

Solutions to test imageQuality



Image Engineering
Product Catalog

2020

Dear Image Quality Professionals,

We thank you for your continued support over the years and, more importantly, for your pursuit of the highest level of image quality.

Since our founding in 1997, we have become a global leader in image quality testing and have helped companies from various industries around the world improve their imaging devices by utilizing our image quality tests, equipment and knowledge. Today, we house the industry's largest independent test laboratory and have become one of the world's leading suppliers for image quality test equipment and solutions.

Our products and solutions are centered around the 250+ test charts that are expertly designed for the assessment of the many different 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 shutter time lag or image stabilization. We have also developed advanced solutions such as the iQ-Automator, which fully automates testing with just one click. Finally, a full analysis of the image quality test results can be done using the iQ-Analyzer analysis software.

All of the equipment and software is regularly used in our test lab and adheres to international standards when applicable. We are actively engaged in many international committees responsible for defining and updating industry standards for image quality. Currently, we are involved with (see website for full list):

- ISO Technical Committee 42 – responsible for standardization of still picture imaging
- IEEE-P2020 - developing an industry standard for automotive ADAS systems
- IEC 62676-5 – the first industry standard for security and surveillance systems

Since our founding, our mission has always been to prepare the ground to create images that change the world. We believe the right 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 with all distributors on our website:
www.image-engineering.com/company/resellers

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imageQuality*solutions*

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imageQuality*tools*

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imageQuality*code*

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imageQuality*charts*

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imageQuality*charts*

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iQ-Teststand

Upgrade your test lab with a customized camera test stand

Choose from an extensive 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.



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

*API sold separately

Designing your iQ-Teststand

There are seven different product groups with a variety of solutions in each to guide you through the customization process. Once you have decided upon the basic or the automated test stand, you can now fill out your setup with other required products.

1 Chart mounting

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



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

Choose from manual to automatic camera alignment.



3-Way tripod head



iQ-Cameramount



iQ-Robot

4 Reflective chart illumination

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



lightHEAD



LED Studio Light



iQ-Flatlight with iQ-LEDs



Tungsten halogen light

5 Transparent chart illumination

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



LE7



LG3



LG4

6 Analysis and control software

The iQ-Analyzer is available for image quality analysis. Control software and API's also available.



7 iQ-Housing

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



Dynamic Test Stand – DTS

Test the performance and effectiveness of ADAS camera systems

The DTS uses contrast detection probability (CDP) and other methods to determine the capability of an automotive camera to differentiate and detect objects within its field of view.

The DTS has been developed to coincide with the objectives of the IEEE-P2020* working group.

Main Features

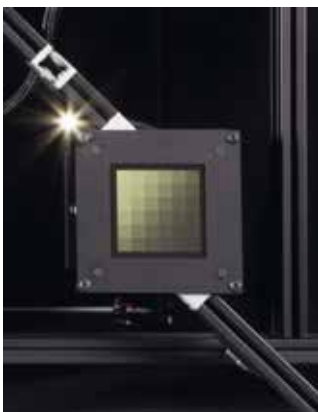
- * Contrast Detection Probability (CDP)
- * Color Separation Probability (CSP)
- * Modulated Light Mitigation Probability (MMP)
- * Motion Artifacts (Blurring)
- * Mounting for distortion compensation



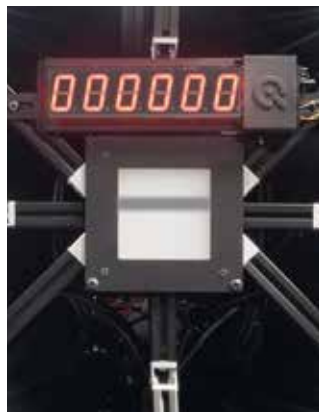
Test key performance indicators (KPIs)

The DTS uses six white LED light sources and two iQ-LED powered CAL2 devices to simulate different lighting situations, including various flicker frequencies, in an automotive environment.

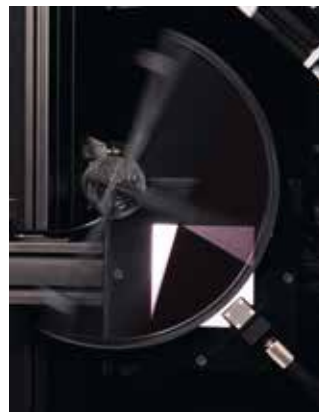
This device is capable of providing a flexible high dynamic scene to the device under test. HDR rendering can be tested and characterized.



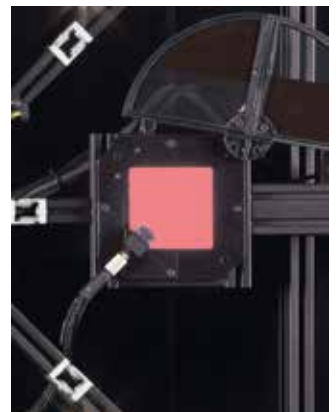
Contrast Detection



Modulated Light Mitigation
(Flicker)



Motion Artifacts



Color Separation

Hardware setup

The six CDP targets are each made up of 36 grey patches for a possible 216 different intensities for differentiating multiple objects in the field of view. The two integrated CAL2 iQ-LED devices produce different colors for analyzing the color separation capabilities of the camera under test.

Use the modulated light mitigation (flicker mode) to analyze the response time of a camera. Varying levels of flicker intensities can be generated using the middle box and the six CDP (performance similar to LG3) boxes. There are also four single LED lights for analyzing local flicker. In front of the LED light boxes, there are two rotating off-axis slanted edge targets that provide a way to measure a camera's response to various blurring and motion effects.

Software Features

* DTS-Sequence Generator

- Generate custom test sequence

* DTS-Control

- Control the hardware and manage sequences

* DTS-Evaluation

- Quickly analyze your test results



The DTS-Sequence Generator software

At a Glance	DTS
Principle	Versatile, dynamic test stand. Automated, sequence based measurement of multiple performance indicators.
Light Source	7 x high intensity LED light sources based on LG3 technology dimmable at 32 kHz, 2 x CAL2 based on iQ-LED technology
Flicker Frequency	10 - 500 Hz, 0.1 Hz steps (10 - 200 Hz), 0.2 Hz steps (200 - 500 Hz)
Flicker Duty Cycle	1 - 99% in 1% steps
Field of View	Variable mechanical distortion compensation 25° - 160° (depending on the distortion of the DUT)
Contrast Charts	216 Greyscale patches (6 x 36)
Dynamic Range	Approx. 120 dB
Metrics	Contrast Detection Probability Modulated Light Mitigation probability (Flicker) - planning stage Color Separation Probability - planning stage Motion Artifacts (Blurring) - planning stage
Motion	Motion artifacts measured on a rotating, translucent, slanted edge test chart
Software	Sequence based measurement divided into three steps: DTS-Sequence Generation, DTS-Control, DTS-Evaluation

*For more information on CDP and IEEE-P2020, please follow: <https://doi.org/10.2352/ISSN.2470-1173.2018.17.AVM-148>

iQ-Automator Solution

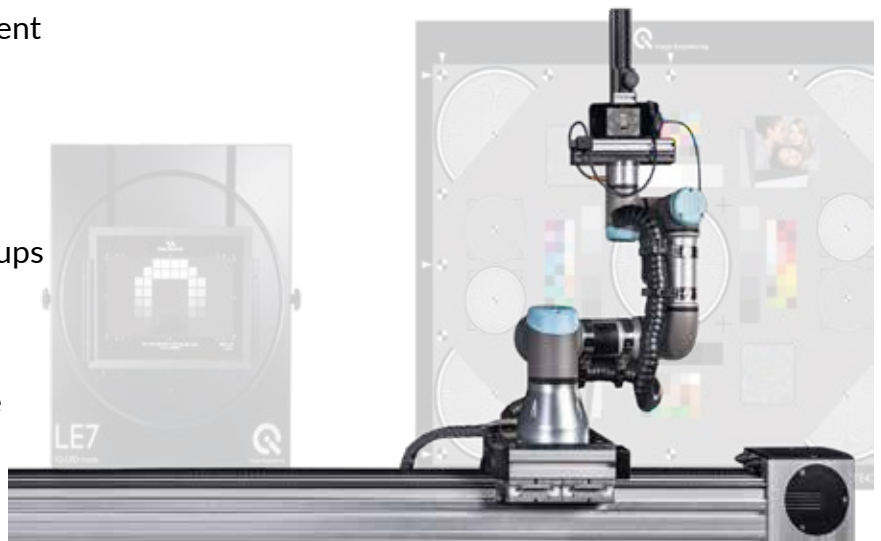
A fully automated camera test is now just one click away

The combination of the iQ-Automator software and the iQ-Robot creates a more efficient and time effective way to automatically test and provide feedback about the image quality of a mobile phone camera.

Main Features

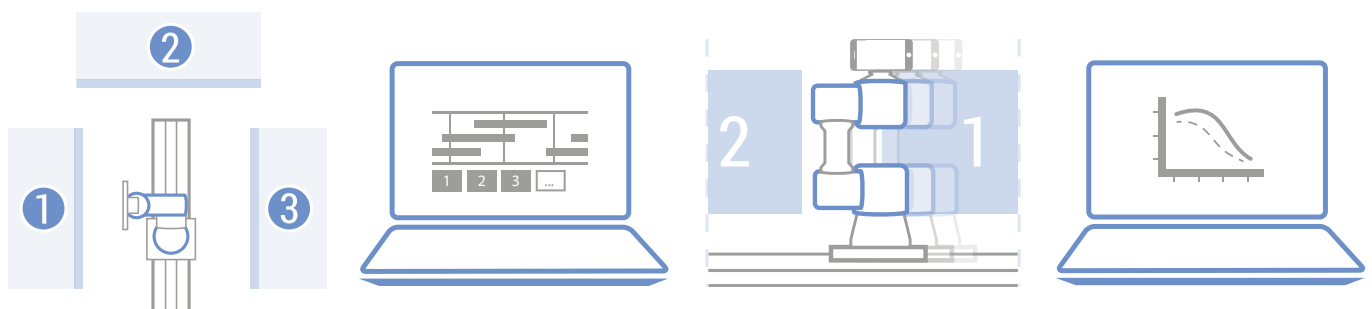
- ✱ Automatic and accurate alignment
 - ▶ to measurement devices
 - ▶ to test charts
- ✱ Manage different hardware setups
- ✱ Customize test workflows
- ✱ Drag and drop control software

Software
INCLUDED



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 software or your in-house analysis solutions.

