

Solutions to test imageQuality



Image Engineering
Product Catalog

2025

Dear Image Quality Professionals,

Since our founding in 1995, we have become a global leader in image quality testing. We have helped companies from various industries worldwide improve their imaging devices by utilizing our image quality testing services, equipment, and knowledge.

Today, we house one of the industry's largest independent test laboratory and have become one of the world's leading suppliers of image quality test equipment and solutions. Our iQ-Lab provides a variety of camera tests, including VCX mobile phone and webcam testing and camPAS testing for performance testing of automotive camera systems.

Our products and solutions are centered around 200+ test charts that are expertly designed to assess the various image quality factors, including camera resolution, distortion, flare, etc. Our illumination devices, many of which are based on iQ-LED technology, provide uniform illumination of the test chart or test scene.

We also provide various measurement devices for accurately measuring the different functions of a camera system, such as geometric calibration or image stabilization. We have also developed advanced solutions, such as Vega, for HDR and flicker performance testing. Finally, the image quality test results can be analyzed using the AI-powered iQ-Analyzer-X analysis software.

We are actively engaged in many international committees responsible for defining and updating industry standards for image quality, including ISO/TC42, IEEE-P2020 for ADAS applications, and IEC 62676-5 for security cameras (see website for complete list).

As of June 2021, we are officially a member of the Nynomic Group. With Nynomic as a strategic investor, we now have a partner from a similar background who can provide us with the resources to achieve our goals much faster and at the highest possible level. In addition, we became ISO 9001 certified* in June 2023 to ensure the highest level of customer satisfaction.

Since our founding, our mission has always been to prepare the ground to create images that change the world. We believe the right testing solutions can lead to a future with the highest level of image quality.

Thank you for your interest in Image Engineering. We look forward to helping you on your journey to improved image quality!

Best regards,
Your Image Engineering Team

For worldwide delivery, you can find a list of all distributors on our website:

www.image-engineering.com/company/resellers

For more information on Nynomic please visit: www.nynomic.com

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Contents

imageQuality*solutions*

iQ-Teststand	04
Automated Test Solutions	06

VCX Test Solutions	07
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imageQuality*tools*

Illumination Devices

iQ-LED	09
LE7	11
iQ-Flatlight	12
iQ-Chart Box	13
CAL Product Line	14
CAL1	16
CAL2	17
CAL3	18
CAL3-XL	19
iQ-Multispectral	20
lightSTUDIO	21
CAL4	23
LG3	24
LG4	26
Vega	27
VLS Versatile Light System	29
Arcturus	31
Octa Light Player	32

Measurement Devices

GEOCAL	33
camSPECS	35
LED-Panel	37
iQ-Near Focus	39
KORK	40
iQ-Climate Chamber	41
STEVE-6D	42
iQ-Trigger	44
iQ-Defocus	45
iQ-Headturner	46
EX2	47
AEON Camera Calibrator(ACC)	48

imageQuality*code*

iQ-Analyzer -X	49	iQ-Luminance	52
----------------	----	--------------	----

Programming Interfaces (APIs)	51
-------------------------------	----

imageQuality*lab*

iQ-Lab	53	camPAS / Automotive	55
Standardized / Unique		VCX Camera Testing	56
Camera Testing	54		

imageQuality*charts*

TE42 Multipurpose Charts	57	Grayscale Charts	63
TE42-LL / Timing	58	Color Charts	65
Archiving (UTT) Chart	59	Lens Performance Charts	67
TE292 (camSPECS plate)	60	Custom Charts	69
Resolution Charts	61	Chart Sizes	70

Accessories	71	Standards	73
		Glossary	74

Upgrading a Test Lab

Upgrade your test lab with a customized iQ-Teststand

Choose from a wide variety of components to design a camera test stand that is right for your test lab. A proper camera test stand will quickly improve the effectiveness of your image quality testing. Contact our support team* for a free consultation or arrange a visit to our test lab in Germany to see a professional test lab setup.



Basic iQ-Teststand

Main Features

- * Fully customizable
- * With and without motorization
- * Control software (for automated version)
- * API available (for automated version)

Basic vs. Automated

There are two different types of the iQ-Teststand. First is the basic version; this version is without motorization and requires manual movement of the camera and camera mount. The second is the automated iQ-Teststand that uses motorization to align the camera under test to the various testing devices. This version includes control software. There is also an API** that is available as an option.



Automated iQ-Teststand

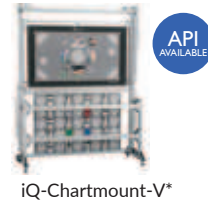
*Contact our support team at: support@image-engineering.de.
**API sold separately

Designing your Test Lab

There are seven different product groups with various solutions to guide you through the customization process. Once you have decided upon the basic or the automated test stand, you can fill out your setup with other required products. For detailed planning and further information, please contact our support team at support@image-engineering.de.

1 Chart mounting

Choose from simple wall and table mounts to an automated chart mount.



iQ-Chartmount-V*



iQ-Chartmount-H V2

2 Camera distance and alignment

Select from manual to fully automatic for the camera distance and alignment system.



iQ-Monopod



iQ-Bench

3 Camera alignment to test target

Choose from multiple test target alignment options. Contact us for automated options.



3-Way tripod head



iQ-Cameramount

4 Reflective chart illumination

Multiple lighting options for reflective charts. A pair is always required for uniform illumination.



LED Studio Light



iQ-Flatlight with iQ-LEDs

5 Transparent chart illumination

Multiple lighting options such as iQ-LED for uniform illumination of transparent test charts.



LE7



LG3



LG4



Vega

6 Analysis and control software

The AI-powered iQ-Analyzer-X for image quality analyses. Control software and APIs are available for many products.



7 iQ-Housing

Customized housing for your test setup to block out all stray light from the surrounding environment.



*Production only available on request.

Automated Test Solutions

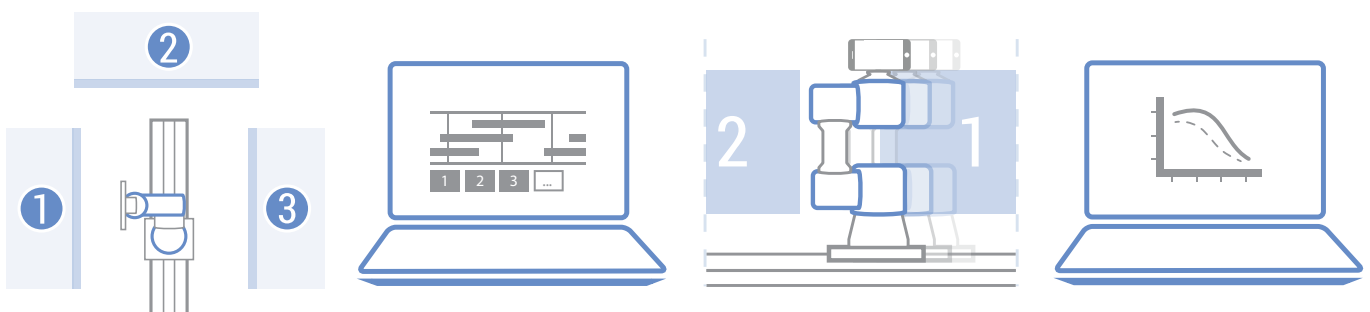
Upgrade your test lab with our automated test solutions

Every test lab requires different setups to meet its specifications, and automating your test lab can greatly improve workflow efficiency. With this in mind, we offer multiple options to automate your test lab*. In the past, we have helped clients set up automated test labs using robot arms and our iQ-Automator software. Below is an example of a test setup using the iQ-Automator software.



iQ-Automator software

This solution is centered around the advanced iQ-Automator software. With this software, you can design custom workflows and then automatically align the device under test with many of our illumination and measurement devices.



1 Setup test scene

Arrange various illumination and measurement devices around the iQ-Test-bench and robotic arm.

2 Create test procedure

Drag and drop control software to create a full test procedure for automated testing.

3 Run test

The DUT is automatically aligned in front of the measuring devices according to the test procedure.

4 Optional: Analysis

Automatic transfer of images from the DUT to your computer for analysis using the iQ-Analyzer-X software.

*We have entered into a partnership with Sofica Ltd. to help us expand our portfolio for automated test lab setups. Learn more at: <https://image-engineering.de/news/newsletters/1263-image-engineering-and-sofica-strategic-partnership>

VCX Test Solutions

Mobile phone testing according to VCX

VCX is a non-profit organization dedicated to objective image quality testing of mobile phone cameras designed to reflect the end-user experience. Each phone submitted for testing undergoes an independent evaluation and receives a numeric score. The camera is tested for its image quality and other performance indicators under a variety of factors, including bright light conditions, low light conditions, and zoom, among others. The final score is a weighted sum of the image quality and performance factors. The VCX organization frequently revises the VCX score to include new technologies in the testing protocol. The current version is VCX v2020. See detailed information at www.vcx-forum.org.



VCX WebCam 2023

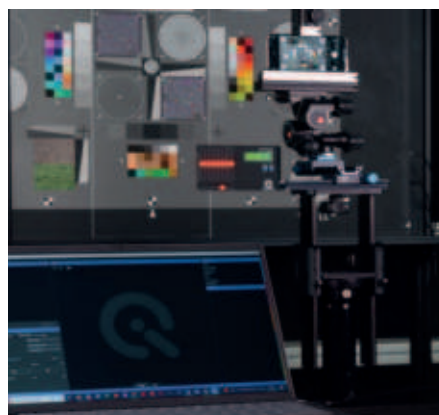
VCX WebCam 2023 is the latest standard released by the VCX Forum. This release marks one of the first international standards for evaluating image quality testing of video conferencing cameras. Tests are performed in a controlled environment by trusted test labs that test the camera's performance for various metrics, such as auto-exposure, white balance, noise, spatial frequency, etc., using a 3D scene with mannequin heads to simulate realistic conditions.

We are a trusted VCX test lab

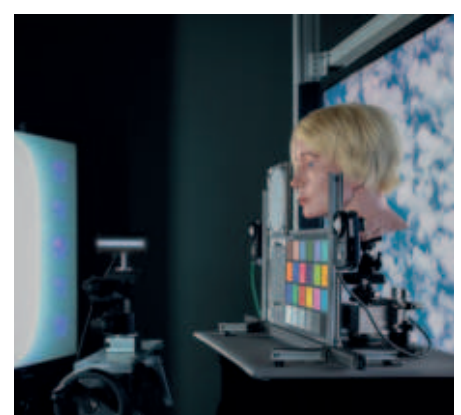
Image Engineering is one of the few trusted VCX testing labs. Using our test equipment, we have set up our lab in line with the specifications outlined by the VCX white paper. As VCX is an open and independent testing organization, any lab can request the white paper to conduct in-house testing independently. As a result, we have also made our test setup available for any test lab that wishes to test for themselves or aspires to become an officially certified test lab of VCX.



Measuring autofocus performance



VCX testing with the TE42-LL Timing chart



VCX-WebCam testing

VCX v2020-Automated

The VCX v2020 automated solution covers all of the performance indicators outlined in the standard. It includes the proper equipment for partially automating the setup and evaluation of a VCX mobile phone test.

VCX v2020-Manual

The VCX v2020 manual solution covers all of the performance indicators outlined in the standard. It includes the proper equipment that we utilize in our test lab when performing a manual VCX mobile phone test.

VCX Solutions Products*	Product Description	Manual	Automated
Test charts			
Universal Multipurpose			
TE42-LL	Multipurpose test chart · 1 x A1066 (16:9) · 2 x A460 (4:3 and 16:9)	3 X	3 X
TE42-LL Timing	Multipurpose test chart with 2x LED-Panel	X	X
TE269-BX	An OECF chart with 36 gray patches	X	X
Mounting			
Chart Mounting			
iQ-Chartmount-VM	Automatic positioning and storage of up to eight different test charts		X
iQ-Chartmount-H V2	Mount multiple charts for testing	X	
Camera and Illumination Mounting			
iQ-Monopod	Floor rail (4 m) - ensure camera stabilization with a proper rail setup	X	
iQ-Bench	For mounting iQ-Robot		X
iQ-Robot	Automated alignment of mobile phone		X
iQ-Anchor	A stabilization mount for STEVE	X	X
iQ-Mobilemount	Mount for mobile phones and tablets under test	2 X	2 X
Honeycomb Breadboard	A heavy stabilized board for securely attaching STEVE	X	X
Illumination Devices			
LE7-2x	Transparent chart illumination	X	X
iQ-Flatlight	Reflective chart illumination with iQ-LED technology	2 X	2 X
Measurement Devices			
STEVE-6D	Stabilization and handshake measurements	X	X
iQ-Trigger /-T	Timing the shutter release	X	X
Software			
iQ-Analyzer-X	Image quality analysis software	X	X
STEVE 2.0	Analysis software - evaluating camera stabilization	X	X
iQ-Automator	Control software for the automated test setup		X
iQ-Drive API	Smooth implementation into custom test setups		X

*Our current VCX solutions and products are subject to change with updates to the VCX testing procedure. Please check our website for the latest iQ-Lab information. www.image-engineering.de/services/test-laboratory-iq-lab.

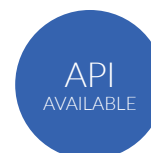
iQ-LED Technology

Generate custom spectra with the all-in-one light source

iQ-LED technology* recreates other light sources in a controlled lab environment. This technology can be found in many of our illumination devices and can replicate almost any light source (from low-light to bright sunlight) for a more accurate camera characterization and calibration.

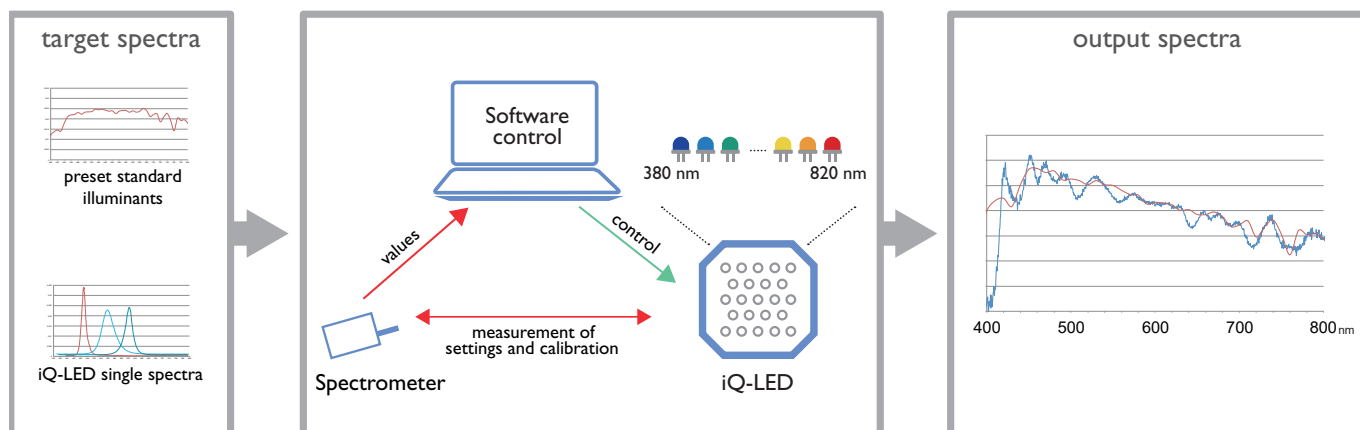
Main Features

- * Spectrally tunable light source
- * 20 individual spectral channels
- * High-frequency PWM with up to 128 kHz
- * Wavelength range of 380 – 820 nm
- * Direct device management without a PC
- * Connect multiple iQ-LED devices
- * Long-term stability via temperature control
- * Short-term high-intensity and spectral stability via temperature control



The iQ-LED device workflow

Each of our iQ-LED illumination devices has iQ-LED control software and a spectrometer to ensure you have proper illumination over the entire lifetime of the device. iQ-LED can recreate various spectra, from standard light sources to different color patches.



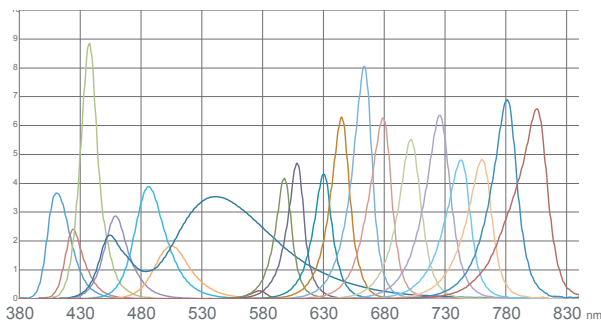
iQ-LED workflow

*The full overview described in the first two pages applies to all of our iQ-LED devices. Information on the devices themselves can be found on the respective product page.

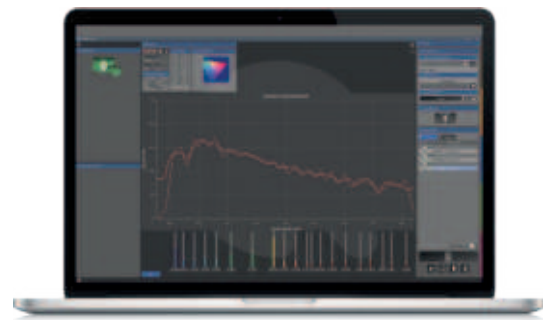
Advanced image quality testing

iQ-LED technology* can generate custom spectra by the optical mixing of emitted radiation from spectrally different LEDs. The standard module consists of 20 different channels generated from 41 high-power SMD LEDs on a 10 x 10 cm board.

iQ-LED technology uses a NIST traceable calibrated spectrometer and iQ-LED control software to calibrate and correctly generate the spectra. Once correctly calibrated, the illuminant can be stored on the device and used without a PC. Up to 44 illuminants and one sequence can be stored on the device.



20 individual spectral channels



iQ-LED software main screen with 20 spectral channels

At a Glance	iQ-LED V2
Principle	High-power SMD-LED based spectral broadband light module used in our iQ-LED devices
Light sources	41 SMD high-power LEDs / separated in 20 color channels / spectral range: 380 – 820 nm / intensity controlled via 4000 steps per channel and 32 kHz PWM (switchable to 1000 steps with 128 kHz)
Spectral measurement	Closed loop functionality with calibrated mini spectrometer via control software Spectral Range: 305 – 1100 nm / Resolution: 2048 pixel / FWHM: 2.5 nm
Control system	Software-based control system via USB (included with all iQ-LED devices), API Storage of up to 44 different illuminants, one sequence, and default light source, controllable via microswitch controller (without connected PC)
Included reference illuminants	D50, D55, D65, D75, A, B, C, E / Planckian spectral curve by selected temperature (1900 - 18000 K) / The iQ-LED technology is optimized for the best spectral match and allows CRI values up to 99, depending on illuminant and intensity
Illumination stability	± 1% when stabilized (2% after switching D illuminants during the first 5 s for most applications)
Response time	< 50 ms (switch illuminant)
Production line integration feature	Operation hour counter Self-diagnosis
Software requirements	PC with Windows 7 operating system (or higher) and USB port
Additional functions	<ul style="list-style-type: none"> • Auto-generation of standard illuminants or externally measured spectra • Save and load function of self-defined spectral arrangements or intensities • Storage of illuminants/sequences on device • Creation of test sequences • Real-time display of spectral measurement • Real-time calculation of CCT, CRI, curve fit and illumination level

*iQ-LED technology is used in many of our illumination devices but is not sold as a standalone product. If you have specific requests or require customization, please contact sales@image-engineering.de to discuss your requirements.

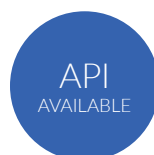
LE 7

Transparent test chart illumination with the LE7 lightbox

The LE7 is a uniform lightbox that uses iQ-LED technology to increase the effectiveness of image quality camera testing with transparent test charts. With five different product variations, the LE7 can generate an extensive range of light intensities for more comprehensive camera testing.

Main Features

- * Includes all features from iQ-LED
- * Uniformity of > 97% in active chart area
- * Available with two, four, or six iQ-LED modules
- * Control single modules to expand intensity range*
- * Accurate low-light testing with LE7-6x-E



LE7 VIS-IR, LE7-E and camSPECS plate

The LE7 VIS-IR uses two normal iQ-LED modules and four iQ-LED VIS-IR elements to extend the spectral range from 380 – 1050 nm.

The LE7-E is capable of creating a dynamic range of up to 1:100,000. Such a wide dynamic range expands the testing possibilities, especially low-light testing.

Using the camSPECS plate (TE292) with the LE7 creates an iQ-LED solution for spectral sensitivity measurements and camera color calibration.

At a Glance	LE7-2x / LE7-4x / LE7-6x / LE7 VIS-IR/ LE7-E
Principle	An integrating sphere to illuminate transparent test charts based on iQ-LED technology (includes micro-spectrometer) / 500 mm diameter integrating sphere
Output window	290 x 220 mm output window / dual slot for D280 sized test charts
Light source	LE7-2x: 2 x iQ-LED V2: 82 SMD high-power LEDs LE7-4x: 4 x iQ-LED V2: 164 SMD high-power LEDs LE7 VIS-IR: 2 x iQ-LED V2 plus 4 x iQ-LED VIS-IR: 82 SMD high-power LEDs / 320 THT LEDs LE7-6x: 6 x iQ-LED V2: 246 SMD high-power LEDs LE7-E: 5 x iQ-LED V2 plus 1 x iQ-LED V2 with 1.8 ND filter: 246 SMD high-power LEDs
Uniformity	> 97% for active chart area, 280.0 x 157.5 mm (for standard D illuminants) > 96% for full chart area, 290.0 x 220.0 mm (for standard D illuminants)
Maximum / Minimum illumination level	LE7-2x / LE7 VIS-IR: 25 lx up to 8000 lx LE7-4x: 100 lx up to 16000 lx LE7-6x: 25 lx up to 24000 lx LE7-E: 0.25 lx up to 20000 lx For standard illuminant D55 (illuminating a TE291 D calibration chart)

*iQ-LED software version 3.2.0 or higher required for single module control.

