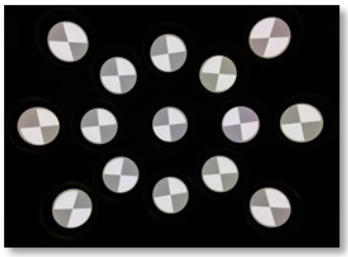
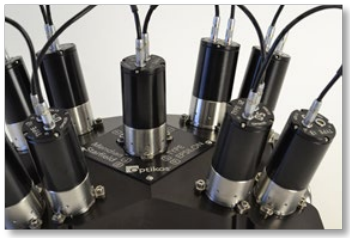
Optikos®

The Optical Engineering Experts®

MERIDIAN® CAMERA TESTING





The Meridian® approach to camera testing: Seeing well outside the box

Short focal length small aperture cameras are everywhere you look, proliferating in cell phones, web cams, personal recording devices, drone surveillance systems, and of course, automobiles. Heightened consumer expectations regarding high quality imaging performance and the use of many cameras in automotive safety systems have established a need for high performance test equipment for these devices that did not exist just a few years ago.

The Meridian® family of test equipment is our answer to this need. We first developed the Meridian Starfield product line in which high volume testing requirements are answered by illuminating multiple field points simultaneously and assessing imaging performance in just a single video frame. Then followed the introduction of our Focusing Target Projector (FTP) suite, in which apparent object distances of reference targets are set on demand. The newest member of this growing family is the Meridian FLEX—a highly configurable testing platform that not only answers the testing challenges that our customers face right now, but is also designed to address many they have yet to encounter.

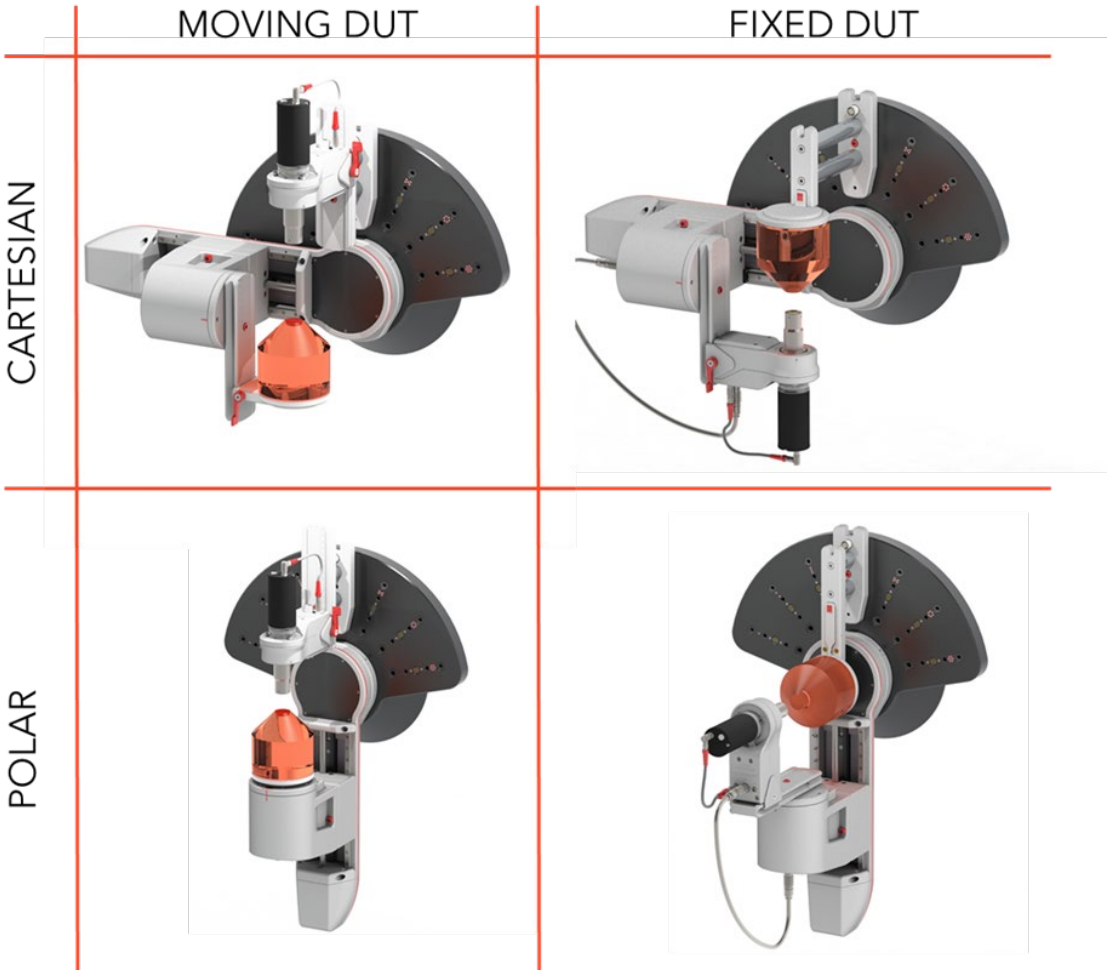
The members of the Meridian family have this in common: they can generate fields of virtual objects in a compact space, obviating the need to place enormous test targets at a large distance. Wide field cameras need ever wider test targets, and there comes a point at which printed targets can no longer serve the need.

