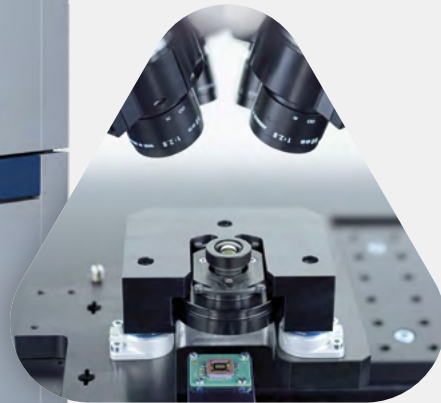# CamTest

Testing and Quality Control of Camera Modules

LEADING TO THE FUTURE OF OPTICS

Optical systems have changed the world. And they will continue to do so. TRIOPTICS is significantly involved in this process.

We are a solution provider for optical measurement and manufacturing systems and offer our customers the right system for their current and future applications.

www.trioptics.com

Quality Testing of Camera Modules and Optical Sensor Systems

Today, the increased demand for complex camera systems used in safety-related and automated object recognition and classification, for instance in the safety & surveillance sector and automotive industry (keywords: autonomous driving and driver assistance systems), has resulted in new and more stringent requirements for the characterization of image quality and the assembly of camera modules.

The entire test chain for optical systems, sensor components and complete camera systems must meet these new requirements. To accomplish this, TRIOPTICS offers the matching technologies and benefits from its long-standing experience in optical testing and complements them with new measurement systems for opto-electric and opto-mechanical parameters.

The following features can be measured:

- Optical characteristics, such as distortion, vignetting and image contrast / MTF
- Opto-mechanical characteristics including the focus position of the image sensor in relation to the lens, the boresight or roll angle
- Opto-electric characteristics, e. g. defective pixels, image noise, linearity and color reprodution

In addition to the complete camera characterization, the measurement parameters are used for an inline calibration of the tested modules.

CamTest R&D   CamTest Stand-alone Device   CamTest Smart

The Right Configuration for Every Application

The CamTest product group covers all use cases for image quality testing of camera modules. Depending on the number of samples to be measured as well as the parameters needing to be tested, the CamTest product group has the right solution in its portfolio.
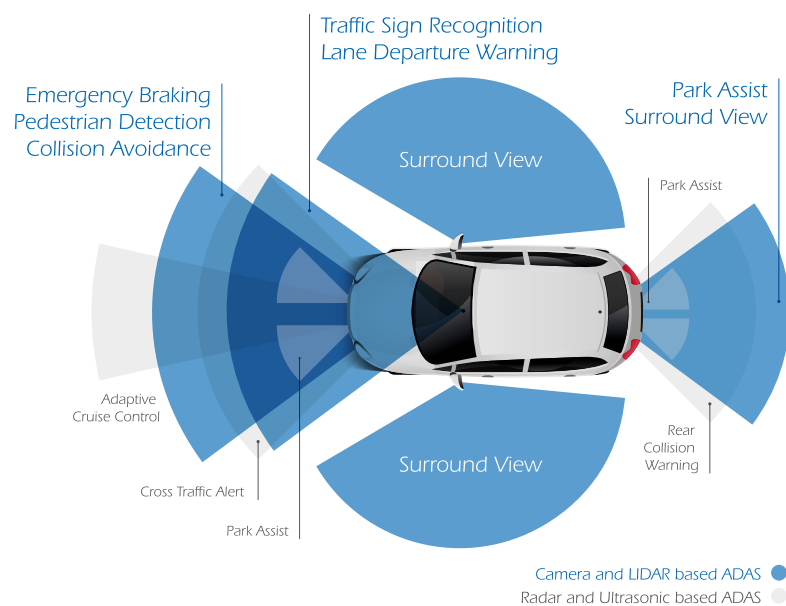
CamTest systems can either be used as semi-automated stand-alone measurement device for sampling and in small-series production or can be integrated in a fully automated production line for high-volume output. Due to the various types of object generators used, there are four different types of CamTest measuring processes:

- CamTest MTF
- CamTest Focus
- CamTest Chart
- CamTest Spectral

New Standard in the Automotive Industry

In particular, the automotive industry is using our 100% testing and quality control technology to achieve a high degree of reproducibility and accuracy in volume production with the shortest possible cycle times. For this purpose, TRIOPTICS offers test systems that make it possible to determine the key measurement parameters in a reproducible way and with the shortest measurement time as an end-of-line (EOL) test integrated in fully automated production lines.