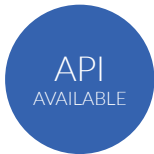
iQ-Flatlight

The most advanced light source for reflective test chart illumination

Powered by iQ-LED technology, the iQ-Flatlight uses ten iQ-LED elements to recreate almost any light source for test chart or scene illumination. This all-in-one light source greatly expands the capabilities of a test lab.

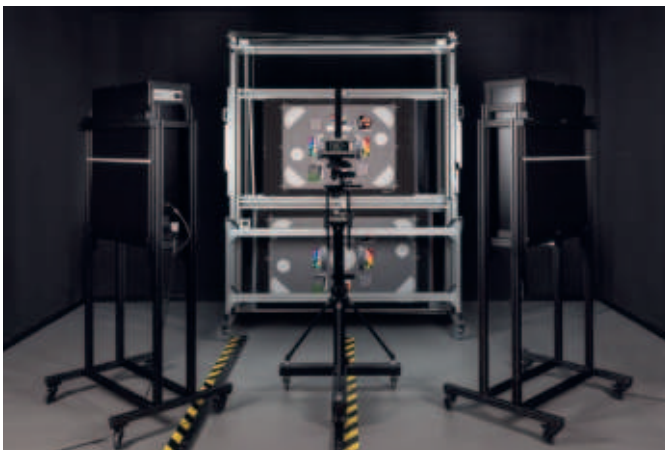
Main Features

- * Includes all features from iQ-LED
- * Spectrally tunable light source for camera tests
- * Used for illuminating the VCX test setup
- * Uniformity of a large test chart > 90% (sample setup)



Sample setup

The iQ-Flatlight is always sold as a pair of two to ensure illumination uniformity of the test chart or test scene. A sample test setup normally positions each light 1.5 m from the test chart, as seen in the image below.



Sample setup

At a Glance iQ-Flatlight	
Principle	Diffuse light panel for illuminating reflective test charts and surfaces
Light area	620 x 780 mm
Light source	10 x iQ-LED V2: 410 SMD high-power LEDs
Uniformity on plane	Up to 90% (with two iQ-Flatlights in ≈ 1.5 m distance, depending on test setup)
Maximum / Minimum illumination level	Single iQ-Flatlight / 400 mm distance: 25 lx up to 7800 lx Two iQ-Flatlights / in ≈ 1.5 m distance, 10 lx up to 2000 lx depending on test setup (for standard D illuminants)

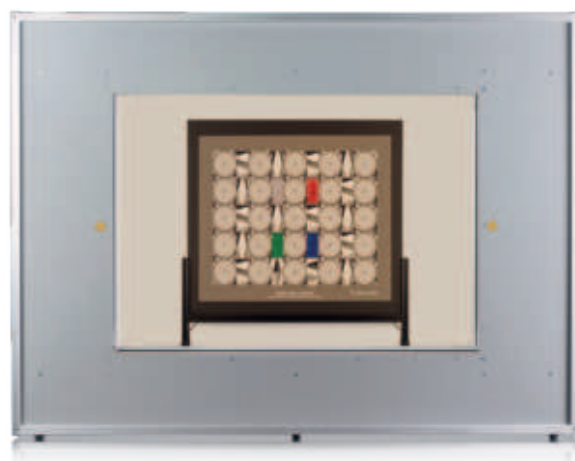
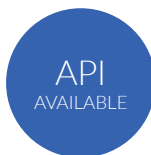
iQ-Chart Box

Uniform illumination of reflective test charts

The iQ-Chart Box has a compact design with eight built-in iQ-LED elements for illuminating reflective test charts in size A460 and under. Each light is aligned and fixed to ensure test charts are always homogeneously illuminated.

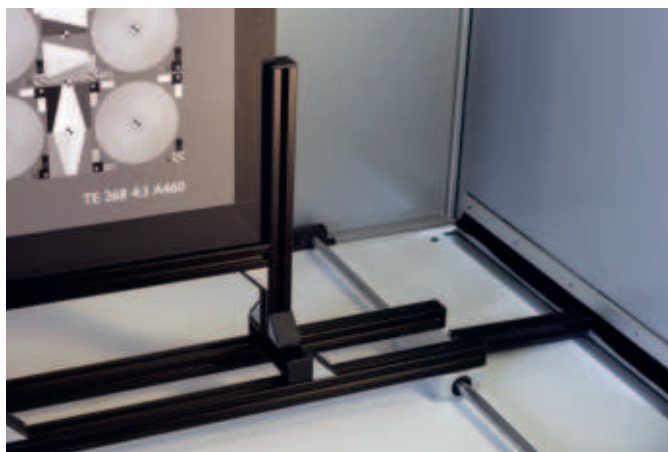
Main Features

- * Includes all features from iQ-LED
- * Uniformity > 95% (chart size A280)
- * Size A460 and A280 reflective test charts
- * Designed for labs with limited space



Designed for smaller test labs

The iQ-Chart Box is designed for smaller test labs where the iQ-Flatlight is less convenient. Now, instead of having a full chart mount and two or more free-standing lights to illuminate the test chart, you can have all of the same illumination features in a practical size that can be placed anywhere in your lab.



Easily switch test charts

At a Glance	iQ-Chart Box
Principle	Compact device to illuminate reflective test charts based on iQ-LED technology
Front opening	820 mm x 530 mm
Light source	8 x iQ-LED V2: 328 SMD high-power LEDs
Uniformity on chart plane	> 95% (A280 picture size) > 90% (A460 picture size)* illuminance on chart plane for selected standard illuminant (D50) at 400 lx
Maximum / Minimum illumination level	25 lx up to 2000 lx (for standard D illuminants) / depending on illuminant and required curve fit / CRI / with ND filters down to 1.5 lx

*measured at center of A460 sized chart

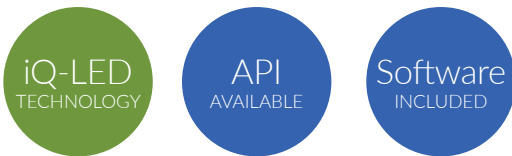
CAL Product Line

iQ-LED light sources for camera calibration and characterization

The CAL product line uses our multispectral iQ-LED technology for flexible camera calibration and characterization. A full calibration can be performed in as little as a few seconds due to the short response time of the iQ-LEDs.

Main Features

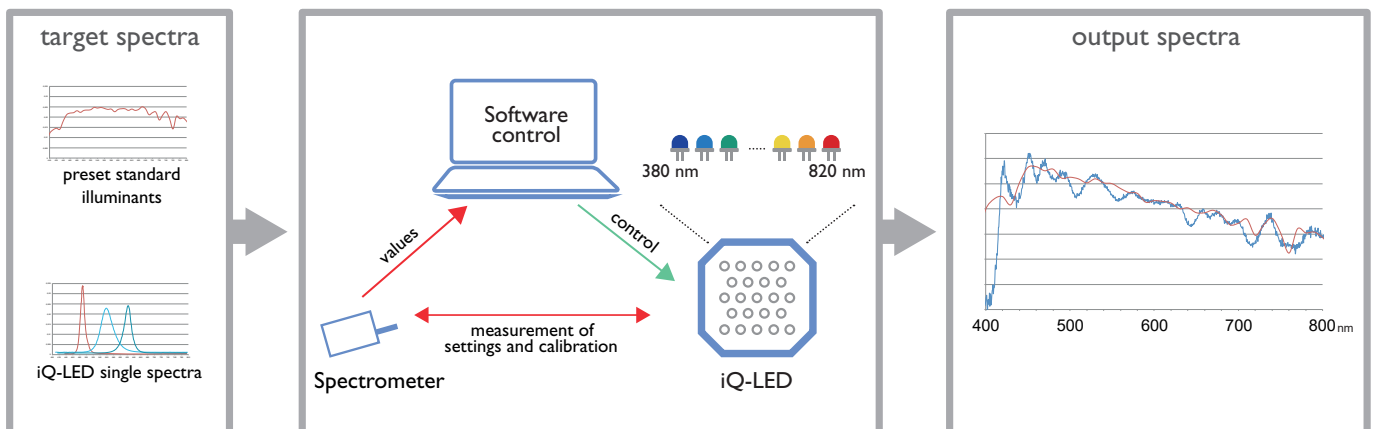
- * Includes all of the features from iQ-LED
- * Measurement of the spectral sensitivity
- * Calibration of gain/sensitivity for exposure
- * Calibrate luminance and color shading
- * Check white balance under various light sources
- * Detection of defect pixels



Example of the CAL1

Only one light source

Each of our CAL devices has iQ-LED control software and a spectrometer to ensure you have proper illumination over the lifetime of the device. The CAL devices can recreate various spectra, including everything from standard light sources to different color patches, using iQ-LED technology.

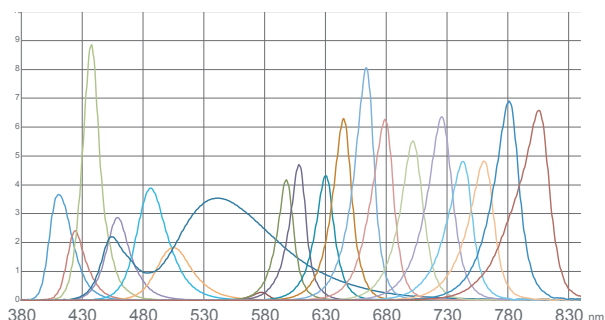


iQ-LED workflow

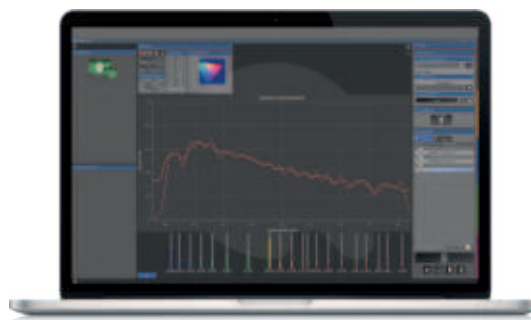
Advanced features of the CAL line

Each CAL product is uniquely designed using a non-reflecting special diffuser filter to ensure even light distribution on the measuring plane. So, as long as the image processing and transfer of the camera are fast enough, a full camera calibration can be completed in seconds. This capability is what makes the CAL products ideal for calibrating cameras on production lines.

The devices are controlled with the iQ-LED control software. We also offer an iQ-LED API for easy integration into your designs. A built-in spectrometer is also included with each device.



20 individual spectral channels



iQ-LED software main screen with 20 spectral channels

At a Glance	iQ-LED V2 in CAL product line
Principle	High-power SMD-LED based spectral broadband light module for spectral programmable camera calibration and characterization devices
Light sources	41 SMD high-power LEDs / separated in 20 color channels / spectral range: 380 – 820 nm / intensity controlled via 4000 steps per channel and 32 kHz PWM (switchable to 1000 steps with 128 kHz)
Spectral measurement	Closed loop functionality with calibrated mini spectrometer via control software Spectral Range: 305 – 1100 nm / Resolution: 2048 pixel / FWHM: 2.5 nm
Control system	Software-based control system via USB (included with all CAL devices), API Storage of up to 44 different illuminants, one sequence, and default light source / controllable via microswitch controller (without connected PC)
Included reference illuminants	D50, D55, D65, D75, A, B, C, E Planckian spectral curve by selected temperature (1900 - 18000 K) The iQ-LED technology is optimized for the best spectral match and allows CRI values up to 99, depending on illuminant and intensity
Output data	Real-time measurement of the spectral trend, CCT, CRI, illumination, and radiant power, with closed loop link with micro-spectrometer
Production line integration	Operation hour counter Self-diagnosis Self-calibration with calibrated spectrometer
Software requirements	PC with Windows 7 operating system (or higher) and USB port
Additional functions	<ul style="list-style-type: none"> • Auto-generation of standard illuminants or externally measured spectra • Save and load function of self-defined spectral arrangements or intensities • Storage of illuminants/sequences on device • Creation of test sequences • Real-time display of spectral measurement • Real-time calculation of CCT, CRI, curve fit and illumination level

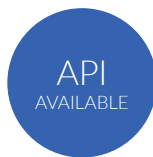
CAL1

Our original uniform light source for camera calibration

The CAL1 is a 0.3 m integrating sphere using iQ-LED technology to illuminate a 70 mm opening for camera characterization and calibration. A non-reflective diffuser filter with improved Lambertian characteristics on the sphere opening ensures illumination uniformity.

Main Features

- * Includes all of the features from iQ-LED
- * Uniformity of > 98%
- * Camera calibration in less than one second
- * Improved non-reflective diffuser filter
- * Production line integration



How to use the CAL1

The CAL1 can be used as a standalone testing device for single-camera testing in a lab. It can also be integrated into a production line for more efficient calibration and characterization of multiple cameras.



CAL1 output window

At a Glance	CAL1
Principle	Integrating sphere with uniform illumination for camera calibration and characterization
Output window	70 mm diameter, circular output window
Light source	1 x iQ-LED V2: 41 SMD high-power LEDs
Uniformity	> 98% (70 mm diameter)
Maximum / Minimum illumination level	25 lx up to 8000 lx (for standard D illuminants) / depending on illuminant and required curve fit / CRI

CAL2

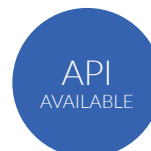
The highly adaptable camera calibration light source

This ultra-compact light source is based on iQ-LED technology and can adapt to many different measurement areas. Its edge box design makes it particularly suited for calibrating cameras on a production line. A non-reflective diffuser filter with improved Lambertian characteristics on the box opening ensures illumination uniformity.



Main Features

- * Includes all of the features from iQ-LED
- * Uniformity of > 96%
- * Camera calibration within seconds
- * Improved non-reflective diffuser filters
- * Optimized for production line integration
- * Small compact design



Production line integration

The CAL2 and the accompanying LED software can substitute for multiple calibration and testing devices on a production line, making mass camera calibration and characterization far more efficient. We provide a separate spectrometer for the CAL2 when it is integrated into a production line.



Calibrate multiple camera modules at the same time on a production line

At a Glance	CAL2
Principle	Highly adaptable edge box for camera calibration and characterization on a production line
Output window	60 mm x 60 mm output window
Light source	1 x iQ-LED V2: 41 SMD high-power LEDs
Uniformity	> 96% (60 x 60 mm output window)
Maximum / Minimum illumination level	25 lx up to 8000 lx (for standard D illuminants) / depending on illuminant and required curve fit / CRI

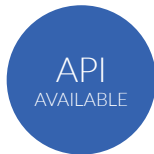
CAL3

Camera calibration light source for wide-angle lenses

The CAL3 is a 0.3 m integrating sphere that uses iQ-LED technology to illuminate a 38 mm concave curved opening. The curved opening, as opposed to flat (CAL1), is more suited for wide-angle cameras. A bowl-shaped, non-reflective diffuser filter on the sphere opening ensures illumination uniformity.

Main Features

- * Includes all of the features from iQ-LED
- * Small compact design
- * Uniformity of > 95%*
- * For cameras with a 180° field of view
- * Production line integration



Production line integration

As a result of the short response time of iQ-LED, a full calibration can be performed in less than a second, making it ideal for integration into a production line.



Calibrate and characterize wide-angle camera systems

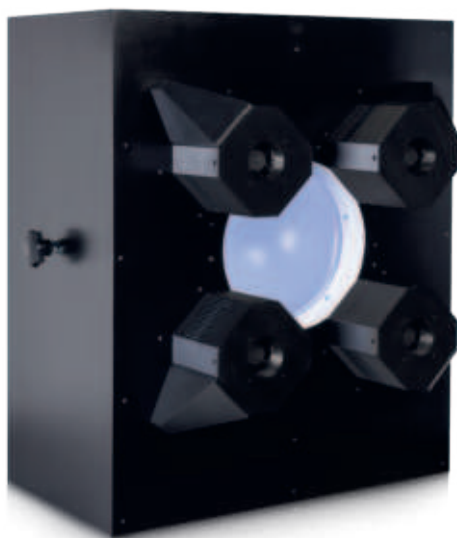
At a Glance	CAL3
Principle	Integrating sphere with uniform illumination for camera calibration and characterization of high field of view cameras
Output window	38 mm diameter circular output window with bowl shaped diffuser
Light source	1 x iQ-LED V2: 41 SMD high-power LEDs
Uniformity	> 95%* for FOV < 160° at min. 10 mm depth inside diffuser for 160°-180° FOV at min. 20 mm depth inside diffuser
Maximum / Minimum illumination level	25 lx up to 7000 lx (for standard D illuminants) / depending on illuminant and required curve fit / CRI

*Measurement performed in the center of diffuser, standard illuminant D65

CAL3-XL

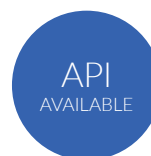
A calibration light source for large wide-angle cameras

The CAL3-XL is an iQ-LED integrating sphere with a circular 196 mm opening and a bowl-shaped diffuser for illumination uniformity. It is ideal for calibration and testing large cameras with wide angles.



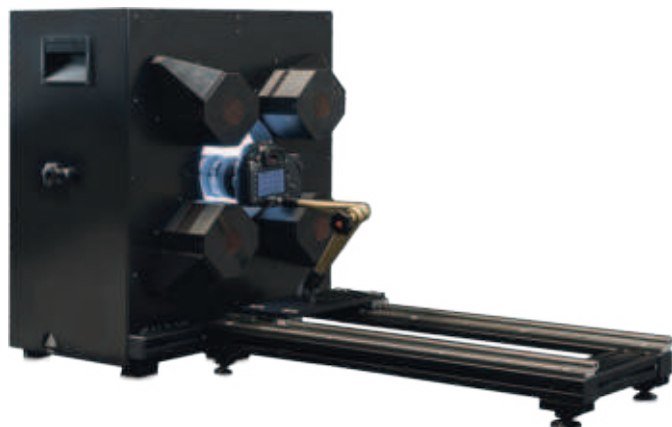
Main Features

- * Includes all of the features from iQ-LED
- * Test large cameras with a wide-angle
- * Uniformity of > 90%*
- * 500 mm diameter of integrating sphere
- * For cameras with a 180° field of view



CAL3-XL design

Due to its size, the CAL3-XL uses four iQ-LED elements instead of the only one used by the normal CAL3. Four elements are necessary to ensure illumination uniformity with a much wider opening.



CAL3 -XL with the iQ-Align XL

At a Glance	CAL3-XL
Principle	Integrating sphere with uniform illumination for camera calibration and characterization of cameras with wide-angles of view
Output window	196 mm diameter circular output window with bowl shaped diffuser
Light source	4 x iQ-LED V2: 164 SMD high-power LEDs
Uniformity	> 90%* at a depth of approx. 65 - 85 mm inside diffuser
Maximum / Minimum illumination level	10 lx up to 4500 lx / (for standard D illuminants)

*Measurement performed with standard illuminant D65

iQ-Multispectral

Using iQ-LED to enhance digitalization and preservation

The iQ-Multispectral is a multispectral illumination device based on iQ-LED technology to enhance digitalization and the preservation of documents, texts, or images.

Main Features

- * Includes all of the features from iQ-LED
- * Uses the narrowband light source method
- * Spectral range between 380 and 1050 nm
- * UV LED (at 365 nm) with bandpass filter*
- * Setup based around a reprographic stand



The advantages of iQ-LED for the archiving industry

iQ-LED technology provides the iQ-Multispectral with many advantages compared to traditional archiving illumination. Each iQ-Multispectral light source has 19 channels in the visible range, 11 channels in the VIS-IR range, and one UV LED, all of which can be controlled with the iQ-LED software to generate specific spectral distributions.

The iQ-Multispectral provides exceptional control over spectral light distribution and, through this capability, enables enhanced digitization and preservation.

At a Glance	iQ-Multispectral
Principle	Diffuse light panels that use iQ-LED technology (includes a micro-spectrometer) to illuminate a reproducible scene for multispectral imaging
Light source	2 x iQ-LED V2 each with 41 SMD high-power LEDs separated into 20 color channels and a spectral range of 380 - 820 nm 3 x iQ-LED VIS-IR each with 11 additional channels and a spectral range of 380 - 1050 nm 2 x iQ-LED UV each with 2 SMD high-power LEDs (365 nm plus bandpass filter)
Bandpass filter for UV channel (optional)	350 nm hard coated bandpass interference filter 50 nm FWHM 365 nm hard coated bandpass interference filter 10 nm FWHM
Uniformity	Up to 90% for A2 space
Illumination stability	± 1% when stabilized (2% after switching D illuminants in the first 5 s)
Dimmable	iQ-LED: Software-based by presetting the intensity, or by selecting different pre-stored intensity illuminants directly on the device

*Bandpass filters are optional

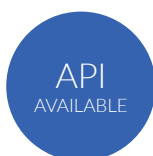
lightSTUDIO

Real scene illumination and testing

Many image quality factors are best measured with test charts. However, many factors also benefit from a real scene analysis. The lightSTUDIO contains multiple objects of various colors and textures for an accurate visual analysis.

Main Features

- * iQ-LED and adaptive white options
- * Same interior for easy comparison between labs
- * Moving targets to measure motion artifacts
- * Evaluate high contrast scenes
- * Includes control software for all components

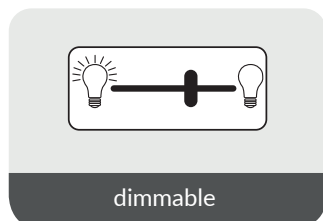
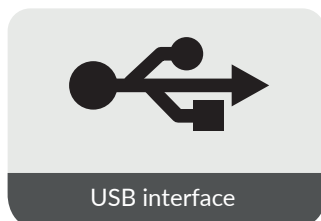


lightSTUDIO lighting options

Every lightSTUDIO is delivered with the same objects to make cross-lab testing and comparison more efficient. The standard lightSTUDIO option is the lightSTUDIO-L. This version uses a light head powered by iQ-LED technology to create a spectrally tunable light source. iQ-LED can accurately recreate standard illuminants, e.g., A, D50, D65, and generate custom spectra.