The iQ-Automator hardware setup

To align the device under test, we use the iQ-Robot and a motorized iQ-Bench. The iQ-Robot has six rotating joints that allow the device the freedom to efficiently align to the various test charts and other measurement devices. The iQ-Robot is attached to a motorized iQ-Bench, which can be customized for length.

Multiple hardware setups can be stored and managed using the iQ-Automator software without any additional on-site software development. As a result, the iQ-Automator Solution can be integrated into your test lab right away without any additional development.



iQ-Automator

At a Glance	iQ-Robot
Principle	Camera positioning and alignment
Robot Arm	UR3
Max. payload	3 kg
Max. arm radius	500 mm
Degrees of freedom	6 rotating joints
Hardware APIs	Component APIs available on request
At a Glance	iQ-Bench
Principle	Camera to chart distance
Length	3730 mm (movement range + 730 mm)

At a Glance	iQ-Automator
Principle	Control Software
Version	C++ API available (OS Windows)
	iQ-Drive API
	iQ-LED API
At a Glance	iQ-Analyzer
Principle	Image quality analysis software

iQ-Selfie Studio

Create the perfect “selfie” image

The iQ-Selfie Studio is a test solution capable of reproducing the unique conditions for a typical selfie scene using naturally occurring lighting conditions.



Main Features

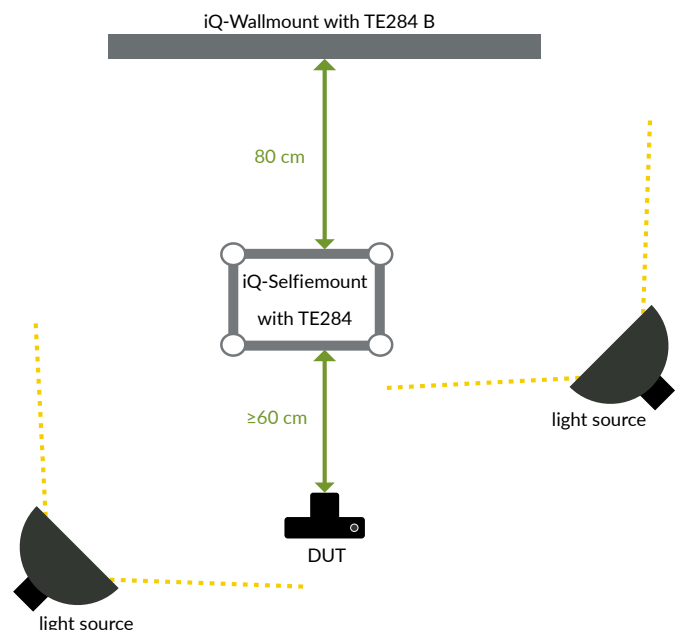
- * Measure resolution, color and texture loss
- * Check for automatic exposure control
- * Check for face detection
- * Visual evaluation with mannequin head

Related products

The iQ-Selfie Studio has been constructed to appear as a typical selfie scene. To ensure proper selfie conditions, some of our charts and equipment have been modified for a more high-quality assessment.



iQ-Selfiemount



Test arrangement

Product setup

At the center of iQ-Selfie Studio are the TE284/-B test charts and a dark-haired mannequin head. The foreground chart (TE284) is positioned, along with the mannequin head, atop the iQ-Selfiemount, while the background chart (TE284B) is mounted on an iQ-Wallmount and placed 80 cm in the background of the iQ-Selfiemount.

Testing for resolution, texture loss, color, and a visual test with the mannequin head, is possible in three different forms of illumination (full, front, background), thus creating more exact measurements. A comprehensive chart analysis can be done with the iQ-Analyzer 42 module.

Included products

- * TE284 front chart and mannequin head
- * iQ-Selfiemount
- * TE284B back chart with iQ-Wallmount
- * Manfrotto Junior Geared Head 410
- * Manfrotto 055XPROB Tripod
- * iQ-Mobilemount
- * iQ-Trigger-T
- * Hedler tungsten halogen light source (optional)
- * TE251 (optional)



iQ-Selfie Studio test scene

At a Glance	iQ-Selfie Studio
Principle	Combinations of multiple test charts are used to determine the resolution and color reproduction of a mobile phone camera in selfie mode. The mannequin head is used to trigger the cameras facial recognition and can also be used for a visual evaluation. Analysis of the test results is done using the iQ-Analyzer software.
Charts included In the foreground and background	TE253: Sinusoidal Siemens Star with 16 surrounding gray patches TE276: 2x horizontal, 2x vertical subcharts of slanted edges with surrounding gray patches and Dead Leaves TE188: 18 color patches and 6 gray patches (X-Rite ColorChecker) TE230: 84 color patches and 56 gray patches (X-Rite ColorChecker SG)
Mannequin Type	Female plastic mannequin head with dark-haired wig
iQ-Selfiemount	Aluminum support for the front chart and head

Starter Kits

Getting started with image quality testing

Cameras today have become an integral part of our society. Everything from a cell phone to a security camera to an endoscopic camera relies on clear images.

As a result of our continued reliance on cameras, it has become increasingly important to improve the image quality of the images. The starter kits, listed below, are an easy and convenient way to begin testing the image quality of your cameras depending on your industry.

Test Charts



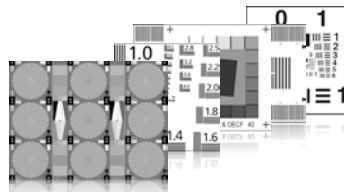
Universal



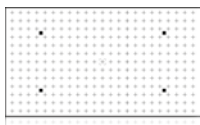
Color



OECF



Resolution

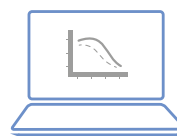


Distortion

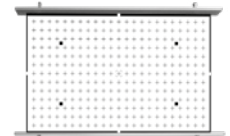


Luminance and Color

Software



Analysis



iQ-Wallmount

Illumination devices* and mounting



LE6



CAL4



LG3

Starter Kits**	
Photo	Begin testing the image quality of digital still cameras
Machine Vision	Test the optics and sensors of industrial image-processing systems
Security	Test the image quality of security cameras under different lighting situations
Cell phone	Begin testing the image quality of mobile phone cameras
Automotive	Test how well an automotive camera responds to a changing environment
Medical / Endoscopy	Ensure high image quality of endoscopic cameras
Broadcast	Test the image quality of broadcast cameras
Scanner	Ensure the best results for scanner images

* Reflective chart illumination is not included in the kits.

**See website for full list of products in each kit.

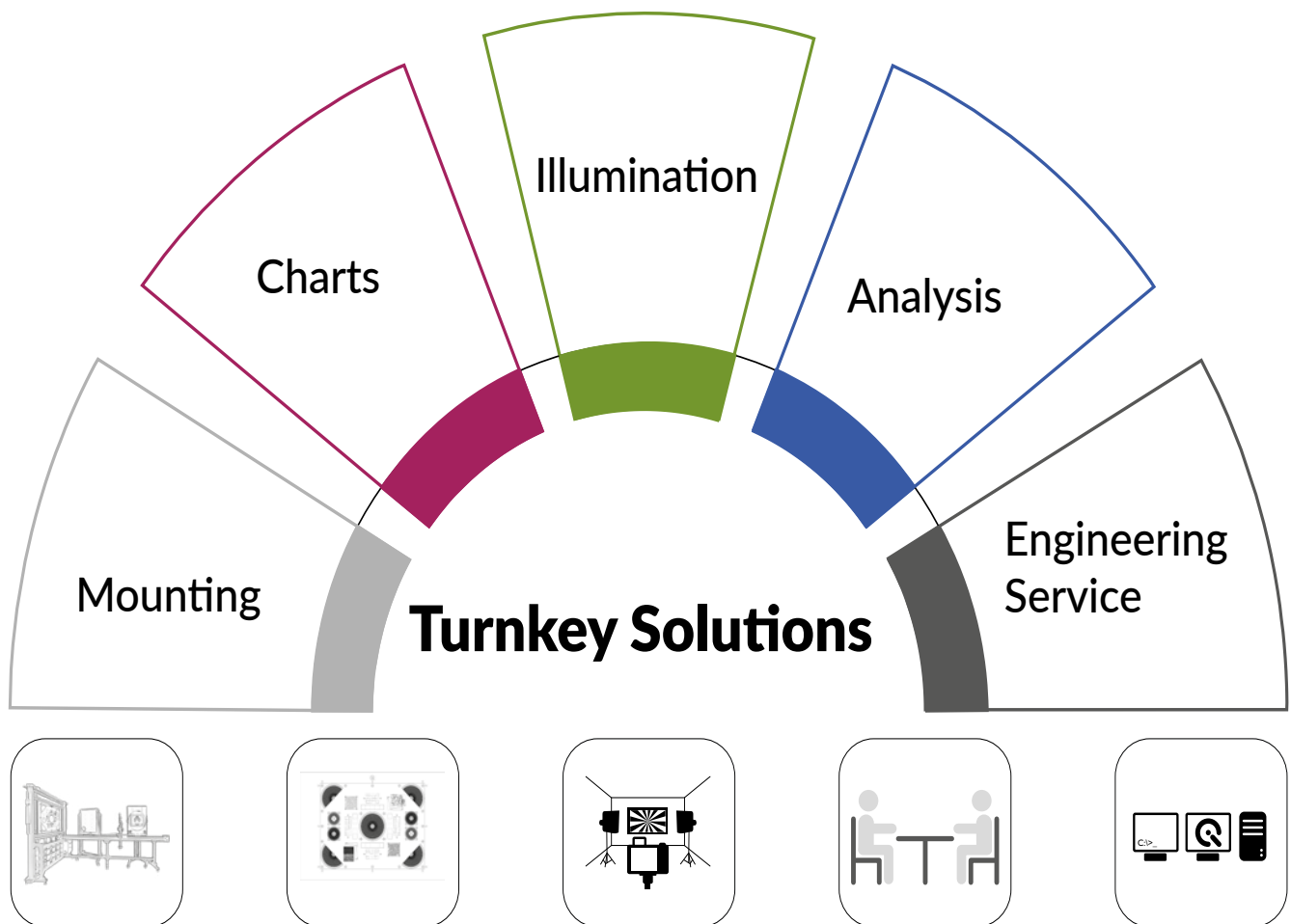
Starter Kits		Photo	Machine Vision	Security	Cell Phone	Automotive	Medical / Endoscopy	Broadcast	Scanner
Products	Product Description								
Test charts									
Universal Multipurpose									
TE42	Multipurpose test chart · A1066				x				
TE261	Slanted edges 16:9 · A1066					x			
TE167	HDTV universal test chart · D280							x	
Resolution									
AI QA-62	Slanted edge target · scanner SFR & OECF								x
TE225	HDTV resolution chart · D280							x	
TE250	USAF 1951 transparent chart · D35						x		x
TE253 9x	Modulated sinusoidal Siemens star · A1066 S/H/L	x	x	x			x		
Color									
TE188	Color rendition chart (X-Rite) · D35						x		
TE226	HDTV color rendition chart · D280							x	
TE230	X-Rite ColorChecker SG mounted on TE182	x	x						
TE258	IT8 scanner characterization chart								x
OECF									
TE182	Neutral gray 18% remission · A1066	x	x						
TE240	ISO 21550 scanner dynamic range chart						x		x
TE259	OECF · noise test chart · 20 steps · D280							x	
TE264	OECF 20 ISO 14524 / 1573 revision · D280	x							
TE269	OECF 36 · D280 A/B/C		xB	xC		xC			
TE270X	Chart with variable center density · D280				x				
Geometry Grid Registration									
TE251	Distortion · chromatic aberration · crosses · A1066	x	x	x					
Signal Evaluation									
TE255	Diffuser plate (for shading measurement) · D280	x	x		x				
TE285	IR reflection · A360			x					
Mounting									
iQ-Wall-mount	Wall mounting frame for charts in size · A1066	x	x	x	x	x			
Illumination Devices									
LE6	Integrating sphere with halogen light source	x	x		x			x	
CF-5400	Conversion filter 5400 K for LE6 · D280	x	x		x				
LG3*	Lighting box with a wide range of intensities and special flicker mode			x		x			
CAL4	Integration sphere without own light source						x		
Software									
iQ-Analyzer	Image quality analysis software	x	x	x	x	x			x