MERIDIAN® FLEX CAMERA TESTING PLATFORM (Patent Pending)

Flexible enough for the R&D lab while fast enough for production testing, the Meridian FLEX platform provides camera manufacturers and integrators with a powerful tool to meet their testing needs. At its heart is a high-speed high-precision robot that can place a target at any specified field point in a variety of different instrument configurations. To begin with, there are two coordinate systems for precise target pointing: Cartesian (uncoupled pitch and yaw), and spherical polar (azimuth and zenith). The Meridian® FieldPoint software takes care of the tricky math, so coordinate transforms are performed seamlessly! The robot then either points the target projector at the Device Under Test (DUT), or points the DUT at the target projector. And finally, there are split configurations in which one motion axis is assigned to the DUT and the other to the target projector.

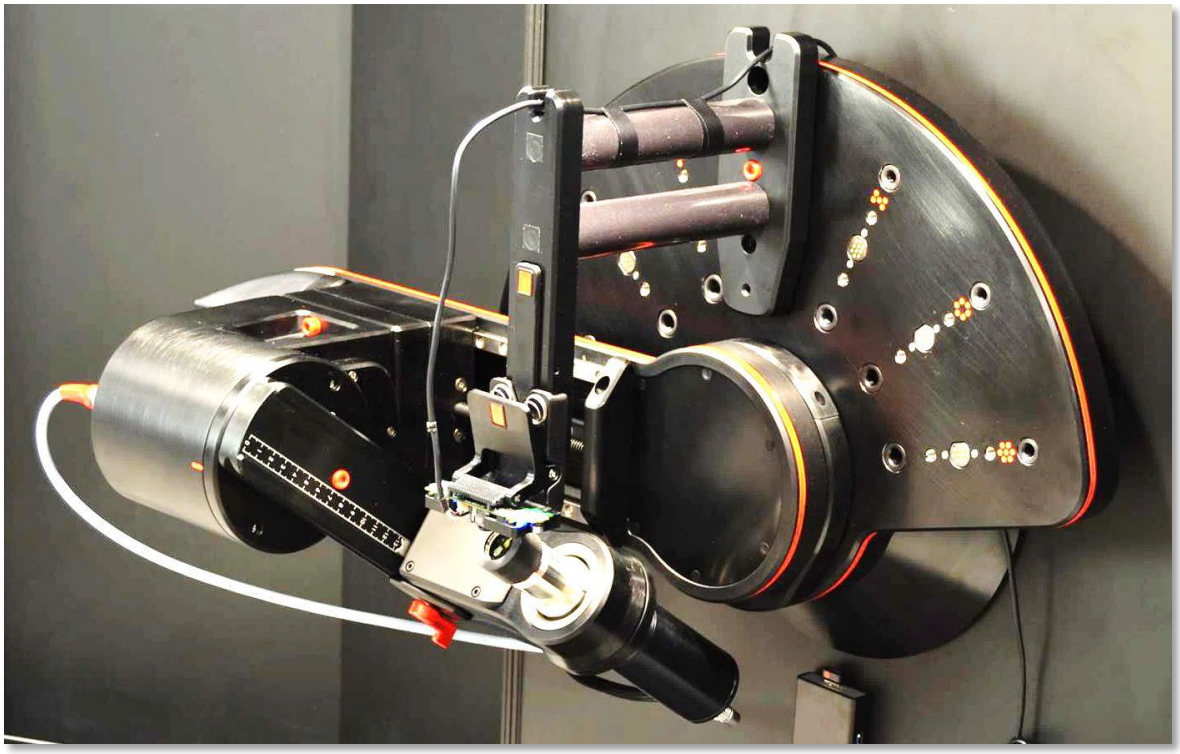
Selecting the appropriate configuration depends on the maximum field of view of the DUT, the DUT housing geometry, the size and proximity of adjacent support electronics, and convenience. An important advantage of mounting the DUT to the robot is that it may then be pointed at optional stimulus stations other than the target projector, thereby enabling the assessment of parameters such as veiling glare, signal transfer function, and chromatic characteristics.