The lightSTUDIO offers many options for performing numerous measurements and comparisons within a small, compact space. It is also possible to control all components of the lightSTUDIO with an API.

Standard features of a basic lightSTUDIO





lightSTUDIO-M with moving targets



lightSTUDIO-H with HDR option



lightSTUDIO-AW

lightSTUDIO setup options

The lightSTUDIO-M has built-in moving targets, including a moving frame for different test charts. These features are beneficial when measuring motion artifacts and blur in photos and videos.

The lightSTUDIO-H or HDR option has two LG4 lightboxes to create and test a high-contrast scene. This setup can provide a contrast ratio of $> 65,000:1$.

The lightSTUDIO-AW uses adaptive white technology, allowing you to select different correlated color temperatures (CCT) instead of a single color temperature with fluorescent tubes. This version has a dividing wall (easily insert or remove), allowing you to create a “twin” scene.

Subjective assessment of image quality by visual comparison of the lightSTUDIO interior*

- | | |
|-----------------------------------|--------------------------------------|
| 1 Resolution | 7 Moiré |
| 2 Texture loss | 8 Distortion |
| 3 Sharpness | 9 Human skin tone color reproduction |
| 4 Near infrared (NIR) sensitivity | 10 Color reproduction |
| 5 Details in highlights | 11 Natural and known colors |
| 6 Details in shadows | 12 Low contrast details |



*The product images and the interior object images are only example images and do not fully reflect the end product.

CAL4

Test endoscopic light sources in the medical area

The CAL4* is a 0.3 m integrating sphere capable of testing endoscopic light sources. It provides uniform illumination over the 50 mm chart plane. The CAL4 includes four different types of adapters for various endoscopic light sources.



Main Features

- * Adaptable to most projectors
- * Uniformity of > 97%
- * High temperature resistant cold light cable

Test for various image quality factors

Specially designed test charts (size D35) are available for more accurate measurements of resolution, color, OECF, dynamic range, and noise of endoscopic light sources.



A few available charts and adapters

At a Glance	CAL4
Principle	Integrating sphere for the measurement of light sources in the medical area (light source not included)
Output window	50 mm x 50 mm output window, with slot for D35 sized test charts
Uniformity of luminance	> 97% in active area
Connection for light source	High temperature resistant cold-light cable, XENON approved

*CAL4 is not powered by iQ-LED

LG3

A flexible lightbox with high power and flicker generation

Get more from high dynamic range test targets by illuminating them with up to 150000 lx to see the differences in camera designs. The LG3 can also simulate flickering light sources, making it one of the most powerful and flexible lightboxes for your image quality test lab.

Main Features

- * High intensity up to 150000 lx*
- * Adjust flicker in frequency, duty cycle and phase.
- * Dimmable in fine steps
- * Expand range of testing
- * Relative illumination stability > 98%



Related products and features

The LG3 works in sync with our high dynamic range test targets, such as TE269C. Targets with such a high dynamic range require powerful illumination to generate a realistic signal for the camera under test. Flickering light sources (e.g., PWM-driven LEDs) are an issue for cameras in many applications. The LG3 can generate these light sources in your test lab to evaluate how well a camera can handle these light situations.



LG3 with OECF test chart TE269C



A wide range of light frequencies are capable of being recreated with the LG3

*Measured on chart plane.

LED-powered light source

The main function of the LG3 is to illuminate transparent test charts. Unlike more standard light-boxes, the LG3 has extremely high intensity can illuminate a high dynamic range test target with up to 150000 lx*. Generation of low-light situations is also possible due to its flexible dimming function.

The other main feature of the LG3 is the flicker mode. Choose between a range of 10 to 500 Hz and variable duty cycle when using flicker. This feature allows for greater simulation possibilities of light sources with variable frequencies. The flicker mode can be adjusted in frequency and duty cycle. The LG3 is controlled with a connected remote for easy adjustment.

Two illumination methods can be selected in three intensity ranges:

1. Pulse width modulation of 32 kHz and 128 kHz
2. Flicker mode with 10 - 500 Hz

Each with

✱ Low mode:

0 - 100% 32 kHz / 10 to 6500 lx

✱ Normal mode:

0 - 100% 32 kHz / 100 to 65000 lx

✱ High mode:

100% max. 60 s lighting duration / 150000 lx



LG3 with support

At a Glance	LG3
Principle	Light source with a wide range of intensities and special flicker mode
Light source	432 LEDs
Color temperature	approx. 5000 K \pm 5%
Maximum / Minimum illumination level	10 - 150000 lx ** Normal mode: 0 - 100% / 32 kHz / 100 to 65000 lx ** Low mode: 0 - 100% / 32 kHz / 10 to 6500 lx ** High mode: 100% / max. 60s lighting duration / 150000 lx **
Uniformity of illumination	> 95% for active chart area*, 280 x 210 mm > 95% (70 mm diameter circle)* \geq 85% at very low intensity (intensity < 1%)
Dimmable	1000 steps in 2 modes, feedback of illumination level in [%], illuminance [lx] or luminance [cd/m ²] 32 kHz PWM

*Measured on chart plane.

**Absolute intensity range depends on the inserted chart.

LG4

A lightbox for transparent chart illumination

The LG4 is our standard compact lightbox designed for easy transportation and set up for uniform illumination of transparent test charts.

Main Features

- * > 95% uniformity*
- * Intensity range of 100 to 65000 lx
- * Dim function of 32 kHz PWM
- * Software control



LG technology

432 LEDs illuminate the LG4 with a range of 100 to 65000 lx and a dim function of 32 kHz PWM. Control software comes with the device, as well as the option for the LG API. The LG4 is also incorporated into the HDR lightSTUDIO for real-scene testing.

The Controller Areas Network (CAN) system allows up to 99 LG4s to be connected and controlled by the LG software.



LG4 with OECF test chart TE269

At a Glance	LG4
Principle	Uniform illuminator for transparent charts based on LED technology
Light source	432 LEDs
Color temperature	approx. 5000 K ± 5%
Maximum / Minimum illumination level	Normal mode: 0 – 100% / 32 kHz / 100 to 65000 lx ** Low mode: 0 – 100% / 32 kHz / 10 to 6500 lx **
Uniformity of illumination	> 95% for active chart area*, 280 x 157.5 mm > 85% at < 1% of max. intensity
Dimmable	32 kHz PWM

*Measured on a chart plane

**Absolute intensity range depends on the inserted chart

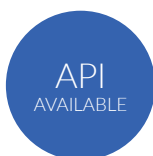
Vega

A unique DC-driven LED light source for all your testing requirements

Vega is a light source developed for high-precision measurements of camera systems, including those with extremely short exposure time, such as automotive-grade cameras. It uses LEDs driven by DC (direct current) technology, making it one of our most sophisticated and unique light sources ever developed.

Main Features

- * DC-driven LED technology
- * Extremely high stability
- * Temperature stability within half a degree
- * Advanced flicker capabilities
- * Sine, triangular, and square waveforms



When to utilize Vega?

Vega is best utilized for high-intensity measurements such as contrast transfer accuracy (CTA), modulated light mitigation probability (MMP), contrast signal-to-noise ratio (CSNR), and tone curve measurements. These measurements are very beneficial for automotive-grade cameras and other systems with high demands on accuracy.

Vega is available as a starter set that includes one light source or a set with either three or seven light sources. Every set comes with a controller and control software. In addition, we offer unique grayscale test charts specifically designed for high-performance measurements using Vega. Charts are always sold separately.



Vega Starter Set



Vega set with seven light sources



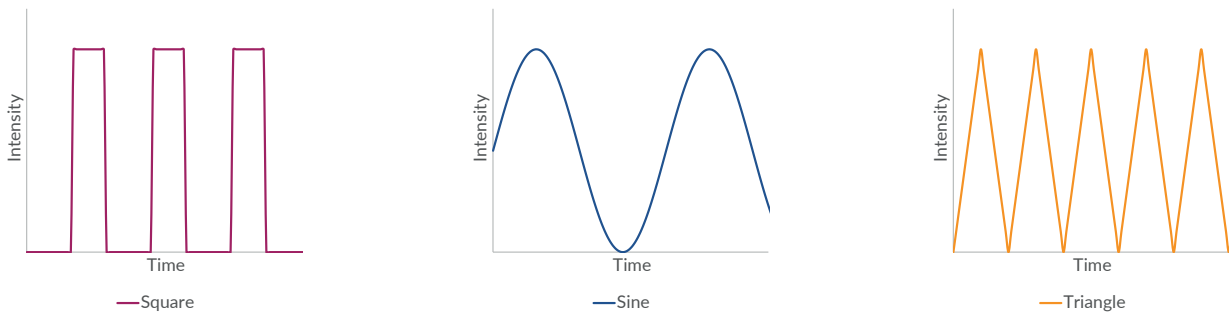
Unique Vega test charts

Why Vega over other light sources?

Unlike PWM-controlled light sources, where intensity is regulated by the high-frequency of switching the LEDs on/off, Vega regulates the intensity by the amount of current. Vega offers 1,000,000 equal-width steps for intensity control. In addition, the DC driver does not affect temperature regulation and can achieve temperature stability within half a degree. The temperature system works both ways (i.e., heating and cooling) and will remain consistent even when turning on/off different light sources or changing the intensities.

Generate flicker functionality

Vega also has advanced flicker capabilities and can be generated from a more comprehensive frequency range. We have further developed the low-frequency functionality to include sine, triangular, and square waveforms, which allows us to cover nearly all real-world scenarios.



At a Glance	Vega
Principle	Temperature stabilized, DC controlled, dimmable light source
Light sources	36 Temperature controlled LEDs based on iQ-DC technology
Uniformity (active area)	> 95% at 100% output intensity > 94% at 10% output intensity > 90% at 1% output intensity > 90% at 0.1% output intensity
Illumination stability	± 0,5%
Correlated Color Temperature (CCT)	4900 K (± 200 K)
Color Rendering Index (CRI)	> 95
Minimum luminance	0.1 – 0.5 cd/m ²
Maximum luminance	55,500 – 61,500 cd/m ²
Dim function	Software based 10 ⁶ - 10 steps
Flicker frequency range	1 – 1000 Hz (Square) 10 – 1000 Hz (Sine) 10 – 1000 Hz (Triangle)
Flicker frequency step width	0.1 Hz (1 – 200 Hz) 0.2 Hz (200 – 500 Hz) 0.5 Hz (500 – 1000 Hz)
Software requirements	PC with Windows 10 operating system (or higher) USB port
Functions	<ul style="list-style-type: none"> ● Intensity ● Frequency ● Duty cycle ● Mode selection ● Phase shift
API (C/C++/Python)*	Optional

*API sold separately

VLS Versatile Light System

Automotive KPI testing according to IEEE-P2020

The VLS (Versatile Light System) is a versatile illumination solution suitable for efficiently measuring a variety of image quality KPIs, including contrast transfer accuracy (CTA), modulated light mitigation probability (MMP), contrast signal-to-noise ratio (CSNR), and high dynamic range (HDR). The setup uses multiple Vega light sources and specialized software to create a dynamic test scene.

Main Features

- * IEEE-P2020 KPI testing
- * Flexible setups and movements
- * DC-powered light sources
- * Control software included
- * Evaluation software included



Spatial and temporal recordings

The VLS supports both spatial and temporal recording measurements as outlined in the IEEE-P2020 standard. Spatial and temporal measurements are both beneficial to the overall test results.

Temporal recording measurements avoid issues with flare that often occur during camera alignment to a light source. Spatial recording measurements are faster and benefit systems unsuitable for temporal measurement due to lens influences or dynamic image processing (e.g., auto-exposure).



Full VLS setup with laptop*

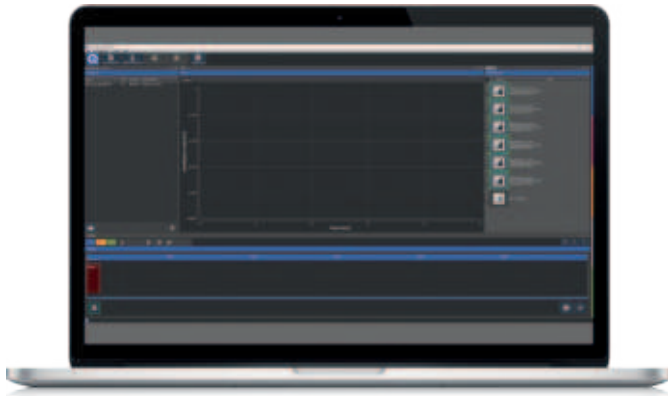


Unique test charts

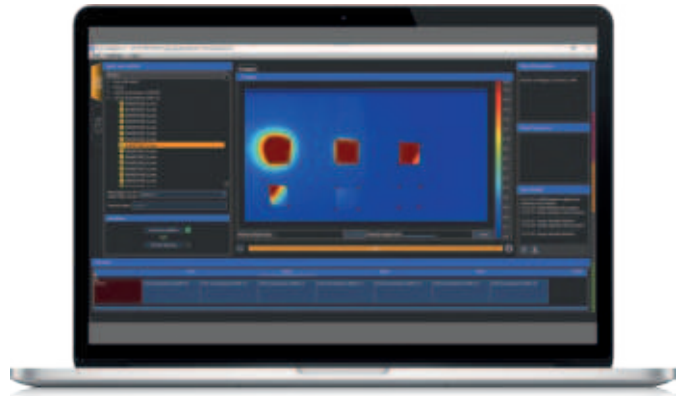
*The product images are only example images and do not fully reflect the end product.

VLS Software

The VLS Software includes the VLS-Control Software and the VLS-Evaluation Software. The VLS-Control Software generates illumination test sequences for the Vega devices and can control up to six Vega devices at once. The VLS-Evaluation software analyzes the camera's performance using the defined KPIs, including CTA. Results are exported as XML files.



VLS-Control Software



VLS-Evaluation Software

At a Glance	Vega
Principle	Temperature stabilized, DC controlled, dimmable light source
Light sources	36 Temperature controlled LEDs based on iQ-DC technology
Uniformity (active area)	<ul style="list-style-type: none"> > 95% at 100% output intensity > 94% at 10% output intensity > 90% at 1% output intensity > 90% at 0.1% output intensity
Illumination stability	± 0,5%
Correlated Color Temperature (CCT)	4900 K (± 200 K)
Color Rendering Index (CRI)	> 95
Minimum luminance	0.1 – 0.5 cd/m ²
Maximum luminance	55,500 – 61,500 cd/m ²
Dim function	Software based 10 ⁶ - 10 steps
Flicker frequency range	<ul style="list-style-type: none"> 1 – 1000 Hz (Square) 10 – 1000 Hz (Sine) 10 – 1000 Hz (Triangle)
Flicker frequency step width	<ul style="list-style-type: none"> 0.1 Hz (1 – 200 Hz) 0.2 Hz (200 – 500 Hz) 0.5 Hz (500 – 1000 Hz)
Software requirements	PC with Windows 10 operating system (or higher) USB port
Functions	<ul style="list-style-type: none"> <li style="width: 50%;">• Intensity <li style="width: 50%;">• Mode selection <li style="width: 50%;">• Frequency <li style="width: 50%;">• Phase shift <li style="width: 50%;">• Duty cycle
API (C/C++/Python)*	Optional

*API sold separately

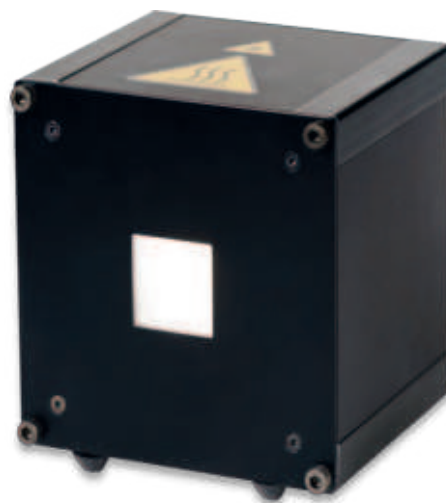
Arcturus

A new high-intensity light source in the Vega line

Today's image sensors and high dynamic range configurations make testing at or close to sensor saturation challenging. With Arcturus, we can generate enough intensity to challenge these sensors with a much higher sensitivity than what is currently possible, making it a powerful addition to the Vega line.

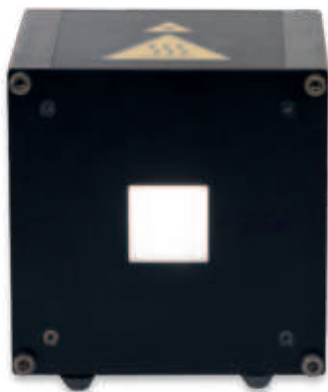
Main Features

- * Maximum illuminance of up to 1 Mcd/m²
- * Flicker free (DC driven LED)
- * Extremely high stability and consistency
- * Create real HDR scenes when combining with other Vega devices



Arcturus use case

During camera testing, our iQ-Lab relied on Vega to perform high-intensity measurements for cameras with very short exposure times. However, while Vega is an exceptional light source for these tests, we often needed something even more powerful to generate the illumination levels encountered by some camera systems, particularly automotive-grade systems. Arcturus can simulate bright sunlight illumination with very high stability to test these cameras for the highest levels of intensity that they will face in the real world.



Arcturus prototype

At a Glance	Arcturus
Principle	Temperature stabilized, DC controlled, dimmable light source
Light sources	36 Temperature controlled LEDs based on iQ-DC technology
Correlated Color Temperature (CCT)	approx. 4900 K (± 200 K)
Color Rendering Index (CRI)	> 95
Maximum luminance	≥1Mcd/m ²
Dim function	Software based 10 ⁶ - 10 steps
Flicker frequency range	1 - 1000 Hz (Square), 10 - 1000 Hz (Sine / Triangle)

The illustration is a prototype and may not represent the final product.

Octa Light Player

Multi-channel light source

The Octa Light Player from Tealumen is a multi-channel light synthesizer with an 8-channel, full-spectrum, dynamic light source with high-quality color rendering that can be installed in the ceiling and replace conventional light sources. It covers the complete temperature range of 1500 K to 20000 K (e.g., fire to blue sky) and can generate standard illuminants such as D50 and D65.

Main Features

- * Spectrally tunable light source
- * Temperature range of 1500 K to 20000 K
- * Peak wavelengths from near UV to deep red



Octa Light Player use case

This light source is ideal for research environments and test labs, including camera test labs. The Octa Light Player is an excellent addition to test labs looking to control their test environment



Multi-channel



Installed in a hospital



Installed in a hospital

At a Glance	Octa Light Player
Principle	Multi-channel light source for color-critical work environment
Color channels	8 (various options from 365 nm to 660 nm)
Correlated Color Temperature (CCT)	1500 K - 20000 K
PWM dimming	>250:1
PWM frequency	32 kHz
Data and Control	Ethernet
Weight	5 kg

GEOCAL

Geometric camera calibration

GEOCAL is a geometric camera calibration device that uses a beam-expanded laser in combination with a diffractive optical element (DOE). This device introduces a new dimension in geometric camera calibration.

Main Features

- * Create a regular grid of light spots from infinity
- * Camera position is translation invariant*
- * Easily manage the angle of camera rotation
- * No relay lens required
- * Measure distortion, focal length, principle point
- * Calibrate large-field-of-view cameras
- * Stereo camera alignments and adjustments
- * IR option available

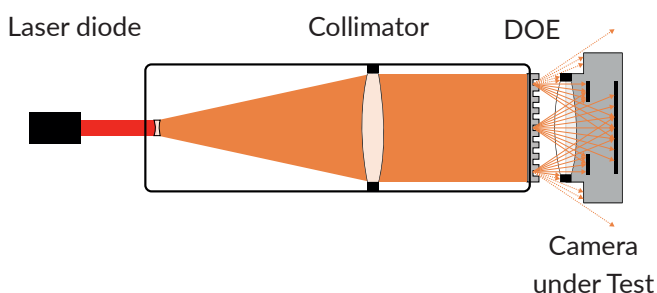


The importance of geometric calibration

Geometric calibration is essential for camera systems that rely on detecting objects in a moving scene, e.g., ADAS or security camera systems. A geometrically calibrated camera will be able to measure distances more accurately, detect objects, compensate for high levels of distortion, and align stereo camera pairs.

GEOCAL XL and GEOCAL IR

The GEOCAL XL is ideal for the geometric calibration of cameras with large front lenses and in instances where the distance between the camera and GEOCAL needs to be large (e.g., calibrating through a windshield). The IR version expands the laser diode wavelength range to 935 nm for geometric camera calibrations in the NIR region.



An example of how the GEOCAL functions

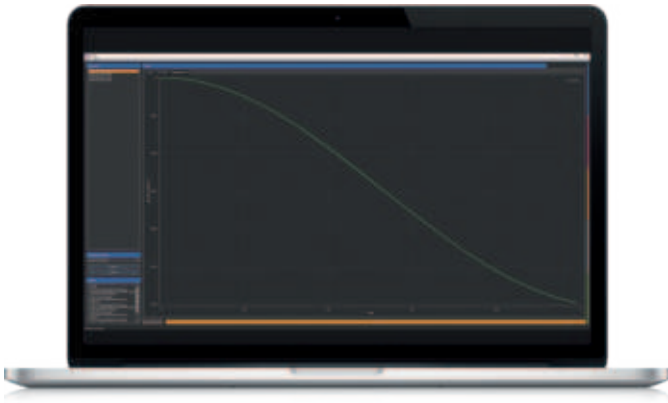


GEOCAL XL

*To a certain extent.