* API (application programming interface) available

Turnkey Solutions

Ready to use image quality testing solutions

The Turnkey Solutions are our ready to use product packages that contain everything you need to begin image quality testing and analysis. Each solution comes with test charts, camera mounting devices, scene illumination devices, and analysis software. These four parts are vital for a proper image quality assessment.



Build your test lab the way you want

The following pages are selected examples of potential Turnkey Solution setups. These solutions are organized into different categories based on the needs of our customers and various ISO standards. Our solutions, however, are not limited to this list. Any one of the solutions described can be customized with different products to fit individual requirements, or a completely new solution can be designed and built to accommodate your needs.

Contact us for a free consultation on what is the best solution for your lab.

Basic - Get started with basic camera assessments

This solution is perfect for those looking to get started with image quality testing. This setup can be used to test numerous cameras for various factors that influence image quality including resolution, dynamic range, and color among others.

Included products*

- * TE42
- * iQ-Wallmount
- * Hedler Tungsten halogen light 2x
- * iQ-Analyzer



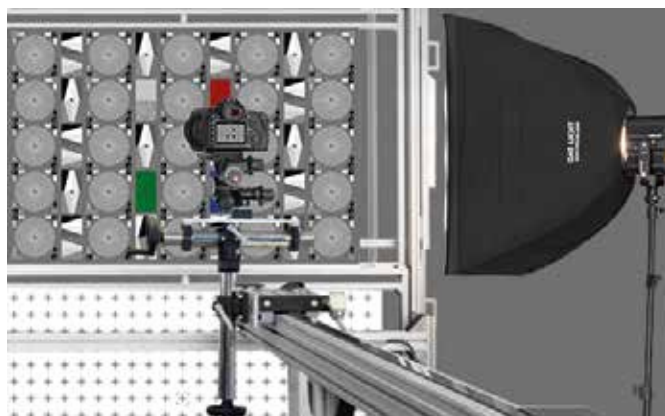
An example of a test setup with a smartphone

Expert - Advanced image quality testing with more specified charts and features

The expert solution is for those who are already image quality testing and now require even more comprehensive information on the device under test. This package contains multiple charts for more precise measurements of a particular image quality factor.

Included products*

- * TE268
- * iQ-Chartmount-V
- * LE7
- * iQ-Analyzer



An example of a test setup with a SLR camera

*See table on page 18 for a full list of products

Lens - A comprehensive analysis of your lens based on ISO 12233

The lens solution provides a deep insight into the lens and system performance. This solution is ISO 12233 compliant and has been built around measuring the Modulation Transfer Function (MTF), which is the most important factor when describing the quality of the lens system.

Included products*

- * TE268
- * iQ-Chartmount-V
- * LE6
- * iQ-Analyzer



An example of a lens test setup

Standard
COMPLIANT

Timing Measurement - Camera timing according to ISO 15781

The timing measurement solution is ideal for measuring the various timing factors of a camera system including shutter release time lag, shooting time lag, shooting rate, and startup time. This solution is designed to meet the requirements of ISO 15781.

Included products*

- * TE261
- * iQ-AF Box
- * iQ-Trigger/-T
- * LED-Panel



An example of a timing measurement test

Standard
COMPLIANT

*See table on page 18 for a full list of products

Image Stabilization - Evaluate the image stabilization of your camera system (CIPA compliant)

Most cameras today have built-in image stabilization because capturing well-focused high-resolution images, even under low light conditions, is a major performance indicator of the digital camera. As a result, our image stabilization solution has been developed to evaluate the performance of the optical or electronic image stabilization systems built into cameras.

Included products*

- * TE261
- * iQ-Mobilemount
- * STEVE-6D
- * iQ-AF Box

Standard
COMPLIANT



The example of a test setup for with STEVE-6DS

Security - Security camera testing for IEC 62676-5

The security solution is based around the recently released IEC 62676-5 standard. This standard has been developed to ensure that specifications for video surveillance cameras are comparable. This setup is ideal for measuring the image quality performance of a security camera as outlined in the standard.

Included products*

- * TE42
- * TE269C
- * LG3
- * iQ-Analyzer

Standard
COMPLIANT



An example of a security camera test with the LG3

*See table on page 18 for a full list of products

Turnkey Solutions							
Products	Product Description	Basic	Expert	Lens	Timing Measurement	Image Stabilization	Security
Test charts							
Universal Multipurpose							
TE42	Multipurpose test chart · A1066	x					x
TE261	Slanted edges 16:9 · A1066				x	x	
Resolution							
TE253 9x	Modulated sinusoidal Siemens star · A1066 S/H/L						x
TE268	Combinaton of resolution pattern · A1066		x	x			
Color							
TE230	X-Rite ColorChecker SG mounted on TE182		x				
OECF							
TE264	OECF 20 ISO 14524 / 1573 9 revision · D280		x				
TE269	OECF 36 · D280 A/B/C						xC
Geometry Grid Registration							
TE251	Distortion · chromatic aberration · crosses · A1066		x	x			x
Signal Evaluation							
TE255	Diffusor plate (for shading measurement) · D280		x	x			
TE285	IR reflection · A360						x
Black To White							
TE281	Flare target according to ISO 18844 · A1066						x
Mounting							
Chart Mounting							
iQ-Wallmount	Wall mounting frame for charts in size · A1066	x					
iQ-Chartmount-V*	Vertical sliding chart holder with integrating sphere support		x	x			x
Camera and Illumination Mounting							
Manfrotto 055XPROB	The 055XPROB is an extremely versatile tripod	x			x		
Manfrotto Junior Geared Head 410	This unique head offers gear movement in three directions	x	x	x	x		x
iQ-Monopod	Mono stand with rail system for precise camera positioning			x			x
iQ-Cameramount	Special mount for vertical and horizontal camera movement		x				
iQ-Bench*	A system based on a linear guide that can be motorized		x				
Camera plate	Camera mounting for STEVE					x	
iQ-Mobilemount	Tripod mount for mobiles and tablets					x	
HoneycombBreadboard	Platform for mounting STEVE-6D					x	
Illumination Devices							
Back Illumination							
LE6	Integrating sphere with halogen light source			x			
CF-5400	Conversion filter 5400 K for LE6 · D280			x			
LE7* 2x / 4x	Integrating sphere that uses the iQ-LED light source		x				x
LG3*	Lighting box with a wide range of intensities and special flicker mode						x
Front Illumination							
Hedler Tungsten halogen light	Tungsten halogen bulbs	2 x	2 x				2 x
Fluorescence Illumination	Fluorescent tubes			2 x			
Measurement Devices							
STEVE-6DS or STEVE-6DL	Camera shaking device					x	
iQ-AF Box	Illumination box with four dimmable fluorescent tubes				x	x	
LED-Panel*	Array of LEDs to perform timing measurements on digital cameras				2 x		x
iQ-Trigger* and/or iQ-Trigger-T*	Mechanical finger that can press the shutter release button				x	x	
Gossen Digipro F2	Exposure meter for high precision incident light measurement	x					
Gossen MAVOLUX 5032 B USB	Digital luxmeter and luminance meter class B		x	x	x		
PRC Krochmann RadioLux 111	Digital luxmeter and luminance meter class L						x
Software							
iQ-Analyzer	Image quality analysis software	x	x	x			x
LED-Panel	Control and analysis				x		
STEVE-6D	Control and analysis					x	

* API (application programming interface) available

VCX Solutions

Mobile phone testing according to VCX

VCX is a non-profit organization dedicated to objective image quality testing of mobile phone cameras. Each phone that is 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. See detailed information at www.vcx-forum.org.



VCX testing 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 on their own. 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.



Timing measurement setup



VCX testing with the TE42 multipurpose chart

VCX-Complete

The most extensive VCX solution that allows you to perform all of the image quality tests described in the white paper.

VCX-iQ

Measure all of the main image quality factors outlined in the VCX whitepaper. A great solution for just getting started with mobile phone camera testing.