The standard optical source for testing is a Meridian® Focusing Target Projector (FTP), which is used in the measurement of Modulation Transfer Function (MTF) and geometric imaging parameters such as distortion. Prior to testing, an FTP of a focal length suitable for the DUT is mounted in the FLEX. FTPs are easily interchanged, and mount into a small annular roll stage that serves to set an appropriate angle between the target edge and the sensor pixel array at each field position. Future product offerings will include target projectors for measuring LWIR cameras.



In configurations in which the DUT is mounted to the robot, free cabling is minimized by the provision of USB3 and Ethernet hookups for retrieving the video signal, and DUT power on an adjacent connector. This is important since the robot is capable of making large moves very quickly. For safety reasons, and to minimize ambient light, the robot is entirely enclosed behind locking safety doors during operation. The entire instrument is floor standing and the height of the enclosed portion may be adjusted for the standing or seated comfort of the operator.

Camera assemblies differ in their optical characteristics, their mechanical interfaces, and their electrical interfaces. The mounting scheme for any given DUT will necessarily depend on the specific features of that device, but generally comprises a standard riser assembly furnished as standard equipment and a custom DUT nest usually provided by the user. In some cases it may even be possible to print the nest.



Meridian FLEX with the FieldPoint application will measure multiple optical parameters of cameras, including:

- Horizontal and vertical resolution (MTF)
- Through-focus MTF (with Focusing Target Projector)
- Geometric Distortion
- Focal Length
- Field of View
- Bore-sighting and roll (with special DUT Nest)
- Stray light type measurements (with optional stimulus source)
- Signal Transfer Function (with calibrated stimulus source)
- Chromatic Functions (with optional stimulus source)

Specifications for the Meridian FLEX platform are not easily summarized because so many aspects of the instrument are configurable, and because many parameters are coupled. For example, a large DUT may shorten the travel range of one of the motions in a particular mode. Given the number of configuration modes, there is usually more than one way of setting up for a particular DUT. The specifications listed here are therefore abbreviated and serve as general cases. They are mainly mechanical in nature since the optical specifications are determined by the FTP or other stimulus source that is used. Our engineers are always ready to answer specific questions about your DUT and the applicability of this platform for your testing needs.

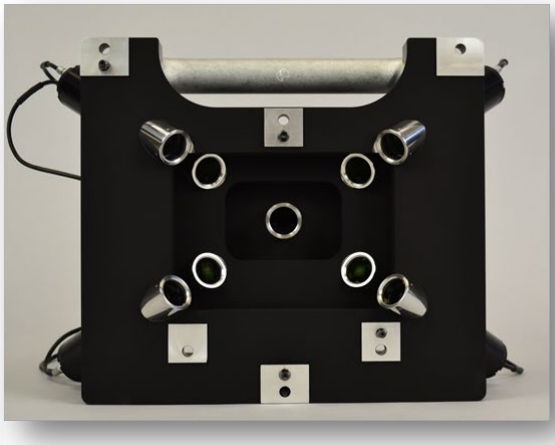
SPECIFICATIONS*

MERIDIAN FLEX	
Allotted DUT Volume	Approximately cylindrical, 100mm diameter x 100mm height
Maximum FOV (Cartesian Mode, Moving Projector)	110°x110° (60mm FTP)
Maximum FOV (Polar Mode, Moving DUT)	Hemispherical
Speed	Typically 1s per field point for a typical webcam measurement with 17 field points, one video frame per field point.
Pointing Accuracy	0.01°