GEOCAL evaluation software

The GEOCAL has a standalone software with a GUI interface for evaluating test results. An API is also available for our customers to apply the GEOCAL functionality into to their custom software, production line solutions, or device testing applications. Both the software and API are compatible with the GEOCAL XL.



GEOCAL software distortion curve



A mobile phone under test

Why GEOCAL over traditional geometric calibration methods?

Traditional geometric calibration methods rely on test charts with regular patterns, but these patterns need to be scaled depending on the field of view and the intended object distance. As a result, relay lenses must be utilized for accurate calibration, but these setups cannot calibrate from infinity. GEOCAL, however, is a compact device that avoids using relay lenses and test charts altogether while calibrating from infinity and thereby improving the accuracy of the calibration.

At a Glance	GEOCAL / GEOCAL XL / GEOCAL IR
Principle	DOE-based geometric calibration of digital cameras
Light source	Frequency-stabilized diode laser
Wavelength	GEOCAL / GEOCAL XL: 638 nm GEOCAL IR: 935 nm
Diffractive optical element (DOE)	Generates a very evenly distributed grid of light points, virtually originating from infinity
Output window	GEOCAL / GEOCAL IR: Usable aperture: Ø 77 mm GEOCAL XL: Usable aperture: Ø 155 mm (camera lens needs to have an equal or smaller diameter)
Usable FoV	Approx. 30° – 120° (Larger values possible, depending on the camera. Please contact us for details)
Software system requirements	PC with Windows 10 operating system (or higher)
Functions	<ul style="list-style-type: none"> • Load multiple images • View selected image • Perform calibration • Overlay detected point grid • Various result visualization methods • Export results (CSV and XML) and coordinates of detected points (CSV)

camSPECS

Advanced spectral sensitivity measurements

The camSPECS combines all interference filters into one “test chart” to improve the effectiveness of camera spectral sensitivity measurements. This device makes spectral sensitivity measurements much faster and more convenient.

Main Features

- * Spectral sensitivity measurements
- * 39 high quality interference filters
- * Advanced analysis software included
- * Color transform generation
- * Visual evaluation of ICC profiles with real images



camSPECS XL and TE292

The camSPECS XL uses the same interference filters, but now each has a diameter of 22 mm, making it more suitable for wide-angle cameras from industries such as automotive or security.

The TE292* has been adapted from the front plate of the camSPECS device. This chart has been developed to be used primarily with the LE7 for camera calibration with iQ-LED illumination.



LE7 with the TE292 XL chart



camSPECS XL

*See page 60 for more details on TE292.

camSPECS software

Both of the camSPECS options come with evaluation software. This software calculates the spectral sensitivity with the images and the calibration data of the filters as a direct measurement. The software also includes a module that can be used to evaluate the camera's color correction matrix (CCM). Color transform generation is possible once the spectral sensitivities are determined. This process is done by converting camera values to color metric values.

in-situ Database

In addition to the camSPECS software, we also offer an in-situ database. This database greatly expands on the 14 spectral radiances offered in ISO 17321-1 and includes numerous objects and scenes that people typically photograph. Each object is available in two variants: incident light and white tile corrected.

Software Features

- * Measuring spectral sensitivity
- * Creation of ICC profiles
- * Support for 2D and 3D-MLUT color transforms
- * CIECAM16 implementation
- * Calculation of spectral sensitivity with images of iQ-LED devices



Color transform evaluation

At a Glance	camSPECS	camSPECS XL
Principle	Illumination box with narrow-band interference filters	Illumination box with narrow-band interference filters
Light source	Halogen (24 V / 250 W) Osram 64657 HLX	Halogen (24 V / 250 W) Osram 64657 HLX
Durability of light source	300 h	300 h
Wavelength range	380 - 760 nm (10 nm steps)	380 - 760 nm (10 nm steps)
Bandwidth	10 nm	10 nm
Diameter interference filters	10 mm	22 mm
Diameter ND filters	6 mm	12 mm
Software system requirements	PC with Windows 10 operating system (or higher)	
Additional functions	<ul style="list-style-type: none"> • Spectral measurement based on iQ-LED technology • Test procedure for evaluating CCMs with different training data • Digital camera RAW file processing / dark frame subtraction / batch processing • Validation by comparing camera and predicted RGB values • Calibration with an included calibration spectro radiometer • Side by side comparison of images with separate ICC profiles • Export all results to XML or plain text files 	

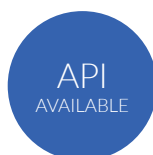
LED-Panel

Accurate camera timing measurements

The LED-Panel, now in its fifth version (V5), is a solution for measuring and analyzing all relevant timing features. It is also optimized to evaluate the autofocus performance of your digital camera.

Main Features

- * Measure all timing parameters
- * Multiple IR versions available
- * Applicable to ISO 15781 and IEC 62676-5
- * Command line interface and control software

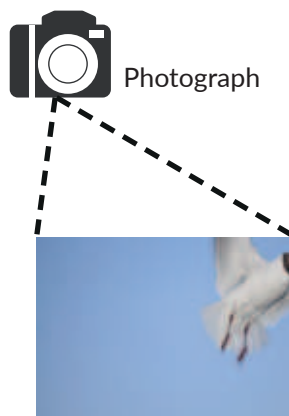


LED-Panel IR and API

The LED-Panel IR expands the testing range to the infrared region. It is available with a peak wavelength of either 850 nm or 940 nm. We also offer the C++ API (as a separate option) to modify various LED-Panel functions for specific requirements.



Shooting time lag, subject missed



Timing measurement solution



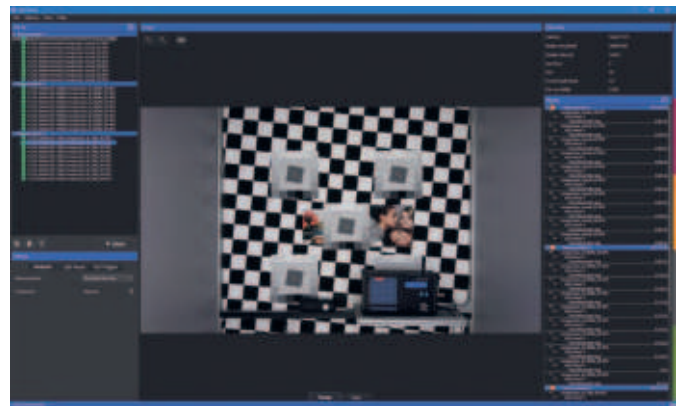
Timing measurement device

The primary function of the LED-Panel is to determine the most important timing values for a digital camera system. You can separately measure shooting time lag and shutter release time lag and then subtract them from one another to determine the precise autofocus performance of the camera.

The LED-Panel uses control software, command-line software, and a USB interface to control the device. The device consists of a 10 x 10 LED light board that can be adjusted for different frequencies to suit testing needs.

Measurable Parameters

- * Shooting time lag
- * Shutter lag with and without autofocus
- * Autofocus time
- * Negative shooting time lag
- * Burst frame rate
- * Display refresh rate
- * Exposure time
- * Rolling shutter speed



LED-Panel software

At a Glance	LED-Panel / LED-Panel-IR
Principle	Array of LEDs to perform timing measurements on digital cameras
Number of LEDs	110 (array of 10 x 10 LEDs, 1 row with 10 LEDs for multiplying counts)
LED Specifications	LED-Panel: diffuse, peak wavelength 630 nm (red), viewing angle 100° LED-Panel (525): diffuse, peak wavelength 525 nm (green), viewing angle 50° LED-Panel IR (850): diffuse, peak wavelength 850 nm (NIR), viewing angle 80° LED-Panel IR (940): diffuse, peak wavelength 940 nm (NIR), viewing angle 90°
Manual control	Operating buttons: switching between single and continuous trigger, Rotatory switch: adjusting the frame rate frequency, time, LCD and LED-array brightness. Display: shows current setting
Operating mode	External trigger, internal single trigger, continuous trigger
Adjustable times	20 μs to 10 s (depending on measurement mode)
Maximum reading measurement time	1000 x of set time
LED running directions	Left to right, right to left, top to bottom, bottom to top
Frame Rate measurement frequency	Adjustable from 1.0 Hz to 200 Hz
Software system requirements	PC with Windows 7 operating system (or higher) and USB port
Additional functions	Software control LED-Panel V5 Analysis of images taken from LED-Panel V5

iQ-Near Focus

Evaluating the autofocus performance of a camera system

iQ-Near Focus will help you evaluate the autofocus performance of a camera. This device consists of a high-contrast, motorized, and translucent checkerboard test chart that will assist with precisely focusing the camera at a near distance.

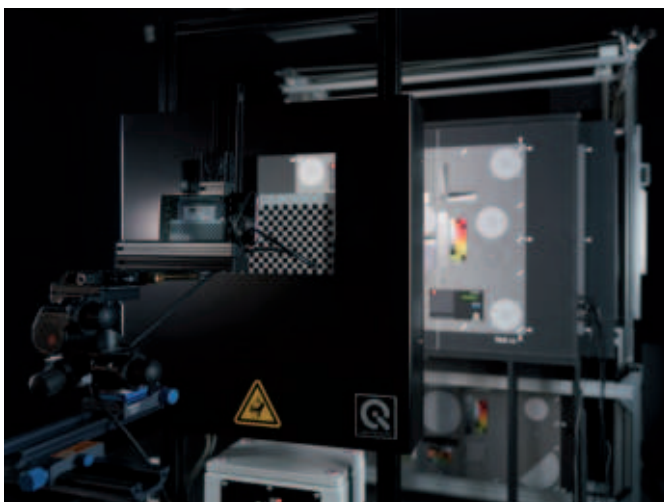
Main Features

- * Remote triggering of the autofocus process
- * A high contrast translucent checkerboard target
- * Easy integration with the LED-Panel
- * Utilized for VCX-PhoneCam testing



Related products and specifications

The iQ-Near Focus can be easily implemented with the LED-Panel, our popular timing measurement device. The LED-Panel can measure all essential timing measurements, including shooting time lag, shutter lag, exposure time, start-up time, etc. Together with the iQ-Near Focus, you have a powerful solution for analyzing your camera system's timing and autofocus performance.



iQ-Near Focus with iQ-Mobilemount

At a Glance	iQ-Near Focus
Principle	Solution for remote triggering of the autofocus process using a high contrast translucent target
Max. stroke distance of chart	290 mm
Specialties	Reversible motion-profile (down→up / up→down) Adjustable delay between down and up motions in steps of 1 s Designed for optimal workflow with the LED-Panel
Height-adjustable frame	Range of adjustments: 20 cm Minimum height (center of chart to the floor): approx. 149 cm Maximum height (center of chart to the floor): approx. 169 cm

KORK

An active radar reflector

KORK introduces an active radar reflector combined with a visible optical marker to create a solution for aligning visual cameras and radar. The optical marker marks the reflector surface's center and corresponds to the radar signal's reflection center. The planarity of KORK allows it to sit in the same plane and avoid any angular error when aligning two or more sensor systems.

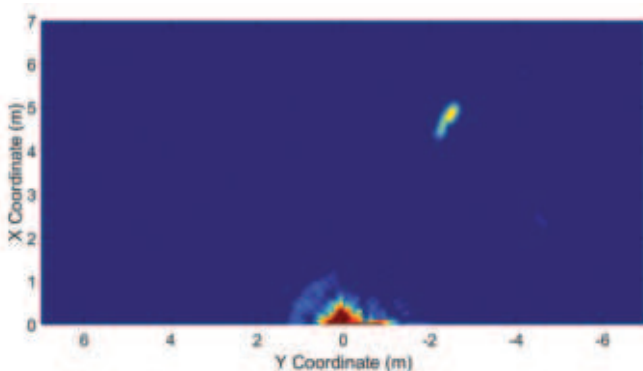
Main Features

- * Visual camera and radar alignment
- * Reduction of angular errors
- * A visible radar cross-section over a wide angular range
- * A frequency range of 76 – 81 GHz



Benefits of KORK

KORK's versatile design allows it to be integrated into a test laboratory or onto a production line. It is especially beneficial for sensor development and end-of-line (EoL) testing. In addition, verification of sensor alignment (e.g., for online algorithms) is possible with active radar reflector solutions.



The reflector shows up as a clearly visible spot in the radar image

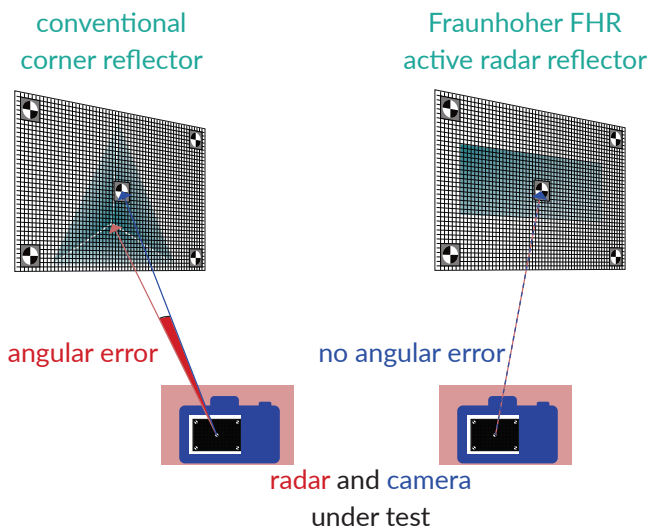


Image Engineering test chart with FHR Active Radar Reflector

Image is only a prototype and subject to change

iQ-Climate Chamber

Temperature-controlled camera performance testing

The iQ-Climate Chamber creates different temperature scenarios for camera performance testing. It is currently the only device on the market for testing a camera system in a temperature-controlled environment.

Main Features

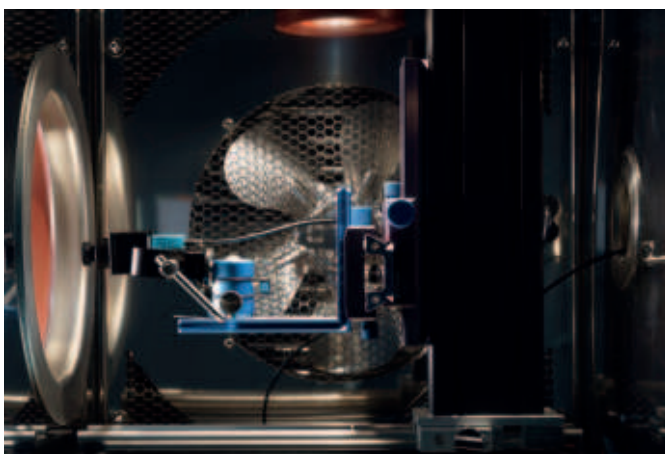
- * Test range of -40° to 120 °C*
- * Temperature stability of ± 0.3 K
- * Bundled with an universal camera mount
- * Create test sequences directly on the device
- * Software control



Example image - actual product design may vary.

ADAS testing

ADAS cameras can often experience performance issues with fluctuating temperatures. As a result, these systems must be rigorously tested in a lab before they are safe for consumer use. Almost all current test methods rely on testing in an actual outdoor setting with, naturally, unpredictable weather conditions. The iQ-Climate Chamber, however, provides a temperature-controlled environment from the confines of a test lab.



iQ-Climate Chamber internal view

At a Glance	iQ-Climate Chamber
Principle	Camera tests under various temperature conditions
Temperature range	-40° to 120 °C
Temperature stability	± 0.3 K
Size of camera window	\varnothing 200 mm
Power supply	230 V / 50 Hz
Dimensions (W x H x D)	620 x 1740 x 770 mm

* The Universal Camera Mount (UCM) in the device has been tested within the temperature range of -30° to 120 °C. We do not recommend testing outside of this range.

STEVE-6D

Automatically test the image stabilization of your camera

The Stabilization Evaluation Equipment (STEVE) uses six degrees of freedom to test the optical image stabilizers of your camera. This device can analyze the camera's response to a natural human hand tremor. STEVE can also be optimized for camera shaking measurements in other applications, such as automotive systems.

Main Features

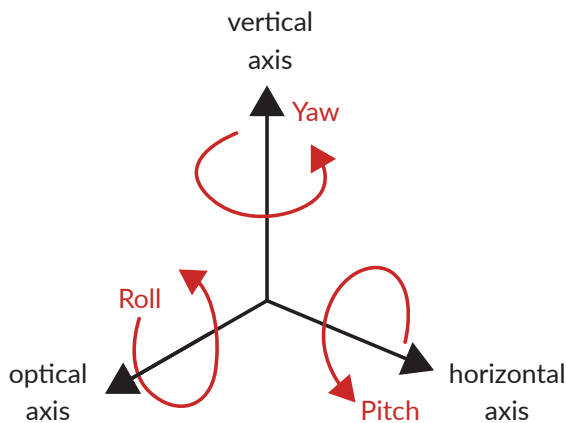
- * Six degrees of freedom
- * Control software
- * CIPA certified



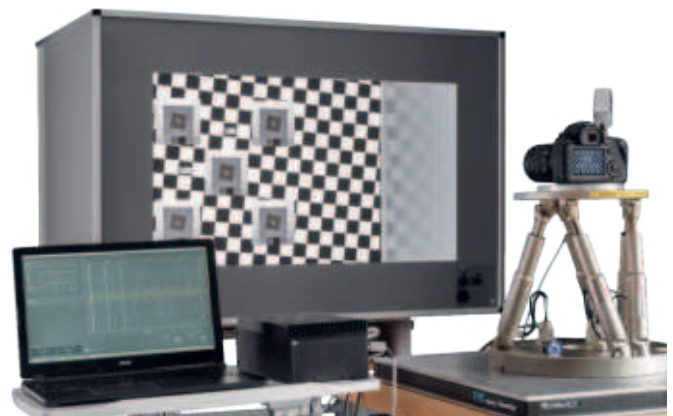
STEVE-6D

Camera shaking measurements

STEVE is originally designed to test how well the image stabilizers in a camera system respond to natural human hand movements. However, as cameras have become more prevalent in other industries, we have begun optimizing STEVE for camera shake measurements for these applications. Autonomous driving systems, for example, need to be tested for their response to uneven road conditions.



Directions of movement

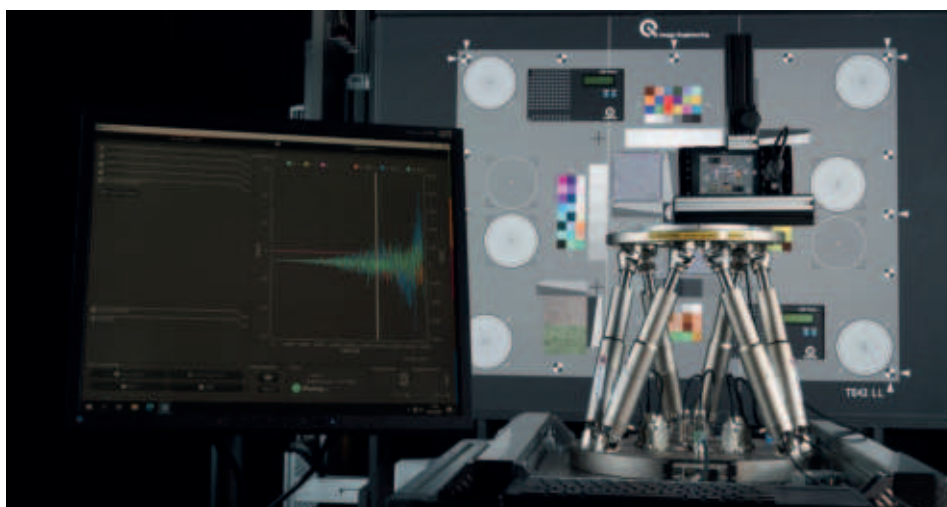


OIS test with the STEVE 6D and the iQ-AF Box

*Check out this blog article for more details: <https://image-engineering.de/library/blog/articles/1215-measuring-camera-shaking>

ISO 20954

ISO 20954 describes a camera measurement procedure with manual control and optical image stabilization. The CIPA handshaking profiles determined for lightweight, mid-weight, and heavy-weight cameras are used depending on which camera is tested. The TC42 WG18 is now working on an annex to the standard to describe how different applications can be generated and applied.*



OIS test with the STEVE 6D and the TE42-LL-Timing

STEVE-6D software

The STEVE-6D software uses two modules: the vibration control module and the data analysis module. The vibration control is used to control the movement of the device. The analyze data module calculates the image stabilization performance using a metadata tool.

At a Glance	STEVE-6D
Max. camera weight	6.0 kg (CIPA certified)
Pivot point	Customizable
Travel range (X / Y / Z)	± 50 mm, ± 50 mm, ± 25 mm
Rotation range (X / Y / Z)	± 15°, ± 15°, ± 30°
Max. linear velocity (X / Y / Z)	50 mm/s
Max. angular velocity (X / Y / Z)	600 mrad/s
Single-actuator design resolution	0.5 µm
Motion type	6-axis sine generator or custom waveform
Mean position error	< 3%
Standard accessories	Motion controller C-887, iQ-Trigger, iQ-Mobilemount
Optional accessories	iQ-Trigger/-T, iQ-AF Box, TE261, Honeycomb Breadboard, iQ-Anchor for STEVE

*Learn more from the ISO website: <https://www.iso.org/standard/91285.html>

iQ-Trigger

A mechanical finger for timing measurements

Eliminate human error and improve the accuracy of your camera testing for various timing measurements. The iQ-Trigger can press the release button of your camera within 20 ms, making it a perfect addition to other products that measure timing accuracy.

Main Features

- * USB interface
- * Control software and C++ API
- * Smooth integration with other products



iQ-Trigger-T

The iQ-Trigger-T (touch) option is our capacitive actuator for touchscreen devices. This device can trigger the camera's capacitive touch release sensor within 0.5 ms.