VCX-Timing

This setup is based on the timing measurement of mobile phones as outlined in the VCX white paper. Measure all of the important timing factors for mobile imaging.

VCX Solutions*		Complete	iQ	Timing
Products**	Product Description			
Test charts				
Universal Multipurpose				
TE42	Multipurpose test chart · A1066	x	x	
TE261	Slanted edges 16:9 · A1066	x		x
Mounting				
Chart Mounting				
iQ-Wallmount	Wall mounting frame for charts in size · A1066	x	x	
Camera and Illumination Mounting				
Manfrotto Junior Geared Head 410	This unique head offers gear movement in three directions	x	x	x
iQ-Monopod	Mono stand with rail system for precise camera positioning	x	x	x?
iQ-Mobilemount	Tripod mount for mobiles and tablets	x	x	
Illumination Devices				
Front Illumination				
Hedler Tungsten halogen light	Tungsten halogen bulbs	2 x	2 x	
Measurement Devices				
STEVE-2D	Camera shaking device	x		
iQ-AF Box	Illumination box with four dimmable fluorescent tubes	x		x
LED-Panel	To determine shutter and shooting time lag, autofocus time, frame rate and exposure times of digital imaging devices	2 x		2 x
iQ-Trigger-T	Mechanical finger that can press the shutter release button	x		x
Gossen MAVOLUX 5032 B USB	Digital luxmeter and luminance meter class B	x	x	x
Software				
iQ-Analyzer	Image quality analysis software	x	x	
LED-Panel	Control and analysis	x		x

* We also offer the iQ-Automator Solution (see page 8) for a fully automatic mobile phone testing solution.

**Our current VCX solutions and products are subject to change with updates to the VCX testing procedure.

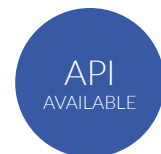
iQ-LED

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

iQ-LED technology* recreates other light sources in a controlled lab environment. This technology, in its second generation (V2), can be found in many of our illumination devices and can replicate almost any light source for a more accurate camera characterization and calibration.

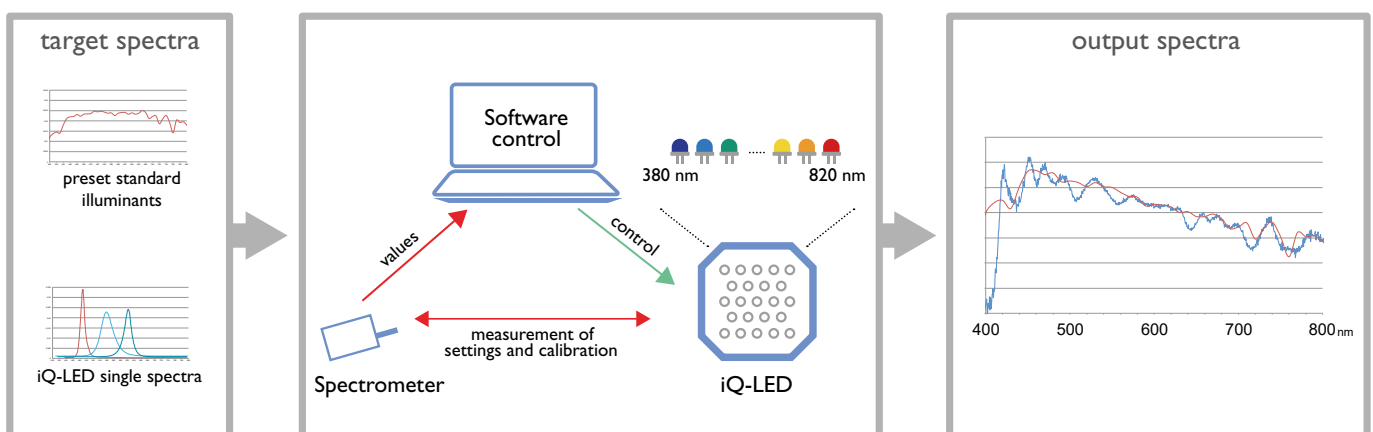
Main Features

- * 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 including everything from standard light sources to different color patches.



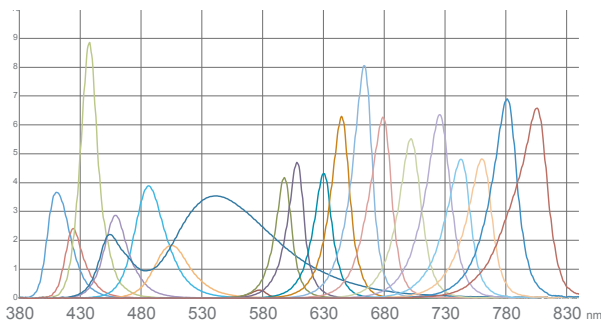
iQ-LED workflow

*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

At a Glance	iQ-LED V2
Principle	High power SMD-LED based spectral broadband light module used in our iQ-LED devices. It can also be used to build your own spectral programmable illumination device
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 (1000 steps with 128 kHz)
Spectral measurement	Closed loop functionality with calibrated mini spectrometer via control software Spectral Range: 350 – 870 nm / Resolution: 2048 pixel / FWHM: 2.4 nm
Control system	Software-based control system via USB (included with all iQ-LED devices), C++ API available** 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

*The iQ-LED V2 module is built into our LED illumination devices. We also offer it as a stand-alone component module for independently designed light sources. This option is sold as a bundle that includes one iQ-LED module and a spectrometer. Additional modules can be purchased.

**API sold separately

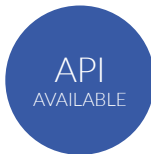
LE 7

Uniform chart illumination with iQ-LED

The LE7 is a uniform light box 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 V2*
- * 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
- * IR version for VIS and NIR testing available



LE7-IR and LE7-E

The LE7-IR uses two normal iQ-LED modules and four iQ-LED 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 expands the testing possibilities, especially low light testing.

At a Glance		LE7-2x / LE7-4x / LE7-6x / LE7-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-IR: 2 x iQ-LED V2 plus 4 x iQ-LED IR: 402 SMD high power 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-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)

*Please see the iQ-LED product page on our website for in-depth details regarding iQ-LED technology.

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

iQ-Flatlight

The most advanced light source for camera testing

Powered with 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.

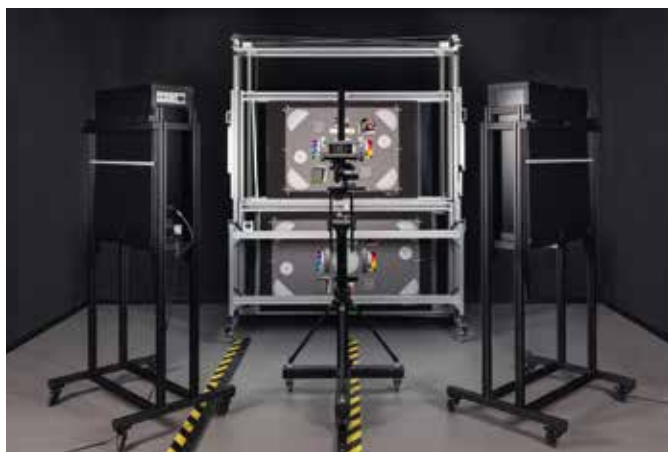
Main Features

- * 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)
- * Fluorescent light option



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 away 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: 41 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)

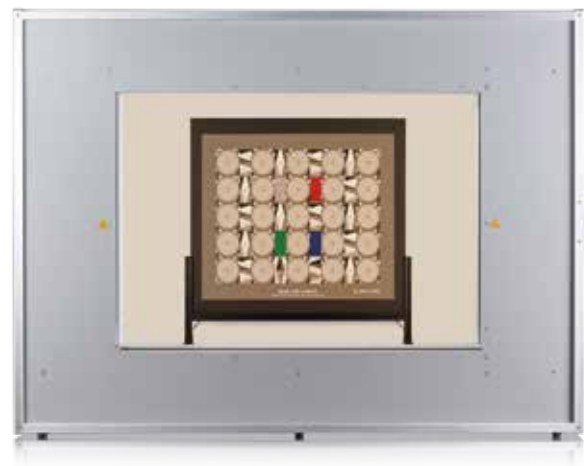
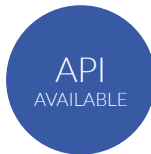
iQ-Chart Box

Uniform illumination of reflective test charts

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

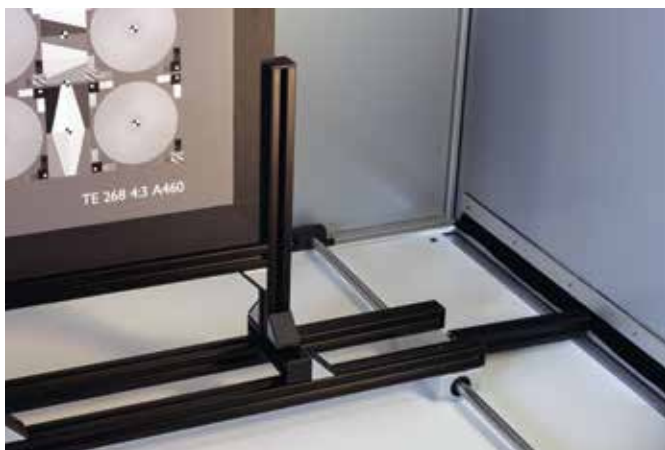
Main Features

- * Includes all features from iQ-LED
- * Uniformity >95% (chart size A460)
- * Size A460 and A280 reflective test charts
- * Fluorescent light option
- * 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 not as 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 4 x 18 W fluorescent lamps, D50
Uniformity on chart plane	> 95 % (A280 picture size) > 90 % (A460 picture size)* only for iQ-LED light source; 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 lux