*Please note that shipments of the Meridian FLEX platform are scheduled to begin in the second quarter of 2018, and that all specifications are preliminary.

MERIDIAN® STARFIELD PROJECTOR ARRAYS

A Meridian Starfield assembly is a rigid assembly of multiple target projectors that together cover the entire field of view of the DUT by projecting test targets from all desired field angles. Target projectors used in a Starfield assembly may either be of the fixed focus type in which the apparent object distance is factory set, or they may be Focusing Target Projectors, or a combination of both types. Different focal length projectors are available to suit the focal length of the DUT. Each projector contains a microcontroller, factory calibration data, and a unique address making it possible to remotely query and control the brightness of any given field point. All illumination is provided by white LEDs which are driven in a linear manner in order to avoid any flicker issues. A range of color temperature white LEDs is offered, and NIR illuminators are available on request.



The Meridian Starfield mount consists of a thick plate into which precision bores are machined to receive the target projector barrels. This allows for consistent and repeatable testing of field points. When provided with a customer's camera lens prescription or black box model, Optikos can design unique targets to compensate for high distortion field points for ultra wide FOV cameras.

If the set of field angles required by a customer cannot be satisfied from our library of existing Starfield designs, we will work with the customer to design one specifically tailored to their needs. This includes specifying the mechanical interface, the selection of focal lengths and targets for the projectors, and configuring them so as to minimize the working distance to the DUT. We have developed special software to analyze projector configurations to ensure that there is no vignetting of the target, and to determine the size and shape of the target pattern in the image plane of the DUT.

Measurements may be made with Meridian® Prime software, or may be integrated through library calls with customer software, and include:

- Simultaneous horizontal and vertical MTF measurements at multiple field points in a single frame
- Geometric imaging parameters
- Camera Line of Sight (LOS) tip-tilt relative to camera housing (Requires alignment of DUT nest to Starfield)
- Camera roll angle relative to camera housing (Requires alignment of DUT nest to Starfield)

Starfield assemblies are also increasingly being used by customers in active alignment setups, especially for wide field camera assemblies in which the need to balance the imaging performance across a wide range of field angles frequently requires a more sophisticated approach than simply back illuminating printed targets.

Target projectors in a Starfield assembly are daisy-chained together with a Power+RS-485 bus architecture. Each assembly ships with a control box with power and USB inputs that creates the RS-485 and power connector interface. High reliability Lemo® connectors are used throughout.

SPECIFICATIONS

FIXED FOCUS TARGET PROJECTORS	
Available focal lengths* (Clear Apertures)	35mm (11mm) 60mm (19mm) 75mm (23mm) 80mm (38mm) 200mm (48mm)
Source Color Temperature Options (White LED)	3000K, 3500K, 4000K, 4500K, 5000K, 5700K, 6500K
Source Lifetime	>50,000 hours
Collimation (Finite object distances available)	±0.005 diopters typical
Target Contrast Ratio	1000:1 typical, 4:1 optional
Target Types	Orthogonal Crossedge (typical), Distorted Crossedge, Crosshairs, Edge
Operating Voltage (of supplied AC power adapter)	100 to 240 VAC

*If we don't have the focal length and aperture you need then we will consider adding it to our library!

STARFIELD ASSEMBLY	
Number of Target Projectors	1 to 98 (9 and 13 are most common)
Pointing Accuracy (w.r.t. line of sight of on-axis target projector)	Semi field angles <25°: ± 0.05° of nominal Semi field angles <40°, ± 0.1° of nominal Semi field angles<60°, ±0.2° of nominal

MERIDIAN® FOCUSING TARGET PROJECTORS (FTP) (Patent Pending)

The Meridian series of FTPs is a growing collection of miniature target projectors in which the apparent object distance and brightness of the projected target may both be set remotely. Besides their routine use in both Meridian Starfield assemblies and on the Meridian Flex platform, these projectors also find application in standalone test setups.