At a Glance	iQ-Trigger	At a Glance	iQ-Trigger-T
Principle	Remote control for triggering hard and soft buttons of digital cameras	Principle	Remote control for capacitive touch screens
Latency	20 ms (depending on position)	Latency	< 0.5 ms
Specialties	Easy adjustment Exchangable finger tips Comes with Manfrotto L bracket and mounting plate type 405	Specialties	Vibration-free triggering of DUT Sticks on all clean and smooth surfaces for easy mounting Designed to fit into iQ-Mobile-mount
API (C++)	Included in iQ-Trigger product bundles	API (C++)	Included in iQ-Trigger product bundles

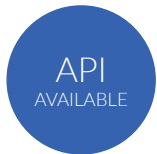
iQ-Defocus

Automatically restart the autofocus system of a camera

Integrate the iQ-Defocus into your workflow to improve the timing measurement analysis of the camera under test by continually restarting the camera's autofocus system.

Main Features

- * Automatic focus on infinity or factory setting
- * Easy integration into test setup
- * Remote trigger
- * Software control



Related products and specifications

The iQ-Defocus is primarily used in conjunction with the LED-Panel. Easily attach the device to the iQ-Mobilemount and control via integrated software in the LED-Panel.



iQ-Defocus with iQ-Mobilemount

At a Glance	iQ-Defocus
Principle	Automated solution for remote trigger of the autofocus process through a provided uniform translucent target
Latency	20 ms
Max. stroke distance	Approx. 11 mm
Specialties	Optimal workflow with the iQ-Mobile mount Adjustable depth
API (C++)	Included in iQ-Defocus product bundles

iQ-Headturner

Control the movement of mannequin heads

The iQ-Headturner offers the possibility of controlling the movement of mannequin heads* used for evaluating webcams and other facial recognition camera systems. This product was designed to be used with the TE295 multipurpose test chart.

Main Features

- * Turning radius of +/- 180°
- * Utilized by the VCX-WebCam 2023 standard
- * Quick change system for the heads
- * Easy integration with TE295



VCX-WebCam 2023

VCX-WebCam 2023 is an internationally recognized standard for evaluating the performance of webcam systems. It's crucial to analyze multiple skin tones when performing a VCX test due to a camera response to changing skin tones. The iQ-Headturner is a flexible solution for quickly changing mannequin heads while providing control over realistic head movements.



The iQ-Headturner with the TE295 chart

At a Glance	iQ-Headturner
Principle	Device to turn a mannequin head at a defined speed
Turning Radius	± 180° from home position
Max. Turning speed	470°/ s or 78 rpm
Min. Turning speed	3°/ s or 0.5 rpm
Fastest time for 180° turn	< 1.5 s
Control software	iQ-Automator software

*Mannequin heads sold separately.

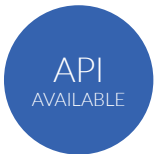
EX2

A convenient way to measure different spectra

The EX2 is an external measuring device for measuring and generating custom spectra through our various iQ-LED devices.

Main Features

- * Small compact design
- * Spectral range of 305 - 1100 nm
- * Spectral resolution of 2.5 nm
- * NIST traceable calibrated



EX2-V2

The latest version of the EX2 combines both the visible and NIR spectrum into one device. It has a more comprehensive spectral range of 200 - 1100 nm (irradiance calibration: 305 - 1100 nm).



The EX2 is delivered with an attached USB cable

At a Glance	EX2-V2
Principle	Direct measuring via optical fiber opening ($\approx 25^\circ$ FOV), or cosine corrector add-on ($\approx 180^\circ$ FOV)
Spectral range	200 - 1100 nm (irradiance calibration: 305 - 1100 nm)
Resolution	2048 pixel/FWHM 2.5 nm
Integration time	30 μ s - 59 s
Control system	Software-based control (iQ-LED software, iQ-LED API, or camSPECS express control software)

AEON Camera Calibrator_(ACC)

Machine vision measurements according to EMVA 1288

The AEON* Camera Calibrator (ACC) is a modular optical system designed to test machine vision cameras based directly on the measurement parameters outlined in the EMVA (European Machine Vision Association)1288 standard.

Main Features

- * Conduct all EMVA 1288 measurements
- * Available in two sizes
- * Measure sensors with diagonals up to 80 mm
- * Adjustable LED light sources
- * Evaluation software**



Measurement Possibilities

The ACC can conduct all measurements specified in EMVA 1288 (version 4.0), including linearity, noise, sensitivity, spatial inhomogeneities, and dark current. Numerous test results can be derived from these measurements, including maximal signal-to-noise ratio, dark noise, dynamic range, non-linearity, absolute gain factor K, and absolute sensitivity threshold and saturation capacity.



AEON Camera Calibrators



AEON Camera Calibrators

At a Glance	ACC2	ACC4
Largest Sensor	80 mm	18 mm
Standard light source	Pulsed, current-controlled LEDs (4 or 8 colors) Pulsed or current-controlled LEDs (4 colors)	
Calibration	Split optical path with built-in calibrated photodiode	
Usable cameras	Linear/non-linear, monochrome/color/multispectral, area/line cameras	
Overall dimensions (LxWxH)	935 x 130 x 140 mm	298 x 79 x 65 mm

*Learn more about our partnership with AEON on our website.
 **AEON's heurisko® image processing platform powers software.

iQ-Analyzer-X

Evaluating image quality performance

The iQ-Analyzer-X is a high-speed analysis software for evaluating the image quality performance of camera systems using various KPIs. The software is built entirely on C++, giving it a more modern and flexible feel. We are currently offering the iQ-Analyzer-X as a free download from our website. The Cultural Heritage (CH) version is a low-priced variant optimized for the UTT test chart used in the archiving industry.

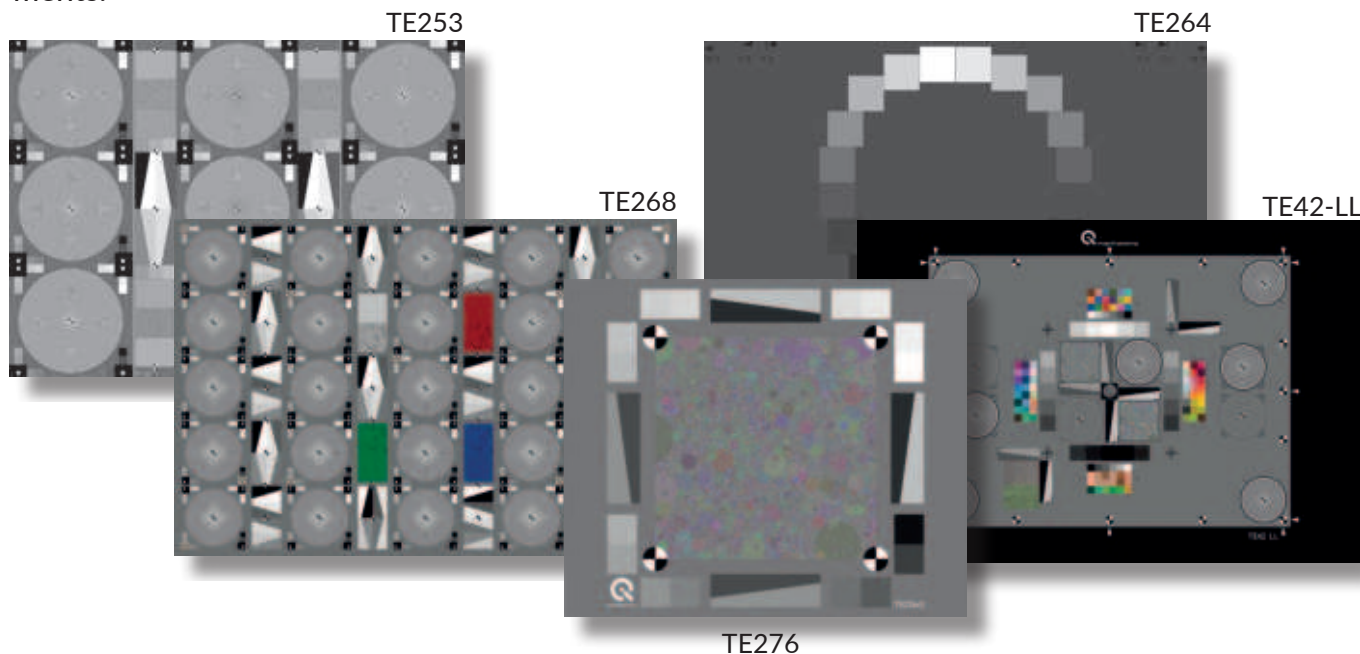
Main Features

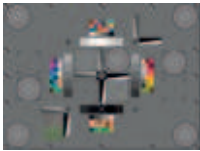
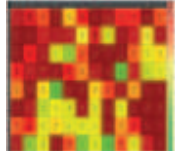
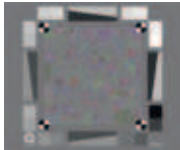



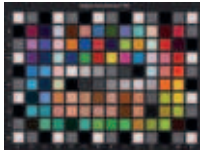
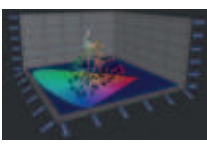
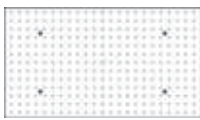

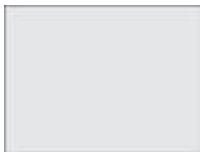



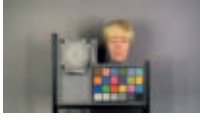
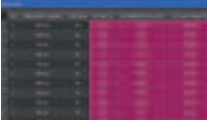
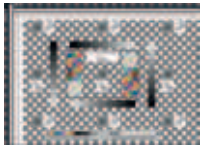





- * Automation feature
- * Result storage on local or remote database systems
- * Automatic chart detection
- * Custom test templates
- * VCX measurements in video and image files
- * Live Video Import and Analysis
- * Network license functionality



Test chart support

The iQ-Analyzer-X supports the analysis of numerous test charts for evaluating the various KPIs of camera systems. The software can automatically detect the chart under test and provide analysis results in seconds. Custom test charts can also be supported to cover all of your testing requirements.



KPIs	Example Charts	Main Features	Results
42 Multipurpose		<ul style="list-style-type: none"> Analysis of the TE42 multipurpose test chart A quick overview of the camera systems image quality Most important image quality factors with one image 	
Resolution		<ul style="list-style-type: none"> SFR on slanted edges MTF on sinusoidal or bitonal Siemens stars (ISO 12233) Texture loss on low contrast Siemens stars (ISO 19567-1) Texture loss on dead leaves (ISO 19567-2) 	
OEFC		<ul style="list-style-type: none"> Camera OEFC (ISO 14524) ISO speed (ISO 12232) Noise and dynamic range (ISO 15739) White balance 	
Color		<ul style="list-style-type: none"> Color reproduction – Delta E* Difference luminance, chroma and hue – Delta (L*, C*, H*) Visual noise Selectable chromatic adaptation and color difference formulas 	
Distortion		<ul style="list-style-type: none"> Lens geometric distortion (ISO 17850 & IEEE P1858 CPIQ) TV-distortion Lateral chromatic aberration Longitudinal chromatic aberration 	
Shading		<ul style="list-style-type: none"> Lens vignetting Luminance shading in f-stops or as a percentage Color shading Noise (depending on image field) 	
Video		<ul style="list-style-type: none"> Capturing frames from video files Capturing frames from USB video cameras 	
VCX		<ul style="list-style-type: none"> Sharpness Color accuracy Auto exposure convergence Auto white balance convergence 	
UTT		<ul style="list-style-type: none"> Scanners and archiving (ISO 19264) Pass/Fail assessment Size A4 – A0 	
Live video		<ul style="list-style-type: none"> Color (RGB, LCh) Visual Noise Slanted Edge MTF 	
Capture Server tool		<ul style="list-style-type: none"> Capturing images/videos from built-in cam in remote laptops via TCP/IP Easy to use: start tool from USB stick connected to laptop Laptop can be connected to local network Full control using Analyzer-X 	

Programming Interfaces

Application Programming Interfaces (API) for flexible integration

The various iQ-APIs have been developed as flexible building blocks to integrate our image quality testing products into existing software systems or custom designs. All of our API interfaces are written in the C++ programming language. The C++ interface only depends on the standard ISO C++ and its Standard Library (STL).

We also offer C interfaces and Python sample scripts for our iQ-LED, GEOCAL, Vega, and LG3 APIs. The C interface can be used in various programming languages and SDKs, such as Python, Matlab, MS Visual Basic, or Labview.

API	C++	C	Related Products	Key Features
Vega API	X	X	Vega	Full control over Vega devices
iQ-LED API	X	X	CAL1 // CAL2 // CAL3 // CAL3-XL iQ-LED // LE7// EX2 // iQ-Chart Box (LED light only) iQ-Flatlight (LED light only) lightSTUDIO-L (-LH, -LM, -LMH)**	Full control over iQ-LED technology as well as over our built-in and standalone spectrometers
iQ-Trigger API	X		iQ-Trigger (-T)	Controlling iQ-Trigger when connected via the USB-Box
LED-Panel API	X		LED-Panel // iQ-Trigger (-T)	Full control over the LED-Panel and connected iQ-Trigger
LG API	X	X	lightSTUDIO-H (LH, LMH, SH, SMH) LG3 // LG4	Controlling the HDR extension of the lightSTUDIO-H, LG3 and LG4
iQ-Timecode API	X		iQ-Timecode	Controlling the iQ-Timecode available with a lightSTUDIO
GEOCAL API	X	X	GEOCAL	Evaluating images captured with the GEOCAL device

Command Line Interface (CLI)

Some of our products also offer a Command Line Interface. The CLI will enable you to automate certain tasks without having any programming knowledge. Control the software by simply issuing text commands in the Windows command prompt or scripting a batch file.

CLI	Related Products	Key Features
iQ-Analyzer-X	iQ-Analyzer	Full-featured batch processing for image analysis
LED-Panel CLI	LED-Panel iQ-Trigger (-T) iQ-Defocus	Full control over the LED-Panel and connected iQ-Trigger, iQ-Defocus

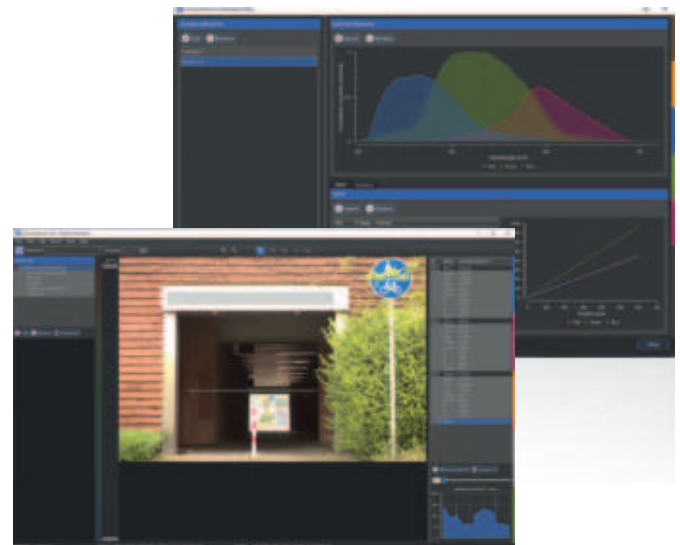
iQ-Luminance

Turn your camera into a luminance meter

With proper calibration*, you can use the iQ-Luminance software to turn your camera into a luminance meter that will provide different advantages compared to conventional luminance meters.

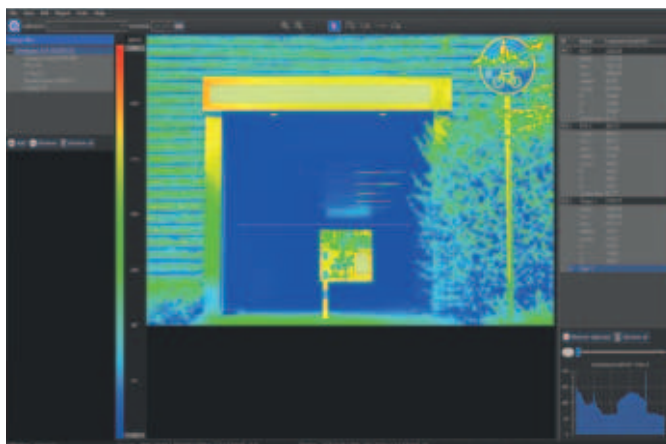
Main Features

- * Calculate luminance values from image data
- * Map raw RGB data to the luminance
- * Calibrate at multiple f-stop levels
- * Calibrate for various ISO-settings
- * Comprehensive ROI selection tool
- * Export results as PDF report and XML file
- * Import / export ROIs



Evaluate the image

Rectangular, circular, line-shaped, or polygonal regions of interest (ROI) can be drawn on the image to evaluate the selected area more efficiently. The corresponding luminance is then visualized as a grayscale or false-color image.



Luminance false-color display



Luminance values display

*Please note that you must send your camera to our test lab for a specific luminance calibration before you can begin measuring luminance on your own.

iQ-Lab

Welcome to the Image Engineering Image Quality (iQ) Test Lab

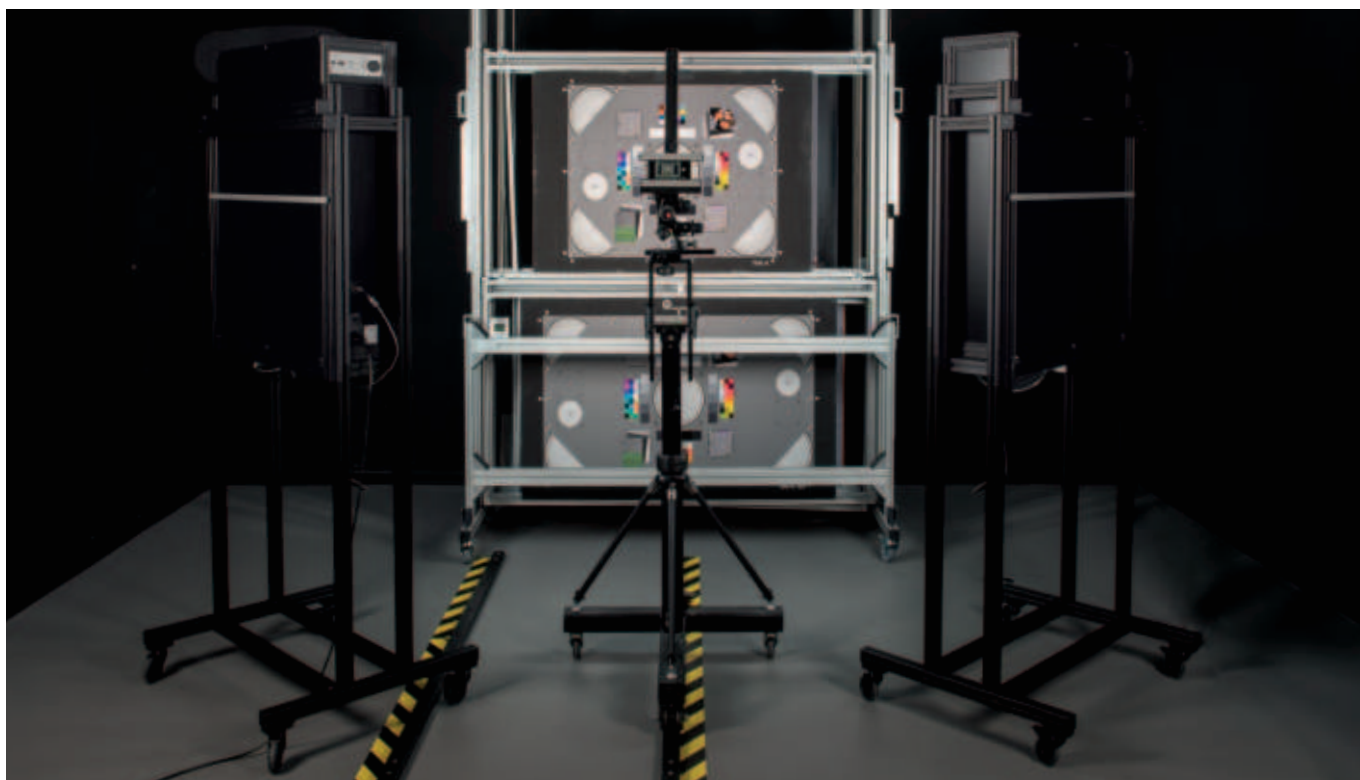
For over twenty years, we have provided objective camera tests to companies looking to improve the image quality performance of their digital cameras. Today, the test lab has grown into one of the world's largest independent camera test labs as we expand our testing capabilities to cover a wider variety of industries relying on camera systems, such as automotive and mobile phones.

Over the years, our iQ-Lab built its reputation as a trustworthy independent camera test lab that provides objective, unbiased test results using standard-driven test methods. Simultaneously, the iQ-Lab focuses heavily on camera testing innovation to ensure we stay current with the latest technology.

You can contact the lab for a test consultation at testlab@image-engineering.de.

Objective Camera Testing

Most camera users and manufacturers want to know if the camera they use or design produces a high-quality image. However, opinions differ on which characteristics make one image better than another; a viewer's style, preferences, and expectations affect our judgments. In contrast, our iQ-Lab performs objective assessments. Objective testing means that lab results are not influenced by the tester's opinion of the camera and its features.