*measured at center of A460 sized chart

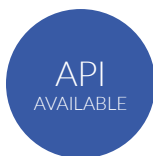
CAL Product Line

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

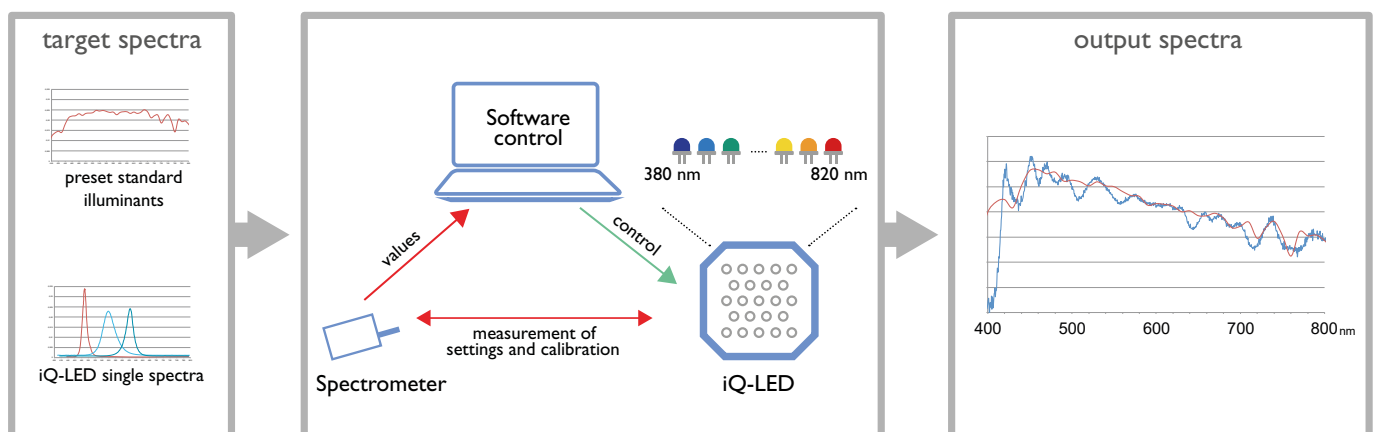
- * Includes all of the features from iQ-LED
- * Measurement of the spectral sensitivity
- * Calibration of gain/sensitivity for exposure
- * Calibrate luminance and color shading
- * Check white balance under various light sources
- * Optimized for production line integration
- * Detection of defect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



Only one light source

Example of the CAL1

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. Using iQ-LED, the CAL devices can recreate various spectra including everything from standard light sources to different color patches.

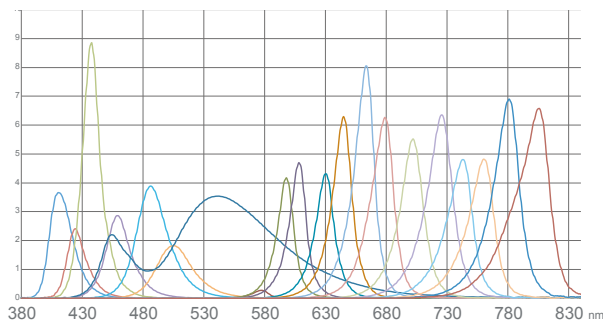


iQ-LED workflow

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 a matter of 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 C++ 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

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: 350 – 870 nm / Resolution: 2048 pixel / FWHM: 2.4 nm
Control system	Software-based control system via USB (included with all CAL devices), C++ API available* 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

*API sold separately

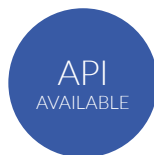
CAL1

Our original uniform light source for camera calibration

The CAL1 is a 0.3 m integrating sphere that uses 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



How to use the CAL1

The CAL1 can be used as a stand-alone 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.



A modified CAL1 for size D35 transparent test charts

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

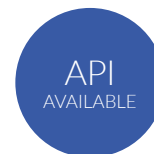
The highly adaptable camera calibration light source

This ultra-compact light source is based on iQ-LED technology and can adapt to many different areas of measurement. 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

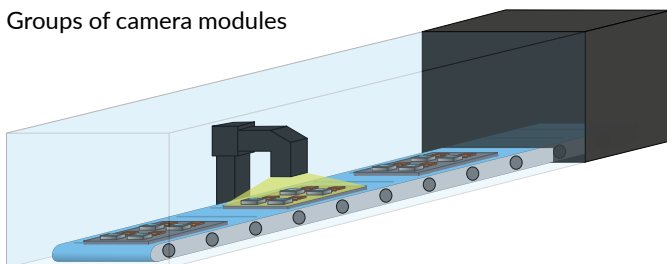
- * Includes all of the features from iQ-LED
- * Uniformity of > 96%
- * Camera calibration within seconds
- * Improved non-reflective diffuser filters
- * Optimized for production line integration
- * Small compact design



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.

Groups of camera modules



An example of the CAL2 calibrating multiple camera modules at the same time

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

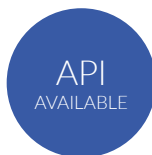
CAL3

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-degree 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.



Production line integration for camera control testing within the CamTest Spectral module from Trioptics GmbH

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

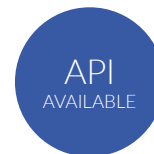
A calibration light source for ultra-wide-angle cameras

The CAL3-XL is an iQ-LED integrating sphere with a circular 196 mm opening and a bowl-shaped diffuser for uniformity of illumination. It is ideal for camera calibration and testing of 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-degree field of view



CAL3-XL design

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

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	4x 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 in the center of diffuser with standard illuminant D65

CAL4-E

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 a uniform illumination over the 50 mm chart plane. The CAL4 includes four different types of adaptors 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-E
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

lightSTUDIO

Real scene illumination and testing

Many image quality factors are best measured with test charts. There are a few though, such as white balance that are better analyzed using a real scene. The lightSTUDIO contains multiple objects of various colors and textures for an accurate visual analysis.

Main Features

- * iQ-LED, fluorescent and halogen light options
- * Same interior for easy comparison between labs
- * Moving targets to measure motion artifacts
- * Evaluate high contrast scenes

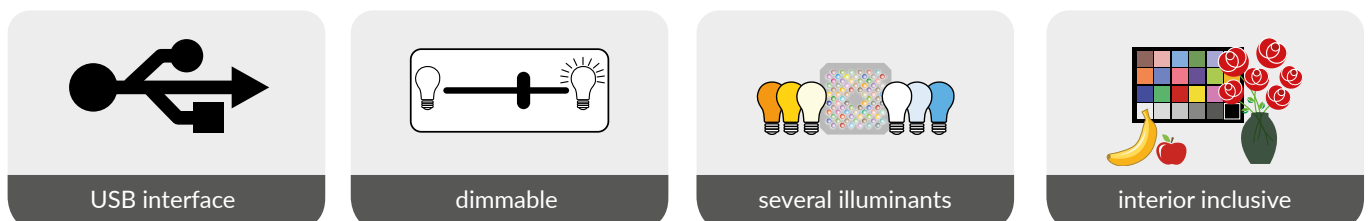


lightSTUDIO lighting options

Every lightSTUDIO is delivered with the same objects to make cross lab testing and comparison more efficient. However, the standard light head can be exchanged for an iQ-LED based light head known as the lightSTUDIO-L. This option can spectrally tune the light to a very accurate standard e.g., A, D50, D65 illumination.

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

Standard features of the lightSTUDIO





lightSTUDIO-M with moving targets



lightSTUDIO-H with HDR option



lightSTUDIO-T with twin option

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 light boxes with transparent test charts to create and test a high contrast scene. This setup can provide a contrast ratio of $> 65,000:1$.

The lightSTUDIO-T or twin option has a dividing wall in the middle of the scene for easy side by side comparison of two independent illuminants.

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 sensitivity | 10 Color reproduction |
| 5 Details in highlights | 11 Natural and known colors |
| 6 Details in shadows | 12 Low contrast details |



LG3

A flexible lightbox with high power and flicker generation

Get more out of high dynamic range test targets by illuminating them with over 150000 lux 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 > 150000 lx
- * Adjust flicker in frequency, duty cycle and phase.
- * Dimmable in fine steps
- * Expand range of testing
- * Relative illumination stability > 98%

Software
INCLUDED



Related products and features

The LG3 works in sync with our high dynamic range test targets such as TE269C. Targets with such 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 that are capable of being recreated with the LG3

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 capable of illuminating a high dynamic range test target with over 150000 lx*. Generation of low light situations are 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
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 sec. 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 +/-5%
Maximum / Minimum illumination values	Low mode: < 10 to > 6500 lx Normal mode: < 100 to > 65000 lx High mode: > 150,000 lx
Uniformity of illumination	> 95% for active chart area**, 280 x 157.5 mm > 95% for full output window**, 290 x 220 mm > 95% (70 mm diameter circle)** approx. 90% at very low intensity (intensity <1%)
Dimmable	approx. 1000 steps in 2 modes, feedback of illumination level in [%] and illuminance [cd/m²], 32 kHz PWM

*We recommend using a PRC Krochmann RadioLux for measuring the exact intensity.

**Measured on a chart plane.

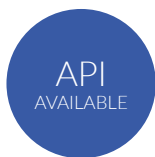
LG4

A lightbox for transparent chart illumination

The LG4 is our standard compact lightbox that is 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

The LG4 is illuminated by 432 LEDs 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 C++ 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 values	100 to 65000 lx
Uniformity of illumination	> 95% for active chart area*, 280 x 157.5 mm > 95% (70 mm diameter circle)*
Dimmable	32 kHz PWM

*Measured on a chart plane

LE6

Uniform chart illumination for transparent test charts

The LE6 is our original integrating sphere that is illuminated with a halogen light and is coated with a special white diffuse coating on the inside. The window of the LE6 is 280 x 210 mm.

Main Features

- * 96% homogeneity
- * Halogen light illumination
- * Dimmable down to 1% of max. illumination
without changing the spectral distribution



LE6-50 and LE6-100

The LE6 is available in two different versions. The first version is the LE6-50 with a 50 W halogen bulb and has a max. intensity of 3000 lx. The second version is the LE6-100 with a 100 W halogen bulb and a max intensity of 8000 lx. The LE6-50S and the LE6-100S are similar but cheaper versions that have the same max. intensities but do not include an illuminance meter or the dimming feature.

At a Glance	LE6-50	LE6-100
Principle	Dimmable halogen light source with constant color temparture	
Light source	12 V / 50 W halogen bulb	12 V / 100 W halogen bulb
Color temperature	3200 K +/- 50 K	
Maximum / Minimum illumination values	Approx. 30 - 3000 lx	Approx. 80 - 8000 lx
Uniformity of illumination	>96%	
Dimmable	1 - 100% of max. illumination	

camSPECS

Advanced spectral sensitivity measurements

The camSPECS combines all interference filters into one “test chart” to improve the convenience of a spectral sensitivity measurement of a camera. 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 63 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 color correction matrix (CCM) for the camera.