For research and development applications TRIOPTICS offers a dedicated versatile measurement device – CamTest R&D. The new CamTest Smart system is suitable for flexible low to mid volume production to cover all essential test parameters.

Traffic Sign Recognition
Lane Departure Warning

Emergency Braking
Pedestrian Detection
Collision Avoidance

Park Assist
Surround View

Surround View

Park Assist

Adaptive
Cruise Control

Cross Traffic Alert

Park Assist

Surround View

Rear
Collision
Warning

Camera and LIDAR based ADAS ●
Radar and Ultrasonic based ADAS ●

CamTest – Four Main Measuring Processes Covers all Relevant Test Parameters

The modular set up of the CamTest system – using different innovative types of object generators – allows fast and comprehensive measurements and quality control of camera modules and optical sensor systems.

Measurement Parameters at a Glance
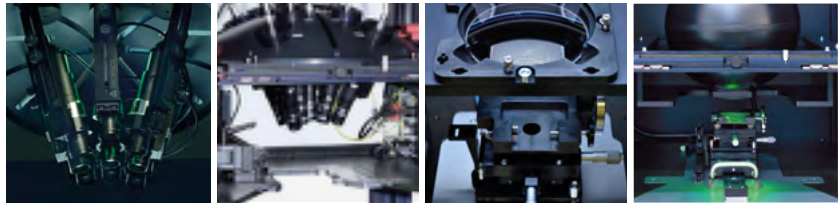
|	CamTest MTF	CamTest Focus	CamTest Chart	CamTest Spectral
Target Projection	Fixed collimators	Focusing collimators	Test chart (with or without relay lens)	Integrating sphere
Measurement Parameters				
MTF, LSF, SFR, ESF	●	●	○	–
Image Plane Tilt, Defocus, DOF	–	●	–	–
Boresight Shift, Roll Angle	●	●	●	–
Optical Centre	–	–	●	–
Distortion, EFL	–	–	●	–
Defect Pixel, Particle, FPN	–	–	○	●
OECF, Dynamic Range, White Balance, SNR	–	–	○	●
Relative Illumination	–	–	○	●
Color Rendering, Crosstalk	–	–	○	●
Spectral Response	–	–	–	●

● core parameter · ○ optional parameter · – not available

DOF: Depth Of Focus · EFL: Effective Focal Length · ESF: Edge Spread Function · FPN: Fixed Pattern Noise
LSF: Line Spread Function · MTF: Modulation Transfer Function · OECF: Opto-Electronic Conversion Function
SFR: Spatial Frequency Response · SNR: Signal to Noise Ratio

CamTest Focus – for Precise Determination of Best Focus Plane

The collimator virtually projects the target onto the sample. By using focusable collimators, any object distance of 1m to infinity can be generated. This makes it possible to measure the position and tilt of the best focus plane. The setup provides a field of view of +/-90°. The CamTest Focus module measures image quality parameters such as:

- MTF
- SFR
- Through-focus MTF
- Image Plane Tilt
- Boresight Shift
- Roll Angle.
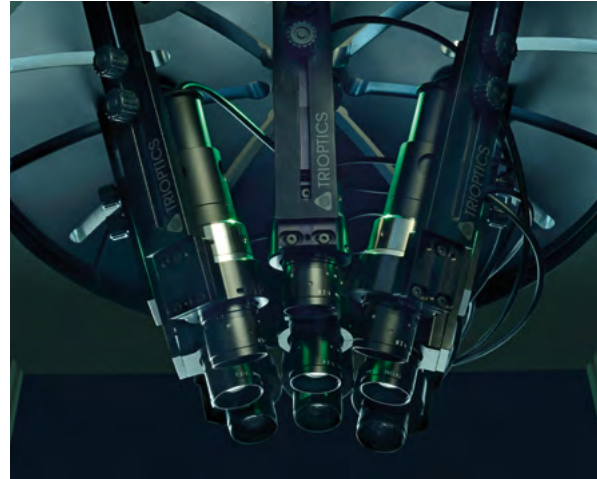
The setup with focusing collimators allows a variable object distance from finite to infinite in one measurement setup.
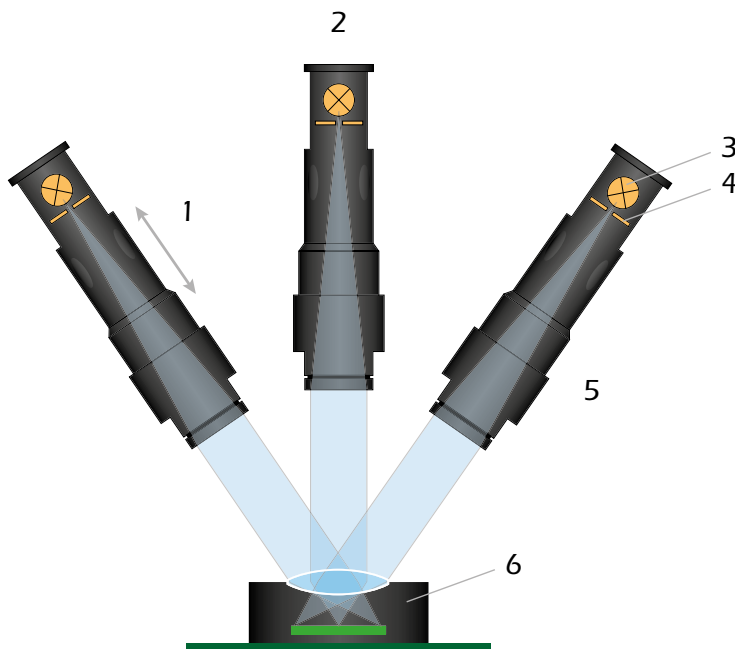
The schematic diagram shows a typical collimator arrangement.

1	Focusable collimator
2	Arrangement of several collimators for measurement from different angles
3	Illumination of the focusing collimator
4	Reticle
5	Variable measuring distance from finite to infinite through the focusing collimator
6	Sample (lens and sensor)

New: Special Collimator Dome Solution for CamTest Focus and CamTest MTF

The „Plug & Produce" dome design offers highest reliability and robustness for repeatable and reliable results in production lines. Furthermore, it ensures safe and stable operation and grants easy maintaining by "Plug & Produce" handling and installation. Due to the optimized design the collimators can be installed at defined measurement positions.


CamTest Focus

Key Features and Benefits

- Easy installation of collimators: Plug & Produce functionality for easy handling
- Reduced change-over times for various products
- Highest stability and robustness because of build-in holders
- Up to 17 collimators
- Customized design for various defined measurement positions
- Stable and fixed default position of collimators at dedicated measurement positions
- Less adjustment effort for collimator installation due to fixed default position

CamTest MTF – One-Shot MTF Measurement
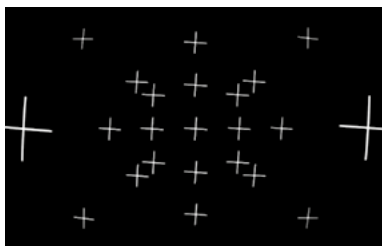

MTF Measurement with fixed collimators

For fast testing of the image quality (MTF) of camera modules at various field positions, a setup with fixed collimators, which are preset for infinite or finite object distances, is suitable. Furthermore, the LSF, SFR and ESF can be easily measured with this module. The CamTest MTF system is particularly well-suited for extremely fast MTF measurements during the final quality check in the series production of camera modules.