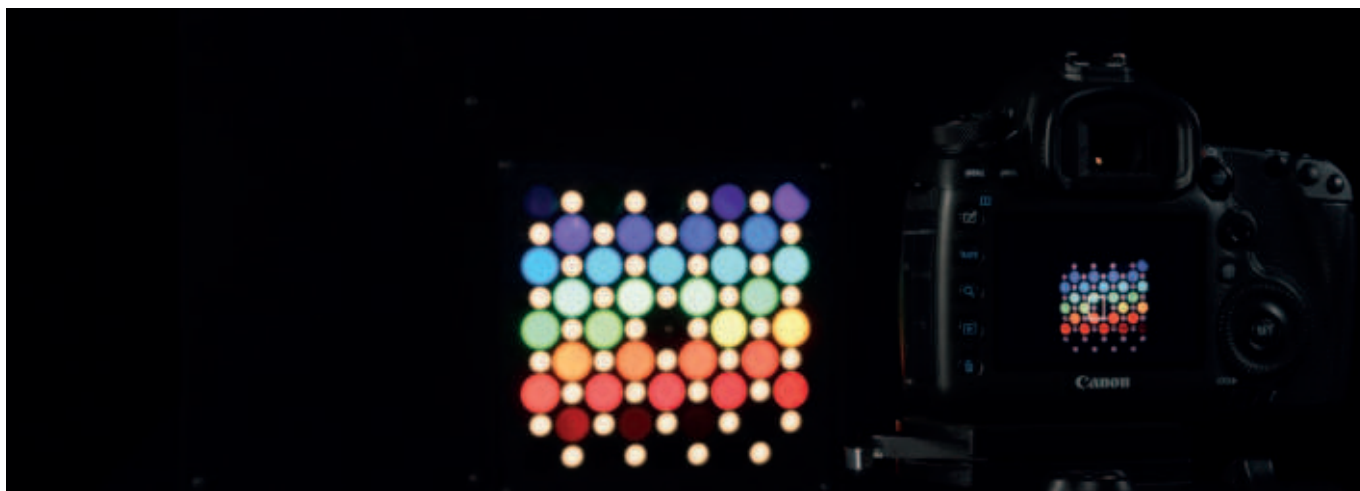
Independent Camera Testing

Apart from objective measurements, IE is also an independent test lab. Being independent allows us to help ensure the test results are trustworthy, valid, and robust.

Standardized Camera Testing

The assessments performed in the IE test lab are carried out per standard protocols that comply with the relevant international standards. Many of our engineers are members of the standard working groups (e.g., ISO, IEEE, VCX, EMVA, etc.) tasked with creating and updating the various standards, thus giving us first-hand knowledge of the test methods.

Using standardized test methods ensures that test results are transparent and can be compared with those produced by any other lab using these same methods. In addition, all of the products, test charts, and software we use in our test lab are available for sale to other labs so that they can recreate a test or build a test lab of their own.



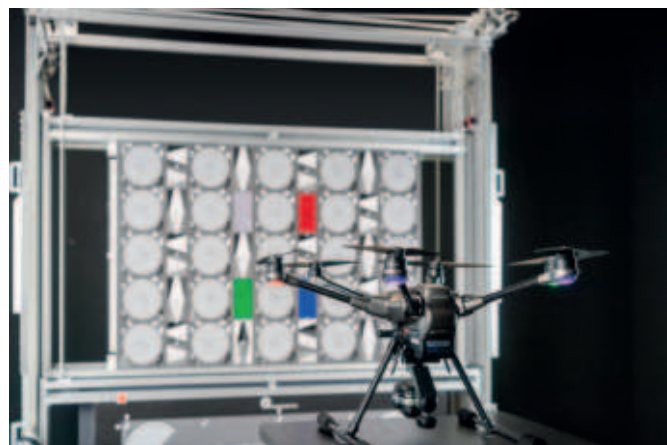
Unique Camera Testing

While most of our everyday testing is for industry-specific tests, our lab also performs special tests upon request. Underwater camera testing, drones, image quality performance under temperature fluctuations, and geometric and luminance calibrations are just a few examples of the unique cameras and tests we can do in our test lab.

We are constantly innovating in the iQ-Lab and are always looking into new ways of testing cameras. If you are looking for a unique test or a partner to establish a new test, we encourage you to contact our team for a consultation on how we can help each other improve image quality testing.



Underwater camera testing



Testing resolution of a drone camera

Camera Performance for Automotive Systems – camPAS

The camPAS test concept is a uniquely designed performance test for camera and sensor systems within the automotive industry. We offer camPAS to automotive manufacturers who need independent and objective results to support their qualification and validation processes as a trusted third party.

The automotive camera industry is experiencing an exceptional advancement in camera system technology. With such rapid changes, testing standards have become challenging to keep up with. We currently model camPAS tests on the pre-release of the IEEE-P2020 international standard. Many of our test Image Quality Scientists are actively participating in developing the standard.



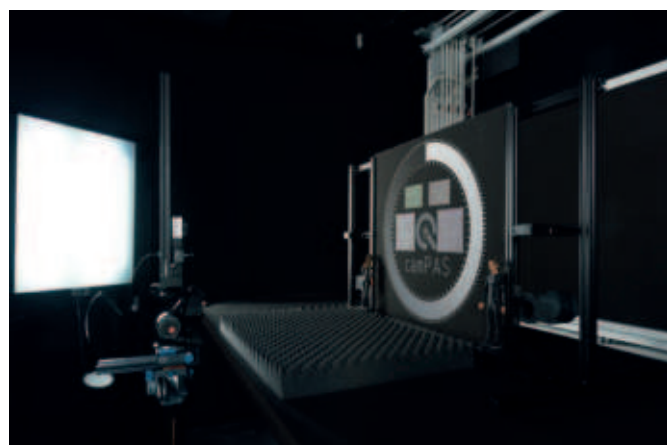
camPAS testing overview

camPAS is developed as a third-party solution for end device manufacturers and component suppliers. We provide objective results based on a custom test agreement between the manufacturer or supplier and us as the third party. The results are always kept confidential between Image Engineering and the other party.

The test consists of the most critical KPIs for evaluating automotive camera system performance. Tests include Contrast Transfer Accuracy (CTA), modulated light mitigation probability (MMP/flicker), high dynamic range (HDR), Contrast Singal-to-Noise Ratio (CSNR) linking objective image quality measurements with a visual assessment of low-light performance, etc.



camPAS testing area



camPAS tesing setup

See our website for more lab testing information: <https://www.image-engineering.de/services/test-laboratory-iq-lab>

VCX Camera Testing

The mission of our test lab has always been to provide our customers with transparent and objective results when evaluating their camera systems. Similarly, the VCX organization aims to provide objective image quality testing for mobile phone cameras and webcam systems so that consumers can make a more informed decision when purchasing a smartphone or webcam based on a final “score.”

We are a trusted VCX testing lab for VCX-PhoneCam testing (we are currently in the process of becoming a certified test lab for VCX-WebCam testing). Using our test equipment, we have set up our lab per the specifications outlined by the VCX white paper (<https://vcx-forum.org/>).

VCX-PhoneCam v2020

When performing a VCX smartphone test, we evaluate the quality of the selfie and primary camera and combine their results for the final score. The primary camera is assessed for its image and video quality and performance, while the selfie camera is tested for its image quality. The tester’s opinion of the camera and its features.



VCX-WebCam 2023

VCX webcam testing uses the same principles as VCX mobile phone tests. These tests emphasize face-present and face-moving scenes, auto-exposure, white balance, noise, and spatial frequency performance. The final VCX score provides the level of camera imaging performance. A high VCX score means a high level of image quality. This test is designed for both standalone and built-in webcams.



TE42

A multipurpose test chart for a quick image quality overview

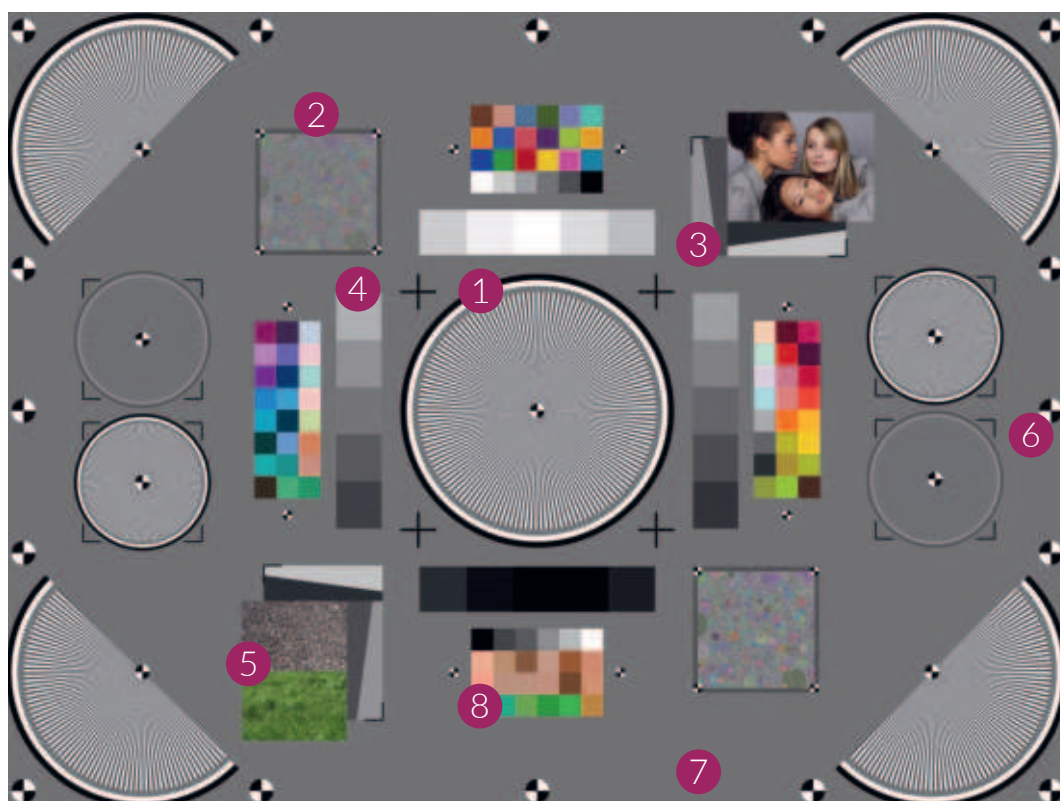
The TE42 chart is a multipurpose test chart that can quickly gather an overview of a camera's image quality performance in a single image. The chart is designed with multiple objects on the same chart plane for testing a wide variety of image quality factors, all of which can be analyzed using the iQ-Analyzer-X software (not included with the chart).

We often use the TE42 in our test lab, and it has become one of our most popular test charts due to its flexibility.



The TE42 chart plane has properties for analyzing many different image quality factors including:

- | | |
|-------------------------------|----------------------|
| 1 Resolution ISO 12233:2023 | 5 Visual analysis |
| 2 Texture loss ISO 12233:2023 | 6 Distortion |
| 3 Sharpening ISO 12233:2023 | 7 Shading |
| 4 OECF and Noise ISO 15739 | 8 Color reproduction |



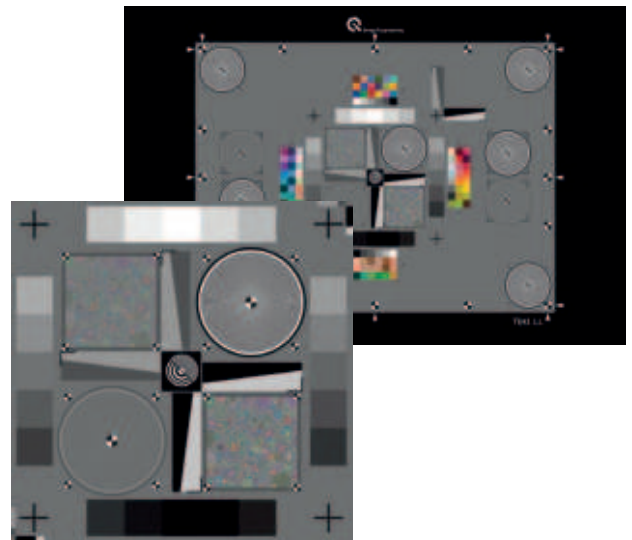
TE42-LL

A multi-purpose test chart for low-light performance testing

The TE42-LL test chart is a multi-purpose test chart used primarily for measuring the low-light performance of digital cameras as described by ISO 19093. This chart is based on the original TE42 chart but now has all of the important structures, such as the low-light Siemens stars and slanted edges, at the center of the layout to avoid fall off at the corners.

Main Features

- * The exact chart recommended in ISO 19093
- * Test targets all equal distance from each other
- * Analyze all important low-light factors in one image

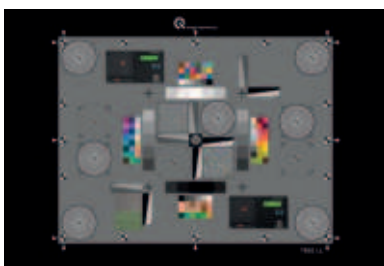


TE42 options

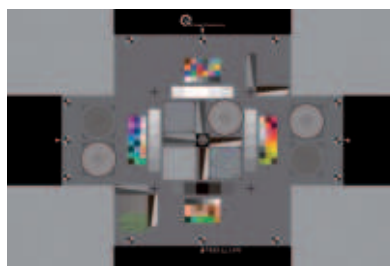
The TE42-LL Timing chart is the chart, but it now incorporates two LED-Panels for measuring the important timing features of a camera in a low-light situation. The LED-Panel can analyze all of the various timing factors described in ISO 15781, including shooting time lag, shutter speed, and frame rate.

The TE42-LL-Ultra-Wide (UW) version of the TE42-LL chart uses tartan targets to allow you to analyze resolution even with distortion present (which is typical for ultra-wide cameras).

The TE42-LL-2AR incorporates two aspect ratios (2AR) into one chart. Both 4:3 and 16:9 aspect ratios are now on one chart plane. This version has a dividing wall (easily insert or remove), allowing you to create a “twin” scene.



TE42-LL Timing



TE42-LL-UW



TE42-LL-2AR

TE42-LL 16:9 + 4:3 iQ-Analyzer-X support

TE262 / TE263

A universal test target (UTT) for archiving

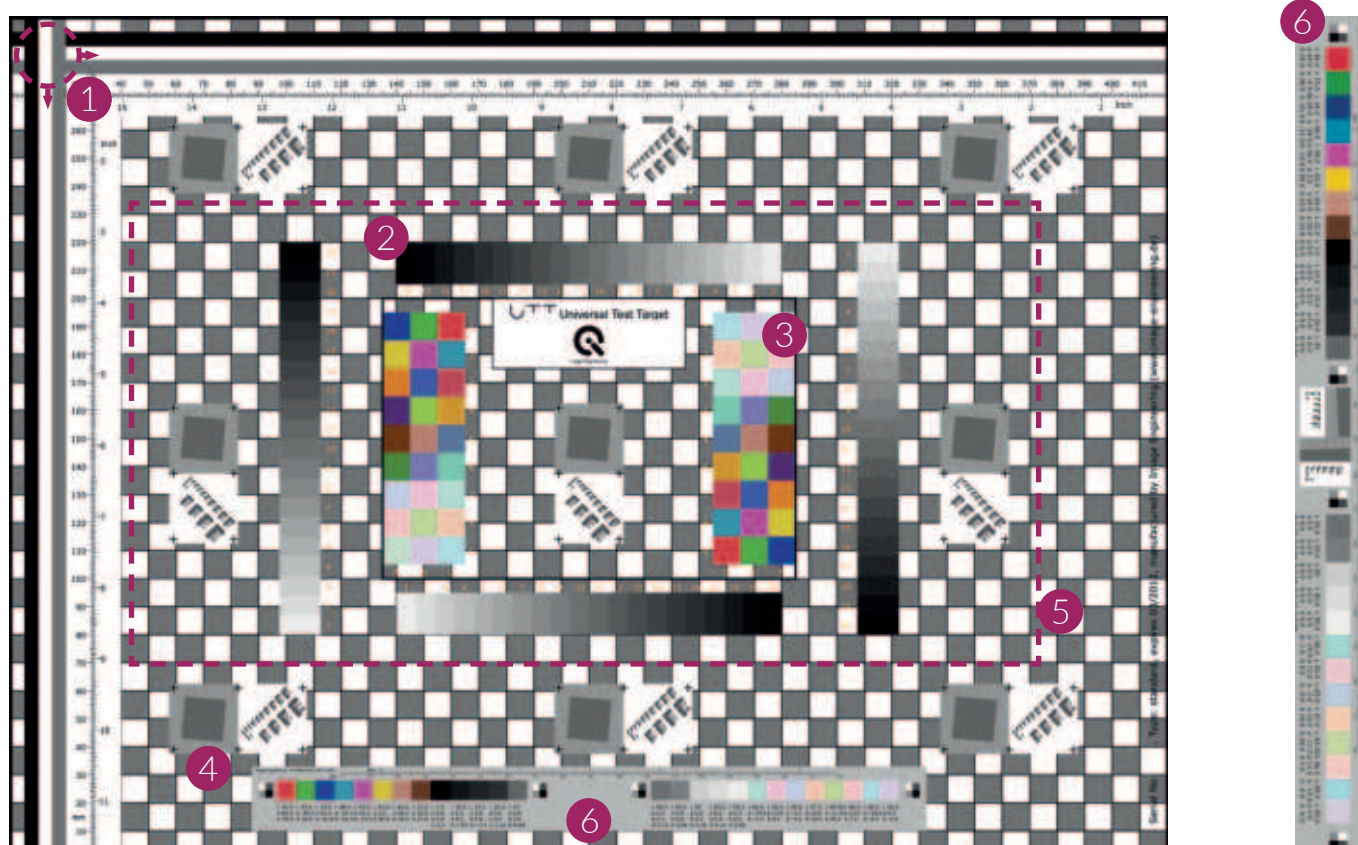
The UTT chart is a multipurpose test chart designed to evaluate the image quality of scanners and other digital input devices for the archiving industry. It is available in various sizes ranging from A4 to A0. The iQ-Analyzer-X software (not included with the chart) can automatically analyze the image and provide the test results.

This chart can be used in accordance with ISO 19264, which describes a method for analyzing image quality in the archiving industry for both scanners and digital cameras.



The chart can measure the following topics in archival scanning:

- | | |
|---------------------------------|--|
| 1 Defect pixels and Shading | 4 Resolution (slanted edge and visual) |
| 2 Dynamic range, OECF and Noise | 5 Shading and Distortion |
| 3 Color reproduction | 6 Additional chart TE263 |



A0,A1,A2,A3,A4  iQ-Analyzer-X support

TE292 the camSPECS plate

Spectral sensitivity measurements with the camSPECS front plate

The TE292 chart (also known as the camSPECS plate) is the most recent development in the camSPECS product line. It is designed after the front plate of the full camSPECS device, with all of the interference filters mounted onto one “test chart” for fast spectral sensitivity measurements and camera color calibration.

Main Features

- * Transparent test chart designed for the LE7
- * The LE7 includes all features from iQ-LED*
- * Measure spectral sensitivities in a single image
- * Both an original and XL version available
- * Evaluation with camSPECS software
- * Software/external calibration device included

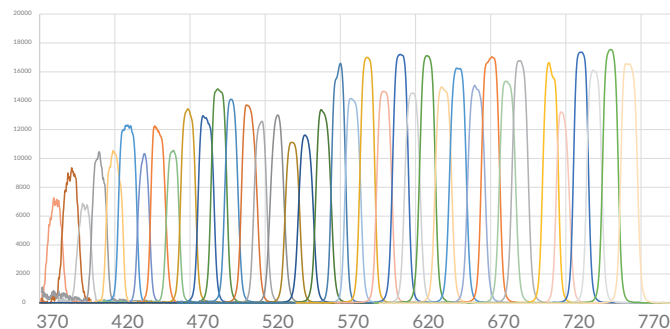


iQ-LED illumination with the LE7

The camSPECS plate** is a standalone product that has been developed to be used primarily with the LE7, our iQ-LED integrating sphere for uniform illumination. The LE7 includes iQ-LED control software, and we also offer a C or C++ API as a separate option.

TE292B VIS-IR

The TE292B VIS-IR version extends the wavelength range from 380 nm to 1050 nm in 10 nm steps and has a total of 68 filters.



Wavelengths [nm] of the TE292 filters



LE7 with TE292B VIS-IR

*See iQ-LED page for more details. More information also available on our website.

**The plate cannot be used by itself and requires a broadband uniform illumination device for functionality. The plate and device are sold separately.