Color transform generation is possible once the spectral sensitivities are determined. This process is done by converting camera values to color metric values.

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	
Light source	Halogen (24V / 250 W) Osram 64657 HLX	
Durability of light source	300 h	
Wavelength range	380 - 760 nm (10 nm steps)	
Bandwidth	10 nm	
Diameter interference filters	10 mm	22 mm
Diameter ND filters	6 mm	12 mm
Software system requirements	PC with Windows 7 operating system (or higher)	
Additional functions	<ul style="list-style-type: none"> • Spectral measurement with 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

Measure and analyze all of the relevant timing features and evaluate the auto focus performance of your digital camera.

Main Features

- * Measure all timing parameters
- * Measurement accuracy greater than one ms
- * Applicable to ISO 15781 and IEC 62676-5
- * Command line interface and control software

Software
INCLUDED

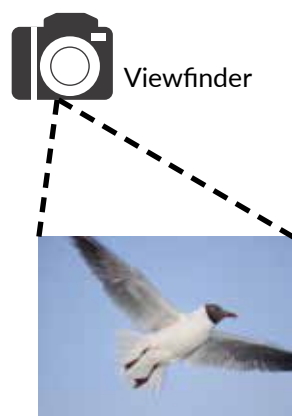
API
AVAILABLE

Standard
COMPLIANT

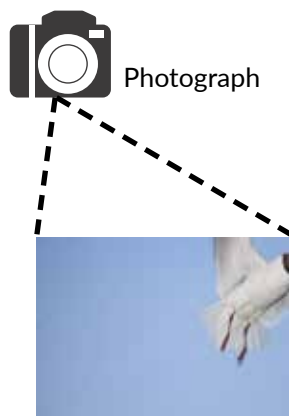


LED-Panel IR and related products and solutions

The LED-Panel IR version shifts the peak wavelength to 850 nm. Our timing measurement Turnkey Solution combines the LED-Panel with other products to perform timing measurements according to ISO 15781.



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 find out the precise auto focus performance of the camera.

The LED-Panel uses control software, command line software and a USB interface to control the device. The device itself 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)
Accuracy	< 0.06% (1 ms - 10 s)
Manual control	Operating buttons: switching between single and continuous trigger, Rotatory switch: adjusting the frame rate frequency, time, LCD brightness Display: shows current setting
Operating mode	External trigger, internal single trigger, continuous trigger
Adjustable times	Via USB: 200 μ s to 10 s (depending on measurement mode) Manual control: 20 μ s 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 100 Hz
Software system requirements	PC with Windows 7 operating system (or higher) and USB port
Additional functions	Software control LED-Panel V4 Analysis of images taken from LED-Panel V4

iQ-AF Box

Measure the shutter display of your camera

The iQ-AF (autofocus) Box illuminates test charts at different light levels. The iQ-AF Box is best utilized when combined with the TE261 slanted edge test chart, the LED-Panel, and the iQ-Trigger/-T. Together these devices can accurately measure the shutter speed and other timing values of a camera.

Main Features

- * Measure camera shutter speed
- * Measure low / bright light shutter delay
- * Measure shutter / shooting time lag
- * Measure image stabilization and autofocus

Solution
OFFER

Standard
COMPLIANT



Related products and specifications

The iQ-AF Box can quickly be switched between two different light levels to more accurately measure low and bright light shutter delay. It is often used with STEVE-6D to measure the image stabilization of a camera. This product is also a part of our timing measurement Turnkey Solution.



Camera stabilization measurement with the iQ-AF Box

At a Glance	iQ-AF Box
Principle	Light box with different light levels
Light sources	4 x fluorescent tubes 18 W 4 x fluorescent tubes 36 W D50 (can be switched on/off separately)
Illumination value	20 - 3200 lx
Size of used test chart	A1066 (124.5 x 83.5 cm)
Provided test charts	TE261 (others on request)
Setting of light level	Two rotary control units

iQ-FoV Box

Measure the resolution for a wide field of view camera

The iQ-FoV Box is a chart illumination positioning system that can be optimized for resolution measurements up to a viewing angle of 180 degrees. Adjust and position the test charts to minimize distortion and adapt to the angle of your camera lens.

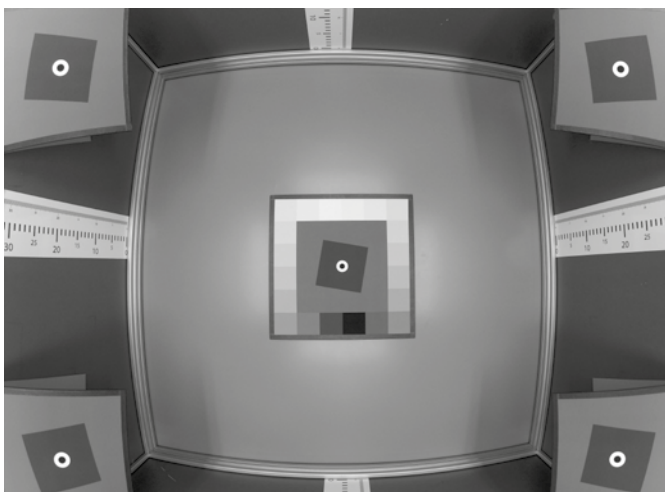
Main Features

- * High FoV resolution measurements
- * Adjustable test charts
- * Easy camera alignment
- * Various opening angles
- * Dimmable illumination system
- * Create low light situations



Product control

The test charts are magnetic allowing for easy adjustment and positioning depending on the viewing angle of the camera lens. The camera positioning for height and depth is remotely controlled by changing the pitch, yaw, and roll.



iQ-FoV Box interior with measurement scales

At a Glance	iQ-FoV Box
Principle	Test box for high field of view cameras
Light source	8 x 18 W 950 fluorescent tubes/ dimmable D50
Extension arm travel range (depth/ height)	75 cm / 15 cm
Rotation range	Pitch: +/- 15 Deg. Yaw: +/-170 Deg. (motorized adjustable via remote control)
Rotation range roll	+/- 10 degrees (manually adjustable)

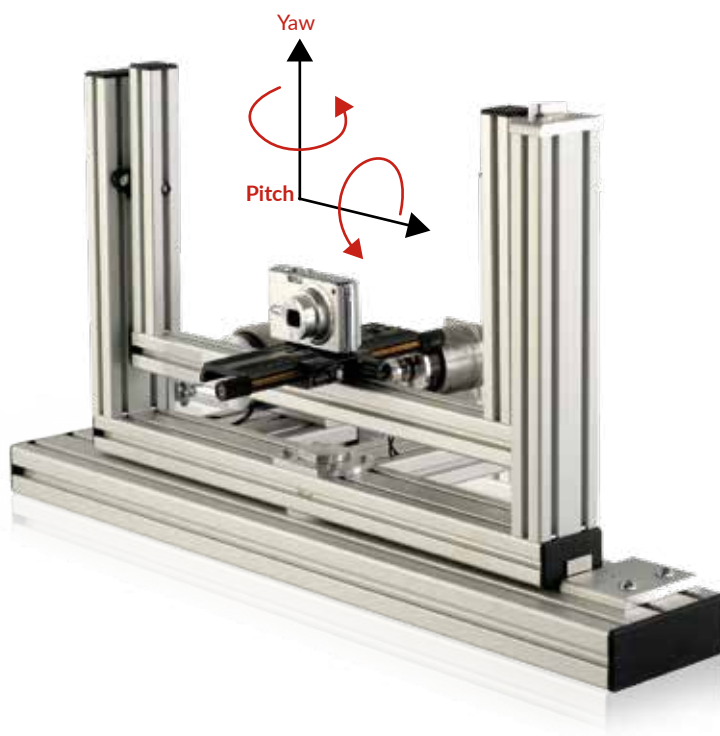
STEVE-2D

Recreate the conditions of human tremors

The Stabilization Evaluation Equipment or STEVE, is designed to test the stability performance of your camera. Various frequencies and two angles of movement can be set for different stability conditions.

Main Features

- * Two axes of movement
- * Individual control of axes
- * Wide range of frequencies



Related products

One of the most significant features of STEVE-2D is recreating human hand shaking. To get the best results, STEVE should be combined with the AF-Box and the TE261 test chart.

At a Glance	STEVE-2D
Principle	Reproducible yaw and pitch simulation of human hand shaking.
Max. camera weight	5.0 kg
Pivot point	Fixed
Rotation range	0.1 - 0.5° (optimized for 0.1 - 0.2°)
Moving frequency	0.1 - 12 Hz (optimized for 4 Hz)
Motion type	2-axis sine generator or custom waveform
Mean position error	< 5%
Standard accessories	Camera mounting stage, controller box, USB cable
Optional accessories	iQ-Trigger/-T, iQ-AF Box, TE261, Honeycomb Breadboard, iQ-Anchor for STEVE

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 natural human hand tremor.

Main Features

- * Six degrees of freedom
- * Control software
- * Two different sizes
- * CIPA certified



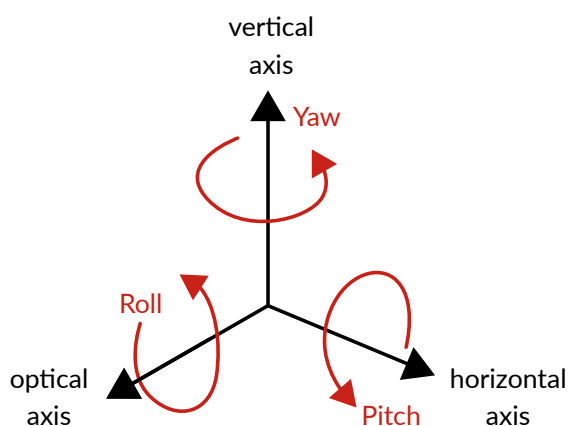
STEVE-6DS



STEVE-6DL

Related products and sizes

STEVE-6D comes in two different sizes, the STEVE-6DL and the STEVE-6DS. Also included is an iQ-Trigger/-T for timing accuracy. STEVE is best used in combination with the iQ-AF Box and the TE261, the slanted edge test chart.



