testing does not mean faster testing comparing to manually operated station. Finally, human is still needed to operated these so called automatic test stations for to load the station, to start testing and to supervise. Therefore there is no practical gain in reduced cost of work force by using so called automatic stations, too.

Because of reasons presented earlier OPO station is a very good choice against other test stations offered on the market for customers who have plans to use the station for many years and have a technician having minimal optical education and skills to operate the OPO station. .

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