Resolution charts

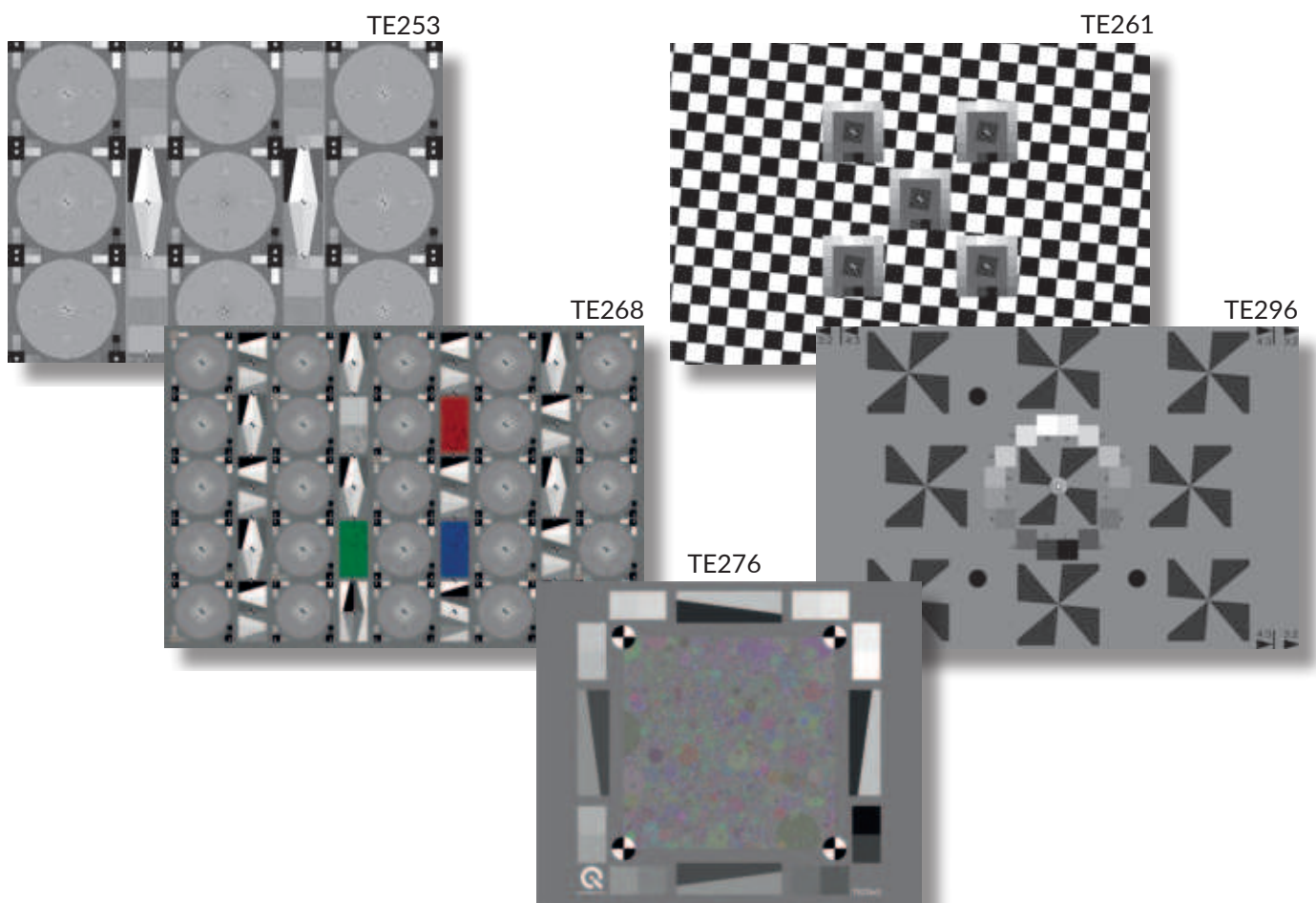
Uniquely designed test charts for measuring camera resolution

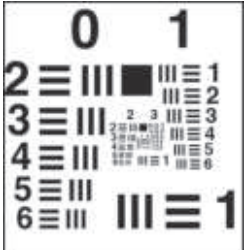
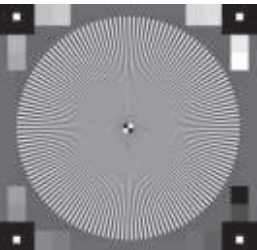
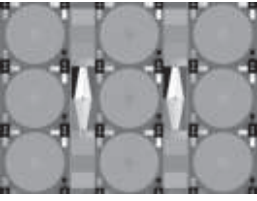
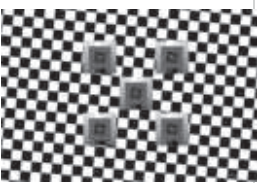
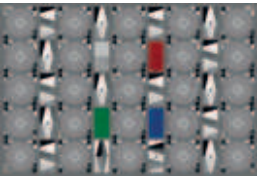
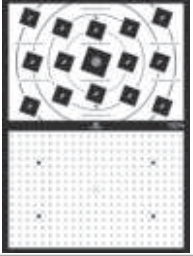
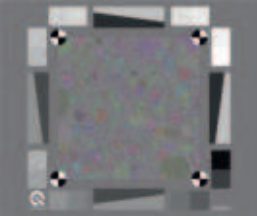

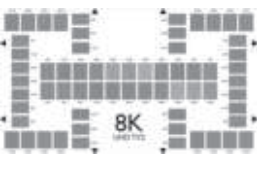

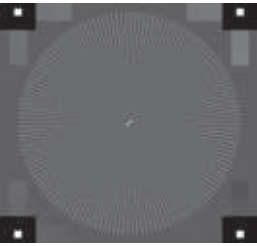

Image resolution is the ability of a digital camera to reproduce the fine details of a scene. In other words, how clearly a human observer perceives an image is based on the resolution of the camera system. As a result, it is vital to thoroughly test and analyze the resolution of a camera system.

The most reliable way to test camera resolution is to use test charts. There are many different test charts that are specially designed to test camera resolution. These charts normally include objects such as sinusoidal Siemens stars or slanted edges, both of which are based on ISO 12233.

Another important image quality factor relating to resolution is texture loss or the loss of fine details with low contrast within the image. Texture loss is caused by the camera system reducing the noise of an image, which often results in the loss of important texture.

Texture loss is best measured using a Dead Leaves chart as opposed to traditional gray targets. Dead Leaves charts create a more natural testing structure for texture loss.



<p>TE250 35 mm</p> 	<ul style="list-style-type: none"> • USAF resolution chart • Evaluate scanner resolution • Measurements up to 10,000 ppi • Transparent 	<p>TE253 4:3</p> 	<ul style="list-style-type: none"> • Modulated sinusoidal Siemens star • Evaluate camera resolution • Reflective
<p>TE253 9x 4:3 / 16:9 / 35 mm</p> 	<ul style="list-style-type: none"> • Follows ISO 12233:2014 • Nine sinusoidal Siemens stars • Slanted edges and white noise patches • Transparent/Reflective 	<p>TE261 16:9</p> 	<ul style="list-style-type: none"> • Slanted edge chart • Evaluate camera SFR • Includes low contrast slanted edges • Reflective
<p>TE268 4:3 / 3:2</p> 	<ul style="list-style-type: none"> • Lens resolution and sharpness chart • 25 sinusoidal Siemens stars • 16 slanted edges in different contrasts • Four colored dead leaves patterns • Reflective 	<p>TE274 3:2</p> 	<ul style="list-style-type: none"> • Macrochart 13 x 13 cm • Slanted edges for resolution • Crosses for distortion • Special alignment frame for positioning • Reflective
<p>TE276 287 x 287 mm (picture size)</p> 	<ul style="list-style-type: none"> • Dead Leaves chart • Evaluate texture loss • Circles in all sizes and colors • Reflective 	<p>TE277 16:9</p> 	<ul style="list-style-type: none"> • 4k (UHD TV) resolution chart • 100-2000 CPH • Frequency response measurement of a 4K camera • 50 multiburst fields • Transparent
<p>TE278 16:9</p> 	<ul style="list-style-type: none"> • 8K (UHD TV2) resolution chart • 200-4000 CHP • Frequency response measurement of an 8K camera • 50 multiburst fields • Transparent 	<p>TE279 16:9</p> 	<ul style="list-style-type: none"> • 4k (UHD TV) universal chart • Quick analysis of transmission characteristics • Multiple gray scales and resolution wedges • Transparent
<p>TE280 334 x 271 mm</p> 	<ul style="list-style-type: none"> • Evaluate texture loss • ISO 19567 • Sinusoidal Siemens star • 18% and 48% modulation available • Reflective 	<p>TE296 4:3 / 3:2</p> 	<ul style="list-style-type: none"> • Slanted edge chart • Evaluate camera resolution • ISO 12233: 2023 • Reflective • 4:1 contrast range of grayscales • 6:1 contrast range of grayscales

 iQ-Analyzer-X support

*Complete list of charts can be found on our website: www.image-engineering.com

Grayscale charts

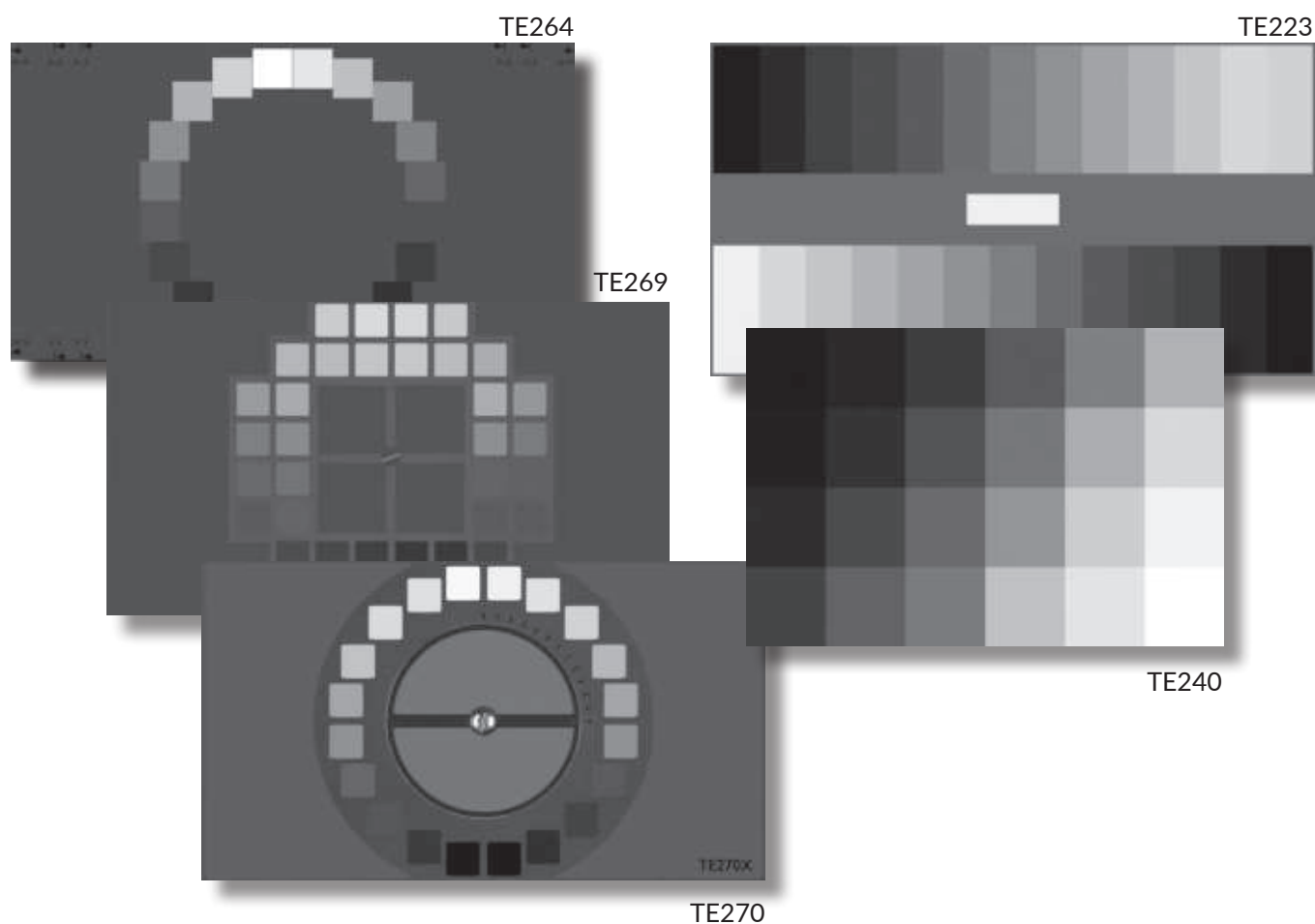
Test charts for analyzing the different grayscale factors




















Grayscale refers to the various shades of gray that are present throughout the image. Many different image quality factors are important when measuring how well a camera reproduces the tonal value of an image, including OECF, dynamic range, gamma, and noise.

The OECF (opto-electronic conversion function) refers to how the camera system transfers the luminance (gray levels) in the scene from the sensor into digital values in the camera. This is important when measuring the dynamic range and signal noise of a camera system.

Dynamic range describes the ratio between the darkest and lightest gray level in the scene capable of being reproduced by the camera (also known as the contrast image). Signal noise refers to the presence of unwanted artifacts that often results from the camera's high sensitivity settings.

Many of our grayscale charts are developed in accordance with ISO 14524 and ISO 15739, including those for measuring OECF, dynamic range, and noise.



<p>TE153 4:3</p> 	<ul style="list-style-type: none"> • Log. grayscale chart (11 steps) • Evaluate halftone reproduction • Two 11-graduated counter current gray scales • 40:1 contrast range of gray scales • Transparent/Reflective 	<p>TE182 9x 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Evaluate exposure control • 18% remission • Transparent/Reflective 
<p>TE197 16:9</p> 	<ul style="list-style-type: none"> • ISO 14524 • Evaluate OECF • 12-step gray scale • Multiple contrasts • Transparent/Reflective 	<p>TE205 4:3</p> 	<ul style="list-style-type: none"> • Gamma measurement chart • Ten gray steps from 1-10% transmission • Ten gray steps from 10-100% transmission • Transparent
<p>TE223 16:9</p> 	<ul style="list-style-type: none"> • HDTV log. grayscale chart • 13 steps with a contrast of 1:200 • Evaluate halftone reproduction • Two 13-graduated counter current gray scales • Transparent/Reflective 	<p>TE240 32:24 mm (transparent) / 100:150 mm (reflective)</p> 	<ul style="list-style-type: none"> • Evaluate dynamic range of 35 mm scanners • ISO 21550 • 24 gray patches • 4.0 density range (transparent) • 2.4 density range (reflective) 
<p>TE241 16:9</p> 	<ul style="list-style-type: none"> • OECF and noise chart • Evaluate the characteristic curve of a camera • 20 gray patches • Transparent 	<p>TE259 16:9</p> 	<ul style="list-style-type: none"> • OECF and noise chart • Evaluate dynamic range on a waveform monitor • 20 gray patches • Contrast range of 10,000:1 • Transparent 
<p>TE264 16:9</p> 	<ul style="list-style-type: none"> • OECF chart • ISO 14524 and 15739 • 12 or 20 gray patches • Metal frame to avoid stray light and reflections • Transparent 	<p>TE269 16:9</p> 	<ul style="list-style-type: none"> • OECF 36 gray patch chart • Densities from 0.03 to 6 • ISO 14524/15739 / IEC 62676-5 • Metal frame to avoid stray light • Contrast up to 1,000,000:1 / 120 dB • Transparent 
<p>TE270 X 16:9</p> 	<ul style="list-style-type: none"> • OECF 20 gray patch chart • 2 polarizing filters in center of chart • For cameras that don't have manual adjustment • Metal frame to avoid stray light and reflections • Transparent 	<p>TE297 16:9</p> 	<ul style="list-style-type: none"> • OECF 36 gray patch chart • Wide dynamic range, IEC 62676-5 • Minimize shading/vignetting errors • Metal frame to avoid stray light and reflections • Transparent 

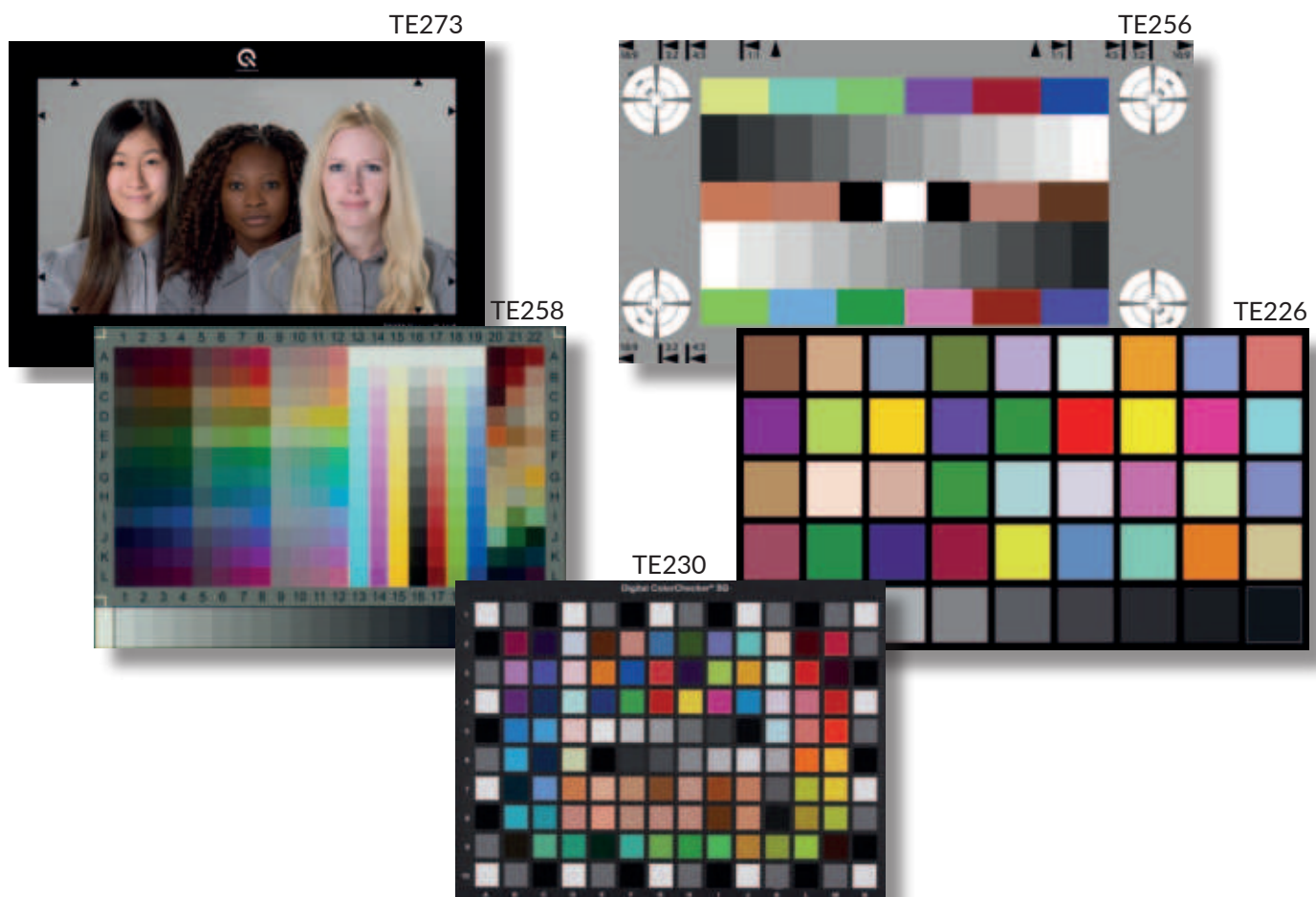
Color charts



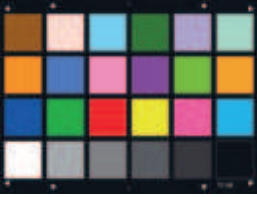

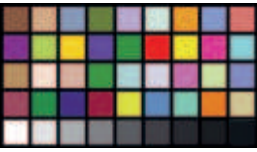
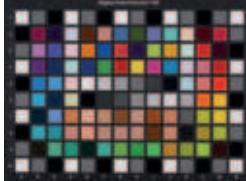



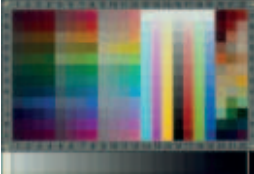


Test charts for analyzing the color reproduction of a camera

Color reproduction or color accuracy describes how well a camera reproduces the original colors in the digital image. Incorrect color reproduction can lead to unintended or false colors within the image.

Color is one of the more important image quality factors, so it is important to analyze the color accuracy as well as the white balance of a camera to ensure proper color reproduction. The white balance function of a digital camera ensures the balance of objects in the correct colors in correlation to the light source.

Color targets are best when checking color accuracy and white balance. For generating a color correction matrix, we recommend measuring the spectral sensitivities with the camSPECS express.



<p>BBC61 4:3</p> 	<ul style="list-style-type: none"> • Flesh tone reference chart • BBC approved • Reflective 	<p>TE106 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Evaluate color rendition • Primarily for TV cameras • 6 color bars • Transparent/Reflective
<p>TE188 4:3 / TE188 16:9 (X-Rite ColorChecker)</p> 	<ul style="list-style-type: none"> • Evaluate color rendition • 18 color patches • 6-step grayscale • Transparent/Reflective 	<p>TE209 16:9</p> 	<ul style="list-style-type: none"> • Primary colors Red, Green and Blue • Secondary colors Yellow, Purple and Cyan
<p>TE226 16:9</p> 	<ul style="list-style-type: none"> • HDTV color rendition • 36 color patches • 9-step grayscale • Transparent 	<p>TE230 4:3 (X-Rite ColorChecker SG)</p> 	<ul style="list-style-type: none"> • Evaluate color rendition • 140 color patches • 14 skin-tone patches • Reflective
<p>TE233 16:9</p> 	<ul style="list-style-type: none"> • Evaluate color reproduction • 24 color patches • 4 skin tone patches • Reflective 	<p>TE234 16:9</p> 	<ul style="list-style-type: none"> • Evaluate color gradation • Check for quantization errors • Reflective
<p>TE256 16:9</p> 	<ul style="list-style-type: none"> • Evaluate color and calibration • Color align HD cameras • Reflective 	<p>TE258 35 mm film / 5 x 7-inch paper</p> 	<ul style="list-style-type: none"> • T8 scanner characterization chart • Create color management profiles • Transparent/Reflective
<p>TE273 16:9</p> 	<ul style="list-style-type: none"> • Natural skin tones • Single image varieties • Group image varieties • Transparent/Reflective 	<p>TE289 4:3</p> 	<ul style="list-style-type: none"> • Color reproduction of a mirror replacement system • ISO 16505:2015 • Munsell (advanced) version • Reflective print (basic) version

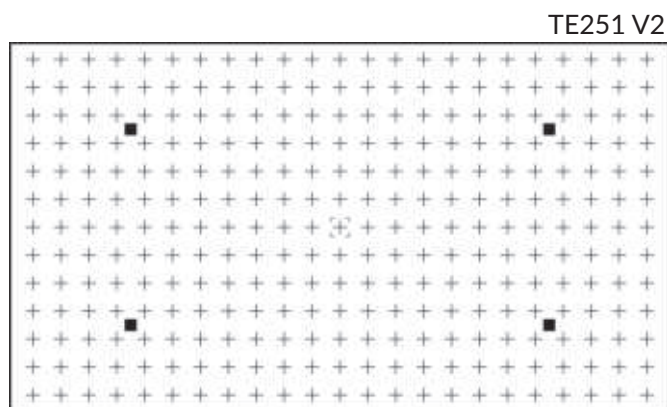
Lens performance charts

Test charts for measuring the performance of a lens

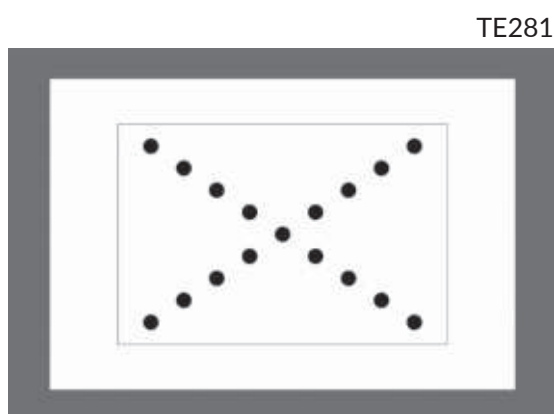
The performance of a lens depends on how the image is affected by different image quality factors, including lens distortion, shading/vignetting, and flare. These factors are frequently a result of optical aberrations and light reflections from the optical components within the lens and are oftentimes unavoidable.