Directions of movement

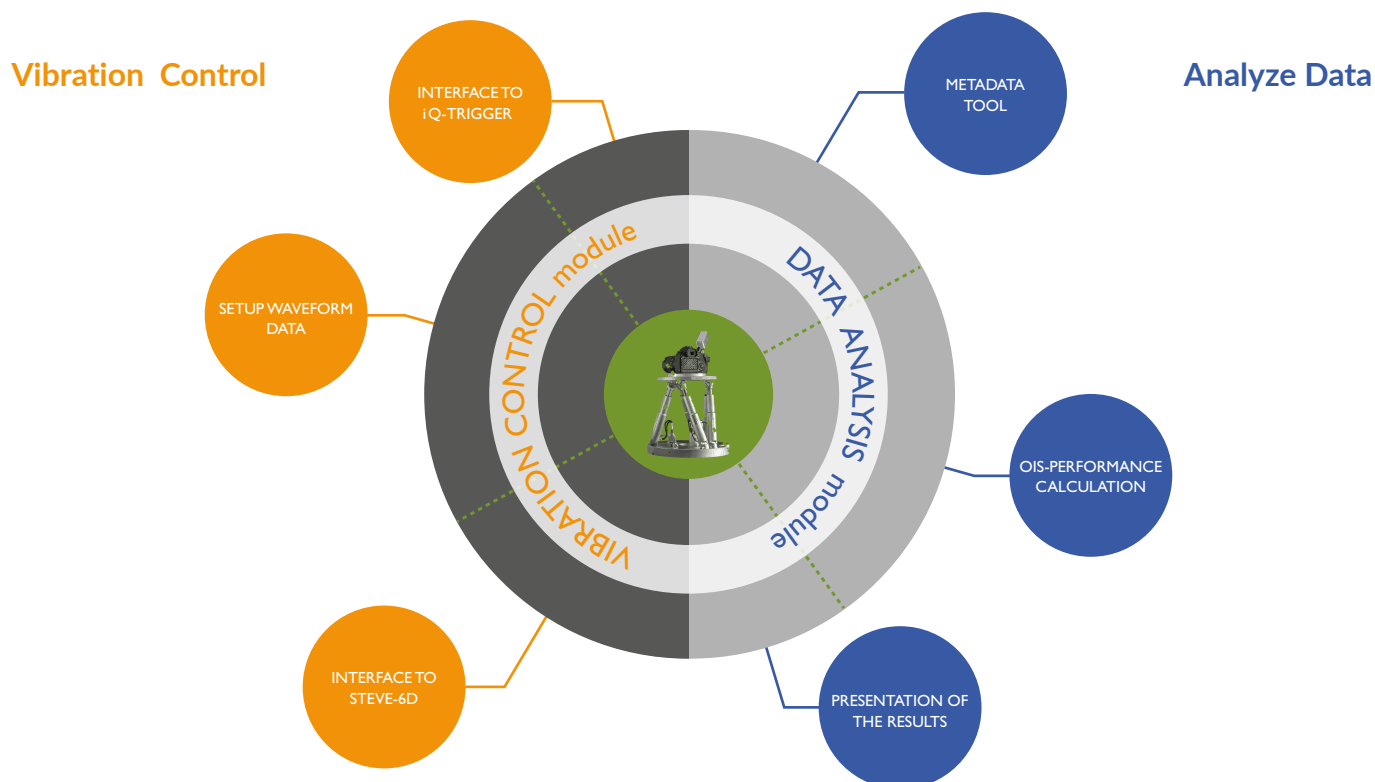


OIS test with the STEVE 6DL and the iQ-AF Box

STEVE-6D modules

The STEVE-6D software uses two modules: the vibration control module and the analyze data module. The vibration control is used to control the movement of the device. You can choose your pivot point and one of the three CIPA handshakes to set up your waveform data. It is also possible to use sinusoidal motion or to upload custom waveforms with Cartesian coordinates.

The analyze data module calculates the image stabilization performance using a metadata tool. The stabilization results can be displayed in f-stops. The edge spread function (ESF) and spatial frequency response (SFR) will also be displayed.



At a Glance	STEVE-6DS	STEVE-6DL
Max. camera weight	2,5 kg	6,0 kg
Pivot point	Customizable	
Translation range (X / Y / Z)	$\pm 17, \pm 16, \pm 6.5$ mm	$\pm 50, \pm 50, \pm 25$ mm
Rotation range (X / Y / Z)	$\pm 10, \pm 10, \pm 21^\circ$	$\pm 15, \pm 15, \pm 30^\circ$
Max. linear velocity (X / Y / Z)	25 mm/s	50 mm/s
Max. angular velocity (X / Y / Z)	325 mrad/s	600 mrad/s
Single-actuator design resolution	80 nm	500 nm
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	

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

API
AVAILABLE

Software
INCLUDED



iQ-Trigger-T

The iQ-Trigger-T (touch) option is our mechanical finger for touch screen devices. This device can press the release button of your camera within 0.5 ms.

At a Glance	iQ-Trigger
Principle	Remote control for triggering hard and soft buttons of digital cameras
Latency	20 ms (depending on position)
Specialties	<ul style="list-style-type: none">• Easy adjustment• Exchangable finger tips• Comes with Manfrotto L bracket and mounting plate type 405
API(C++)	Included in iQ-Defocus product bundles

At a Glance	iQ-Trigger-T
Principle	Remote control for capacitive touch screens
Latency	< 0.5 ms
Specialties	<ul style="list-style-type: none">• Vibration-free triggering of DUT• Sticks on all clean and smooth surfacesfor easy mounting• Designed to fit into iQ-Mobile-mount
API(C++)	Included in iQ-Defocus product bundles

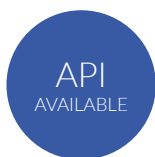
iQ-Defocus

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 autofocus system of the camera.

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 or the DTS. Easily attach the device to the iQ-Mobilemount and control via integrated software in the LED-Panel or DTS.



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	<ul style="list-style-type: none"> • optimal workflow with the iQ-Mobilemount • adjustable depth
API (C++)	Included in iQ-Defocus product bundles

EX2-VIS

A convenient way to measure different spectra

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

Main Features

- * Small compact design
- * Spectral range of 350 – 870 nm
- * Spectral resolution of 2.4 nm
- * NIST traceable calibrated



EX-VIS-IR

The EX2-VIS-IR version includes all of the same features but has an expanded spectral range of 380 – 1100 nm as well a better resolution at 2.35 nm for measuring spectra in the infrared range.



EX2-VIS set

At a Glance	EX2-VIS
Principle	Direct measuring via optical fiber opening (~25° FOV), or cosine corrector add-on (~180° FOV)
Spectral range VIS	350 – 870 nm
Spectral range VIS-IR	380 – 1100 nm
Resolution VIS	Sensor: 2024 pixel/ FWHM 2.4 nm
Resolution VIS-IR	Sensor: 2024 pixel/ FWHM 2.35 nm
Integration Time	1.05 ms – 10 min
Control System	Software based control (iQ-LED software, iQ-LED API, or camSPECS express control software)

Programming Interfaces

Application Programming Interfaces (API) for flexible integration

The various iQ-APIs have been developed as flexible building blocks to more easily integrate our image quality testing products into already 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 a C interface for our iQ-LED API. The C interface can be used in various programming languages and SDKs, such as Python, Matlab or Labview.

API (C++)	Related Products	Key Features
iQ-Drive API	iQ-Alignrig // iQ-Bench-M // iQ-Automator iQ-Chartmount-VM // iQ-Rotation lightSTUDIO-M (-LM, -LMH, -SM, -SMH)*	Full control over motor-driven products
iQ-LED API	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 stand-alone spectrometers
iQ-Standardlight API	lightSTUDIO-S (-SH, -SM, -SMH, -ST)* iQ-Flatlight (fluorescent tubes only) iQ-Chart Box (fluorescent tubes only) lightHEAD-S (stand-alone)	Controlling the fluorescent and halogen light sources in various devices
iQ-Trigger API	iQ-Trigger (-T)	Controlling iQ-Trigger when connected via the USB-Box
LED-Panel API	LED-Panel // iQ-Trigger (-T)	Full control over the LED-Panel and connected iQ-Trigger
LG API	lightSTUDIO-H (LH, LMH, SH, SMH)* LG3 // LG4	Controlling the HDR extension of the lightSTUDIO-H, LG3 and LG4
iQ-Timecode API	iQ-Timecode	Controlling the iQ-Timecode available with the lightSTUDIO

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 by scripting a batch file.

CLI	Related Products	Key Features
iQ-Analyzer CLI	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
lightSTUDIO CLI	lightSTUDIO-S (-SH, -SM, -SMH, -ST)*	Controlling the fluorescent and halogen light sources in the lightSTUDIO-S devices

*For explanations of the various types, please have a look at page 33

iQ-Analyzer

A professional image quality analysis

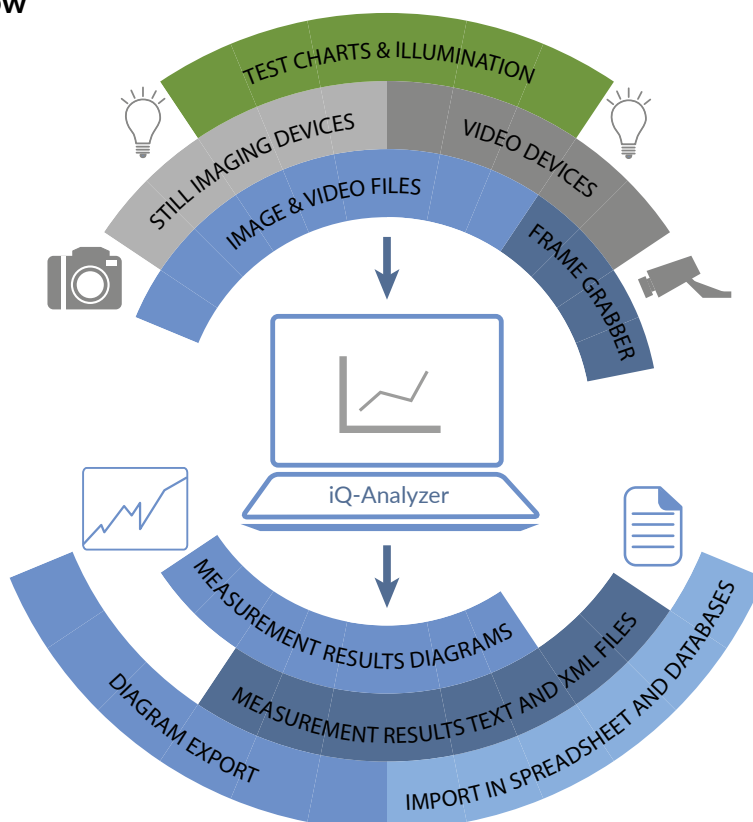
The iQ-Analyzer is an image quality analysis software that evaluates images and video frames of specific test charts. It is best utilized in combination with our test charts and illumination devices.