The FTP provides a convenient means of placing a virtual standard target over a wide range of apparent object distances in a compact space. This functionality enables the test engineer to perform testing over a range of conjugates and to perform through-focus resolution testing of fixed-focus cameras in a compact space. Through-focus data acquired in this manner and which reports the object distance at which the DUT is actually focused can provide important statistical process feedback to active alignment operations.

Focusing Target Projectors are offered in several different focal lengths and with a choice of different color temperature white LED illuminators. All units are factory aligned and calibrated, and all calibration information is stored in the device. The standard target used in the FTPs is an orthogonal "Crossedge Target" but other target geometries are available. Our engineers are always ready to discuss your particular testing requirements and to

make appropriate recommendations. In fact, it is generally a good idea to consult with our engineers regarding the applicability of any given projector for a particular testing requirement. By their very nature FTPs are projectors of extended objects, so they may not be diffraction limited across their entire field or over the full aperture. The clear aperture is sized to prevent vignetting at a given distance, but in a test system it is the entrance pupil of the DUT that serves as the system stop. We will assist in selecting an FTP that does not itself contribute significantly to the measured MTF.

The robustness of the FTP design is assured by the incorporation of linear output encoders and special guide assemblies. The patent-pending drive scheme also enables us to achieve a high degree of straightness of travel of the center of projected target.

SPECIFICATIONS

MERIDIAN® FOCUSING TARGET PROJECTOR				
FTP TYPE	**018**	**039**	**064**	**102**
Nominal Focal Length (mm)	18	39	64	102
Clear Aperture (mm)	8	14	23	23
Standard Target Type	4mm Crossedge	5mm Crossedge	8mm Crossedge	10mm Crossedge
Standard Target Optical Density	1.3	1.3	1.3	1.3
Full target angular extent when collimated (°)	12.6	7.3	7.1	5.6
Closest Virtual Object Distance w.r.t. FTP Forward Flange (m)	0.025	0.05	0.35	0.80
Closest Real Image Distance w.r.t. FTP Forward Flange (m)	-0.10	-0.30	-0.60	-1.20
Maximum time to traverse adjustment range (s)	4	4	4	4
Uncertainty in reticle location w.r.t. objective lens focal plane (mm)	±0.012m	±0.012	±0.015	±0.020
Maximum boresight deviation of target center w.r.t. FTP mounting features (°)†	0.04	0.04	0.02	0.01
Maximum deviation of target edge from notch in mounting flange (°)	0.5	0.5	0.5	0.5
Illuminator options	White LED (3000K, 3500K, 4000K, 4500K (standard), 5000K, 5700K, 6500K), 950nm IR LED			

† The FTP is notable for maintaining boresighting over its travel range. The boresighting error is specified with respect to the mechanical mounting features of the barrel in angular units over the entire travel range. For finite apparent object distances, the lateral object shift may be calculated by measuring the distance to the object location from the front focal point of the FTP, and then applying the boresighting error. For example, an object projected by a 64mm FTP at a distance of 2m will have a maximum lateral uncertainty of 2000 tan 0.02˚ = 0.70mm.

TALK TO US

We're excited to introduce this new category of camera testing equipment that is changing the way engineers and production managers solve testing, characterizing, and quality control requirements. The Meridian product line was created and evolved because we listen to our customers, and it will continue to grow for the same reason. If you have testing needs that we can help with, we'd love to hear from you. It's possible that we can conceive of a new module to solve your particular problem, and it's quite possible that we're already working on it. Optical testing is our core competence. We've been doing it for over 37 years. Talk to us today to learn more.

Get Started with Optikos

Optikos offers metrology products and services for measuring lenses and camera systems, as well as engineering design and manufacturing for optically-based product development. Our standard products are suitable for any industry or application, and we will design a custom product for your specific needs. Learn more at optikos.com.

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DATE OF ISSUE: 09.26.2019