CamTest Chart – for Easy Measurement of Distortion

The CamTest Chart system projects a test target from finite (first schematic diagram) or infinit (second schematic diagram) object distance to the camera module under test. For an infinite test setup a specially designed relay optic is used. The test system measures the camera lens geometric distortion (LGD), TV distortion, camera boresight and optical center, camera EFL and FOV. From the distortion measurement the distortion coeffecients (Seidel coefficients) are

Measurement of distortion

obtained used for the calibration of the camera module under test, which is very important mainly for ADAS (Advanced Driver Assistance Systems).
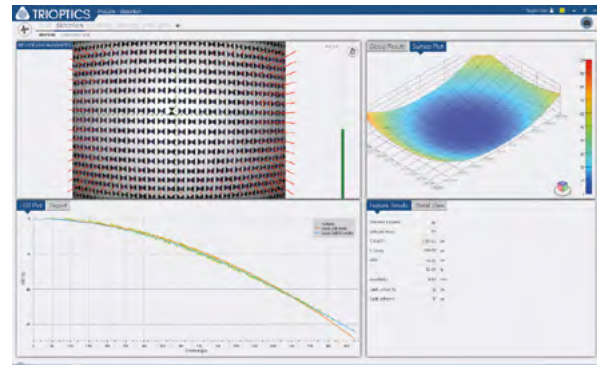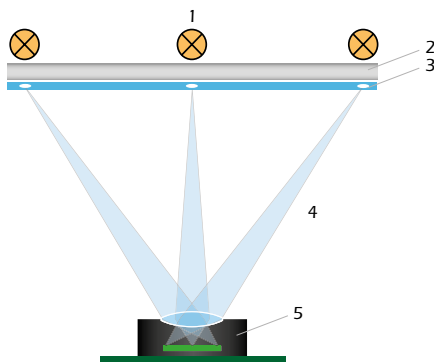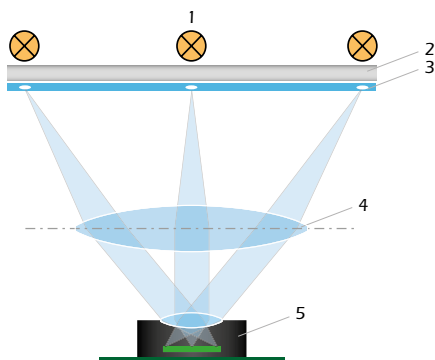

Schematic diagram CamTest Chart

1. Illumination
2. Diffusor
3. Test chart
4. Finite – infinite conjugated setup
5. Sample (objective with sensor)


Schematic diagram CamTest Chart with relay lens

1. Illumination
2. Diffusor
3. Test chart
4. Objective lens for infinite imaging
5. Sample (objective with sensor)

# CamTest Spectral – for Exact Determination of Sensor Parameters

The CamTest Spectral module comes with an integrating sphere in finite object distance. The integrating sphere serves as a light source in order to obtain the diffuse light required for the measurements. This device enables measurements of camera modules with up to 180° field of view. The sphere allows a light uniformity of more than 95 %. The setup is particularly well-suited for measuring parameters such as defect pixels, FPN, color rendering, OECF, relative illumination and dynamic range.
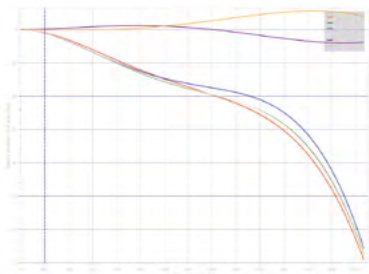
Shading
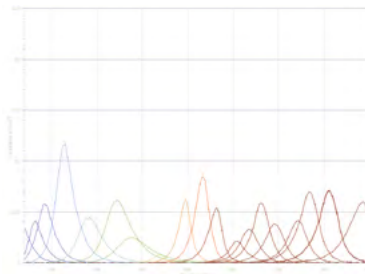
Color Response
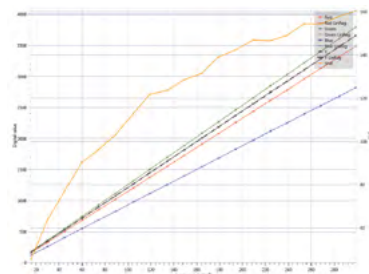
OECF