Distortion leads to unnatural curves in the image and almost always occurs due to a scale variation created by the optics of the lens. Shading/vignetting is when the brightness of an image fades over the image field and can be caused by the design of the lens. Flare refers to scattered light in the image caused by unwanted reflections in the optical path.

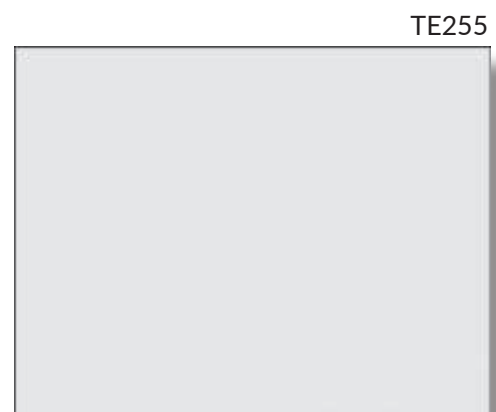
While these factors often depend on the surrounding environment, they can also be tested using specifically designed test charts. We have developed a wide variety of test charts to test for distortion, shading/vignetting, and flare.



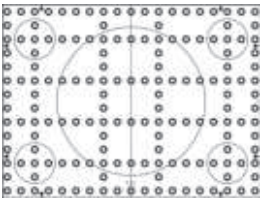
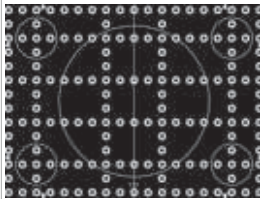
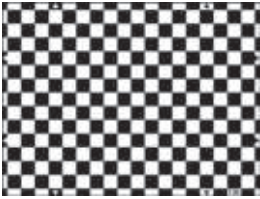
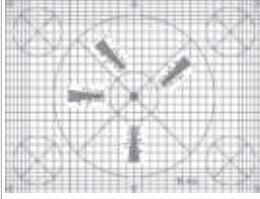
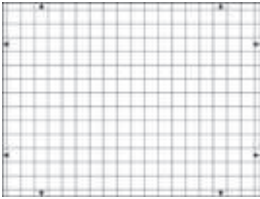
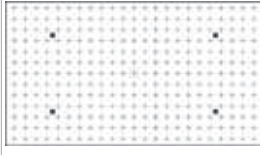



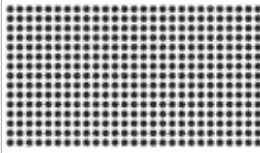

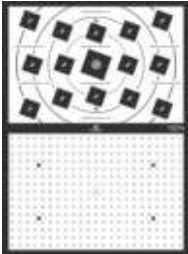
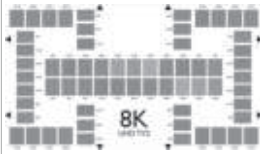
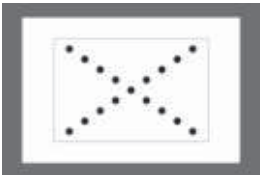

Geometry grid to measure lens distortion



Flare chart based on ISO 18844



Diffuser plate to measure vignetting

<p>T01W 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Geometry ring chart • Measure geometry of cameras and monitors • Rings arranged on grid with white surrounding • Transparent/Reflective 	<p>T01B 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Geometry ring chart • Measure geometry of cameras and monitors • Rings arranged on grid with black surrounding • Transparent/Reflective
<p>T06 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Chess board chart • Evaluate geometry and resolution • Transparent/Reflective 	<p>TE112 4:3</p> 	<ul style="list-style-type: none"> • Grid chart • For adjustment and control of TV cameras • Grid lines for adjusting registration • Wedges for resolution appraisal • Transparent/Reflective
<p>TE183 4:3</p> 	<ul style="list-style-type: none"> • 19/14 Grid chart • IEC 84/60B • Adjustment and control • Visual appraisal of scan linearity • Lines for adjusting registration • Transparent/Reflective 	<p>TE251 V2 16:9</p> 	<ul style="list-style-type: none"> • Distortion and chromatic aberration chart • ISO 17850, • IEC 62676-5, IEEE P1858 CPIQ • 15 x 27 black crosses • Transparent/Reflective 
<p>TE255 4:3 / 16:9</p> 	<ul style="list-style-type: none"> • Diffuser plate • Evaluate shading/vignetting • 61% transmission • Transparent • Included in the scope of delivery of the LE7 <p>(Flat Field) </p>	<p>TE260 16:9</p> 	<ul style="list-style-type: none"> • Dot chart • Two charts different charts on front and back sides • Evaluate distortion and chromatic aberration • Reflective 
<p>TE274 3:2</p> 	<ul style="list-style-type: none"> • Macrochart 13 x 13 cm • Slanted edges for resolution • Crosses for distortion • Special alignment frame for positioning • Reflective 	<p>TE278 16:9</p> 	<ul style="list-style-type: none"> • 50 multiburst fields • Resolution measurement horizontal and vertical • Transparent
<p>TE281 3:2</p> 	<ul style="list-style-type: none"> • Flare chart • ISO 18844 • 17 light traps (super black holes) • Evaluate scattering light • Reflective 	<p>TE287 16:9</p> 	<ul style="list-style-type: none"> • Test geometric distortion over the image field • Review the magnification factor according to ISO 16505

Custom Charts

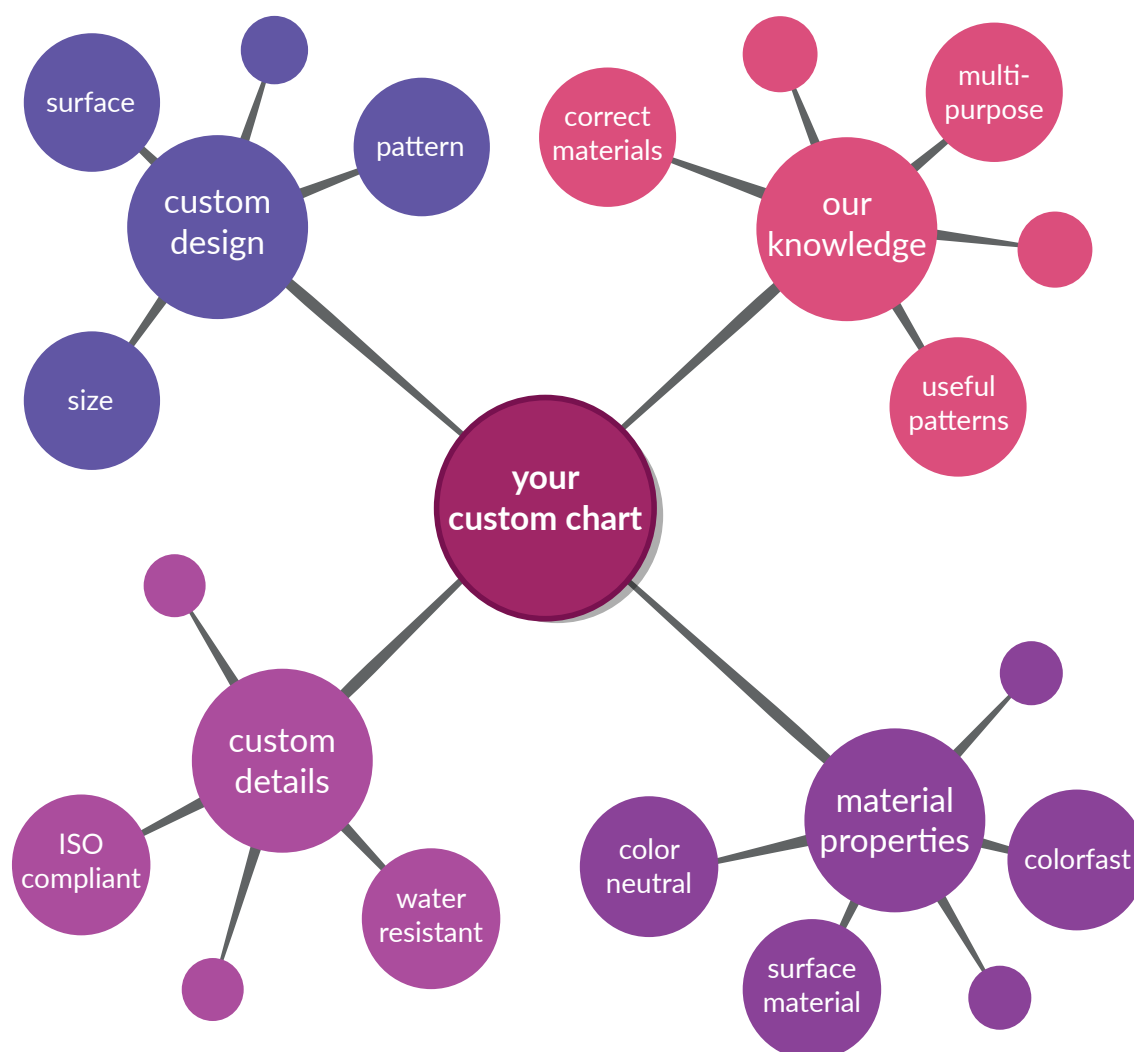
We can help you design a custom test chart

In addition to our 200+ different test charts already available, we also offer the option for test chart customization* for those with different requirements.

We understand that our charts do not always meet the exact specifications required by the customer. As such, we provide the unique opportunity for you to design your own chart layout and then allow our experienced chart production team to create it.

During the customization process, you can choose a custom chart design, select different specifications, and use a diverse range of materials for creation.

To get started with the customization process, please visit our website and contact our support team directly. We will assist you with getting started and answer any questions you may have about the design process.

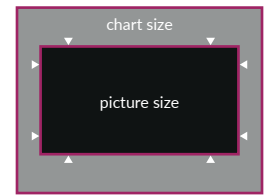


*Not every individual design is possible for print. Please contact us for consultation.

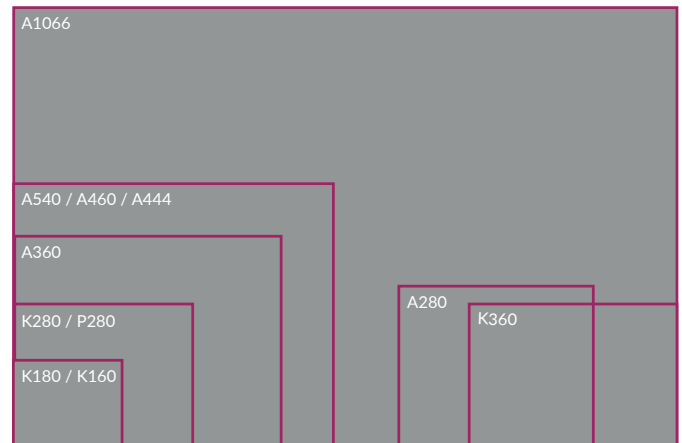
Chart Sizes

The test charts are available in the sizes listed below.

For technical reasons, some charts cannot be manufactured in all sizes. Please do not hesitate to contact us for additional information. Further information is also available on our website.



Designation	Reflective		Chart size** w x h x d [mm]
	Picture size* w x h [mm]		
	4:3	16:9	
A1066	800 x 600		1245 x 835 x 3.2
A1066 (TE42 ¹)	900 x 675		1245 x 835 x 3.2
A1066		1066 x 600	1400 x 835 x 3.2
A1066 (TE42 ¹)		1200 x 675	1400 x 835 x 3.2
A540	540 x 405	460 x 303.8	600 x 500 x 3.2
A460	460 x 345	460 x 258.8	600 x 500 x 3.2
A444		444.4 x 250	600 x 500 x 3.2
A360	360 x 270	360 x 202.5	500 x 400 x 3.2
K360		360 x 202.5	390 x 271 x 2.1
A280	280 x 210	280 x 157.5	365 x 305 x 3.2
K280	280 x 210	280 x 157.5	334 x 271 x 2.1
P280	May vary in size with the chart layout		334 x 271 x 2.1
K180		180 x 101	204 x 164 x 2.1
K160	160 x 120		204 x 164 x 2.1



¹Sizes are for all variations of the TE42 chart series, including TE42 V2, TE42-LL, TE42-LL Timing

A charts (size 280/360/460) are mounted on aluminium plates.

A charts (size 1066) are mounted on aluminium composite panels (aluminium dibond).

P charts mounted on a black polystyrene plate.

K charts are mounted on black polystyrene plates and are only available in chart folders.

Designation	Transparent		Chart size** w x h x d [mm]
	Picture size* w x h [mm]		
	4:3	16:9	
D280	280 x 210	280 x 157.5	360 x 280 x 4.6
D240	240 x 180	240 x 135	320 x 290 x 4.6
D240S	240 x 180	240 x 135	360 x 280 x 4.6
D205	205 x 153	205 x 115.3	253 x 202 x 3.5
D120	120 x 90	120 x 67.5	155 x 135 x 4.0
D60	60 x 60	-	100 x 100 x 4.5
D35	32 x 24	-	50 x 50 x 3-4



D60 charts are intended to be used with the Vega light source and are constructed with aluminium, PLA plates, and a magnet mount.

D35 charts are either between glass plates or mounted in slide frames (glassless). There are exceptions regarding mounting and size for special charts.






Suitable transparent charts for the following illuminators

	D280 / D240S	D240	D205	D60	D35
	Spherical transparency illuminator LE7 Lightbox illuminator LG3/LG4 Sony Pattern Box	DNP standard viewer	Porta Pattern spherical transparency illuminator	Vega	CAL4
With adapter		Spherical transparency illuminator LE6/LE7 Lightbox illuminator LG3/LG4	Spherical transparency illuminator LE6/LE7 Lightbox illuminator LG3/LG4		LE6 and LE7

*Picture size format can vary from the default size. Individual deviation is stated on the specific product page.

** Chart sizes may vary by ± 2 mm as they are handmade in house.

Accessories

<p>iQ-Tripodmount frame for test charts in size A280 / A360 / A460.</p> 	<p>iQ-Foldermount frame for Studio Kits.</p> 	<p>iQ-Tablemount frames for reflective charts A280 / A360 / A460.</p> 	<p>iQ-Wallmount frames for reflective test charts in size A1066.</p> 
<p>chartBOARD a magnetic, neutral gray surface for improving test chart alignment.</p> 	<p>magneticTAPE Self-adhesive magnetic strips suitable for use on all reflective test charts.</p> 	<p>iQ-Chartmount-V a moving test chart holder with motorized options.</p>  <p>API AVAILABLE</p>	<p>iQ-Chartmount-H V2 a flexible test chart holder on wheels (manual operation only).</p> 
<p>Support table for the LE7 series. Includes electric height adjustments.</p> 	<p>Tripods for the LG3 and LG4 series.</p>  <p>LG3 control holder</p>	<p>iQ-Mobilemount Tripod mount for mobiles and tablets.</p> 	<p>Universal Camera Mount Standalone mount for aligning various cameras (optimized for iQ-Climate Chamber).</p> 
<p>Manfrotto 055X Pro3 Tripod</p> 	<p>Manfrotto 410-3-Way-Head</p> 	<p>iQ-Monopod Tripod for a professional, quick and exact camera positioning.</p> 	<p>iQ-Anchor A manual or motorized stand with a flat surface for image stabilization measurements.</p> 

Accessories

<p>Honeycomb Breadboard A stabilizing optical platform for STEVE-6D.</p> 	<p>Restan PTFE (polytetrafluoroethylene) white reference.</p> 	<p>Studio Lights portable LED lights, dimmable, and with adjustable correlated color temperature for test labs.</p> 	
<p>iQ-Align for CAL3 Adjust the camera to the CAL3.</p> 	<p>iQ-Align XL for CAL3-XL Adjust the camera to the CAL3-XL.</p> 	<p>iQ-Align for CAL1 Adjust the camera to the CAL1.</p> 	<p>PRC Krochmann Radiolux 111 The RadioLux 111 is a precision hand held instrument for photometric measurement.</p> 
<p>Gossen Mavo-Monitor USB high-precision luminance meter for contact measurement classified according to class B DIN 5032-7, DIN EN 13032-1 Appendix B and ISO/CIE 19476.</p> 	<p>Gossen Mavolux 5032 B USB high-precision illuminance meter classified according to class B DIN 5032-7, DIN EN 13032-1 Appendix B and ISO/CIE 19476.</p> 		
<p>Cases for storage, protection and transport</p> <ul style="list-style-type: none"> • Chart cases for transparent test charts available in all sizes • Chart cases for reflective test charts available in all sizes • Cases for spherical illuminators LE7/CAL3/ CAL3-XL/ CAL1/CAL4/Geocal/Geocal-XL/camSPECS • Cases for illumination devices LG3/LG4 /CAL2/VEGA • Case for spectrometer EX2 			

*Complete list of accessories can be found on our website: www.image-engineering.com

Standards

International Standards

Many of our engineers are part of the various working groups that develop and publish the image quality standards listed below. Our iQ-Lab also designs all of its tests on available standards when applicable.

IEC 62676-5 – Data specifications, measuring methods, and performance values for security and video surveillance cameras

IEEE P2020 – The working group developing the first standards for autonomous driving systems (ADAS)

ISO 12232 – Method for assigning ISO speed rating, standard output sensitivity, and exposure index and recommendations

ISO 12233 – Methods for measuring resolution and spatial frequency response of digital cameras

ISO 14524 – Methods for measuring opto-electronic conversion functions (OECF) of digital cameras

ISO 15739 – Measuring noise vs. signal level and dynamic range in digital cameras

ISO 15781 – Methods for measuring shooting and shutter release time lag, shooting rate and start-up time of digital cameras

ISO 16505 - Road vehicles ergonomic and performance aspects of Camera Monitor Systems Requirements and test procedures

ISO 17321-1 – Methods for measuring the color characterization of digital cameras in photography and graphic technology

ISO / TR 17321-2 - Considerations for determining scene analysis transforms

ISO / TS 17321-4 - Programmable light emission system

ISO / TS 20490 - Measuring Auto-Focus repeatability of sharpness and latency

ISO 17850 – Geometric distortion measurements of digital and mobile phone cameras

ISO 17957 – Shading measurements

ISO 18844 – Image flare definition and measurements of digital cameras

ISO 18844-2 – Angle dependent image flare

ISO 19084 – Chromatic displacement measurements

ISO 19093 – Methods for measuring low-light performance of digital cameras

ISO 19093-2 – Measuring low-light performance with hand-shake simulation

ISO TR 19247 – Guidelines for camera testing

ISO 19264 – Methods for analyzing the image quality of archiving systems

ISO 19567-1 – Texture reproduction measurements using a cyclic pattern in digital cameras

ISO 19567-2 – Texture analysis for a non-cyclic pattern in digital cameras

ISO 20954 – Image stabilization

ISO 21550 – Dynamic range measurements for electronic scanners

VCX v2020 – Objective mobile phone camera rankings

VCX WebCam 2023 - International standard for evaluating image quality testing of video conferencing cameras

Glossary

Selected Definitions

An overview of the different abbreviations that we use throughout the catalog and on our website.

2D/3D-MLUT	Multi-Look Up Table	ICC	International Color Consortium
ADAS	Advanced Driver Assistance Systems	iQ	Image Quality
ADC	Analog to Digital Converter	iQ-LED	A Multispectral Light Source
AF	Autofocus	IR	Infrared
API	Application Programming Interface (C++/C)	KPI	Key Performance Indicator
camPAS	Camera Performance for Automotive Systems	LCh	CIELAB color space (Lightness, Chroma, and Hue)
CAN	Controller Areas Network	MTF	Modulated Transfer Function
CCD	Charge-Coupled Device	ND	Neutral density filter
CCM	Color Correction Matrix	NIR	Near Infra-Red
CTT	Correlated Color Temperature	NIST	National Institute of Standards and Technology
CIECAM	International Commission on Illumination - Color Appearance Modelling	OEFC	Opto Electronic Conversion Function
CIPA	Camera & Imaging Products Association	PRNU	Photo Response Non-Uniformity
CLI	Command Line Interface	ROI	Regions of Interest
CRI	Color Rendering Index	SDK	Software Development Kit
CMOS	Complementary Metal-Oxide-Semiconductor	SFR	Spatial Frequency Response
DUT	Device Under Test	SMD	Surface Mount Device
ESF	Edge Spread Function	SNR	Signal to Noise Ratio
FOV	Field of View	SPD	Spectral Power Distribution
FWHM	Full Width at Half Maximum	SPI	Safety Performance Indicators
HDR	High Dynamic Range	UTT	Universal Test Target
		VCX	Valued Camera eXperience

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