CamTest R&D – Versatile Testing of Camera Modules for Prototyping and Quality Control

The CamTest R&D is a high-precision measurement device for testing a variety of image quality parameters of camera modules. It features a wide off-axis angle range of up to +/- 110°. The computer-controlled test target distance can be freely selected from finite distances to infinity using a focusing collimator.

The CamTest R&D is available for various wavelength ranges (VIS, NIR and LWIR) and can be used for many types of camera modules. This high degree of flexibility makes the test instrument an ideal solution for comprehensive measurement tasks in the R&D environment.

Upgrade ImageMaster® HR to CamTest R&D

The basic setup of the CamTest R&D is based on the proven ImageMaster® HR, the industry standard for testing the image quality of lenses. Consequently, existing ImageMaster® HR instruments can be upgraded to CamTest R&D devices.

CamTest Smart – a Compact Testing System

TRIOPTICS offers a 100% testing technology for all essential image quality characteristics of camera modules in just one compact system. It integrates all test parameters in one device. Therefore, along with common optical and opto-mechanical parameters such as MTF, SFR, defocus, image plane tilt and rotation, and distortion, the system also covers additional sensor testing parameters, including OECF, dynamic range, white balance, relative illumination, spectral response and more.

Key Features and Benefits

- Testing of all essential image quality characteristics of camera modules
- A very compact system suitable for flexible low to mid volume production and R&D
- Small footprint
- Flexibility with regard to different products
- Fast change-over times
- Target projection: focusing and fixed collimators, test chart, integrating sphere
- Manual and automated loading possible
- Fully automated process

CamTest Smart

Technical Data at a Glance

	CamTest MTF	CamTest Focus	CamTest Chart	CamTest Spectral
Technical Specifications				
Field of view	Up to +/- 70° diagonal field of view (up to +/- 90° after individual clarification)	Up to +/- 70° diagonal field of view (up to +/- 90° after individual clarification)	Up to +/- 35° diagonal field of view (up to +/- 50° after individual clarification)	Up to +/- 70° diagonal field of view (up to +/- 80° after individual clarification)
Standard illumination wavelength (others on request)	White LED colour temperature 6500 K	White LED colour temperature 6500 K	Backlit LED green narrow spectrum	Adjustable spectrum 420 – 780 nm
Sample effective focal length	1 – 12 mm	1.8 – 12 mm	1 – 12 mm	1 – 12 mm
Object distance	infinity	1000 mm – infinity	Finite / infinite	1000 mm – infinity
Typ. measurement time	< 2 s	< 15 s	< 5 s	< 5 s particle & defect pixel, < 5 s shading, < 10 s OECF, < 15 s spectral response
Sample diameter / Free aperture	n.a. / < 5 mm	n.a. / < 5 mm	n.a. / < 5 mm	2 – 20 mm / n.a.
Camera interface	Software Development Kit provided enabling to connect customer camera with own framegrabber to all standard interfaces (either MIPI, analog or directly to e. g. USB, FireWire, CamLink, GigE).			

	CamTest Stand-alone Devices	CamTest Smart
Dimensions		
Depth	875 mm	1226 mm
Height	2150 mm	2159 mm
Width	1120 mm	1740 mm
Weight (approx.)	Up to 350 kg	750 kg
External Supplies		
Voltage	100 – 130 VAC or 220 – 230 VAC	
Power consumption	typ. 100 W – 500 W	300 W – 1000 W
Compressed air	5bar – 7bar (optional for sample fixation)	
External Communication Interface	TCP – IP OPC – UA	

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