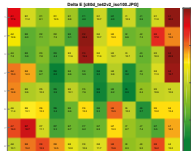
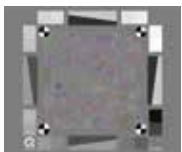
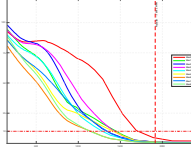

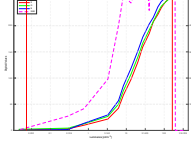

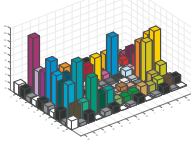
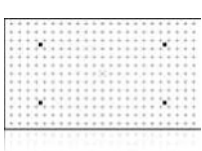
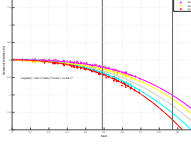

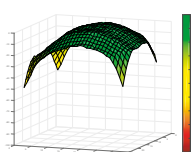
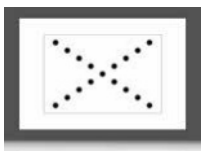
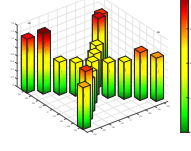

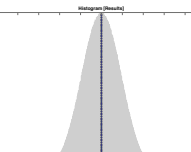


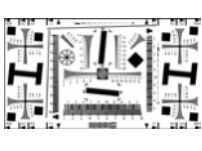



Main Features

- * Eleven separate analysis modules
- * Over 40 compatible test charts
- * Versatile user interface
- * Quick results assessment
- * More flexibility via command line interface
- * Flexible output format
- * Multiple licensing options



iQ-Analyzer workflow



Modules	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) 	
OECF		<ul style="list-style-type: none"> Camera OECF (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) 	
Flare		<ul style="list-style-type: none"> Flare measurement over the image field (ISO 18844) Dark frame subtraction (optional) 	
Histogram		<ul style="list-style-type: none"> Intensity histogram Defective pixels outside tonal range – dead, hot, single, cluster 	
Video		<ul style="list-style-type: none"> Live video and video file acquisition Waveform monitor, vectorscope, histogram display Color difference analysis Live color comparison (when one camera is a reference) 	
Measurement		<ul style="list-style-type: none"> On-the-fly analysis (2D-FTT, visual noise, SFR) Selections of differently shaped regions of interest Contour plot Histogram display 	
UTT		<ul style="list-style-type: none"> Scanners and archiving (ISO 19264) Pass/Fail assessment Size A4 – A0 and “mini” test target Metamorfoze compliant 	

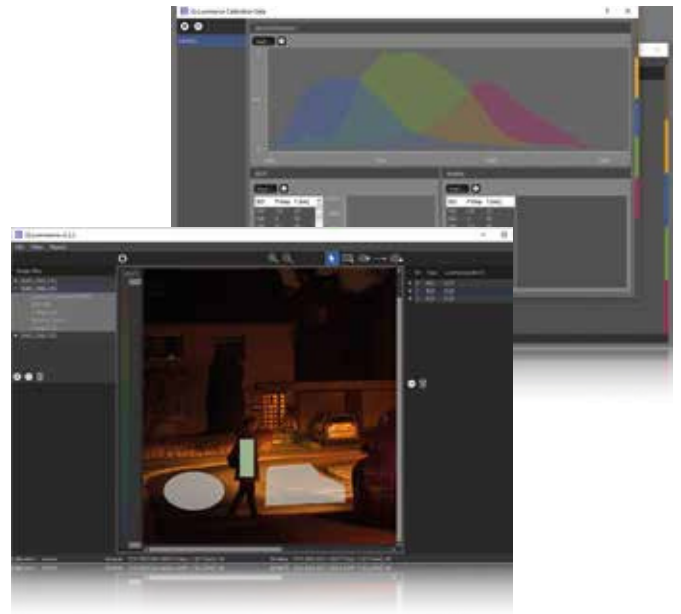
iQ-Luminance

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.

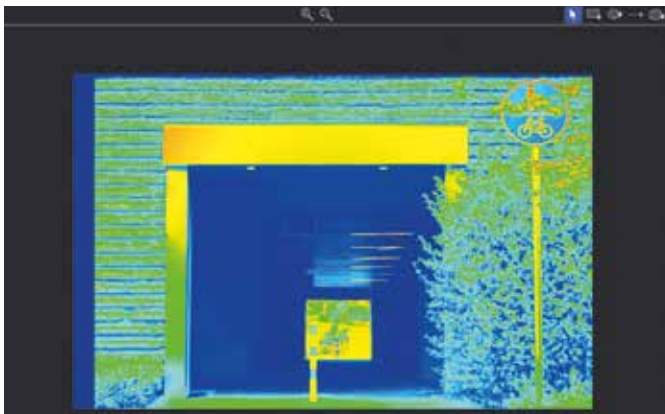
Main Features

- * Calculate luminance values from image data
- * Map raw RGB data to the luminance
- * Calibrate at multiple f-stop levels
- * Calibrate for various ISO-settings

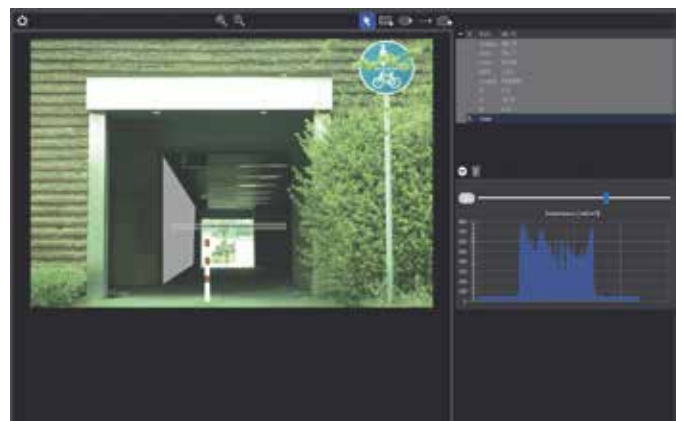


Evaluate the image

Rectangular, circular or polygonal regions of interest (ROI) can be drawn on the image to more efficiently evaluate the selected area. 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.

In-situ Data

An in-situ spectral radiance database

Our in-situ database is a collection of several thousand spectral radiance measurements of various objects and scenes that people typically photograph. The database began as a way to provide training data for the color characterization of digital cameras in combination with their spectral sensitivities. Now you can optimize your color correction matrix based on real life data instead of using a ColorChecker.

Main Features

- ✱ Approx. 2500 measurements
- ✱ Objects under various illuminations
- ✱ Measurement data range: 380 to 780 nm



Why in-situ?

Until now, the only commonly known source for in-situ measured spectral radiances was ISO 17321-1, which provides spectral radiances for 14 common objects. Our database has approx. 2500 spectral radiance measurements using numerous objects and lighting situations. Each object is available in two variants, incident light and white tile corrected.



Selection of biological objects



Element details

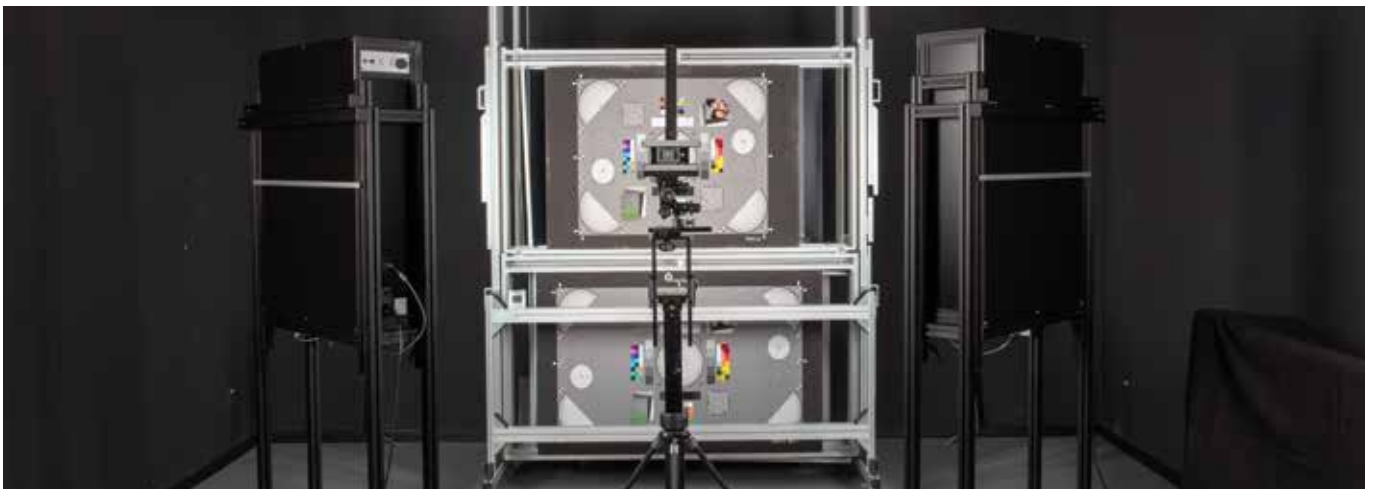
Test Laboratory

One of the world's largest independent image quality test labs

Over the last 20 years, our onsite testing facility has grown into the world's largest independent and objective image quality test labs. Every year we receive hundreds of different camera systems from various imaging related industries such as mobile phone and automotive manufacturers.

Each camera system that we receive is put under a comprehensive image quality test by one of our specially trained engineers. The tests that we use on a daily basis (we test for magazines every day) are always adapted to the most up to date industry related international standards for all of the various image quality factors. We also work with companies to develop a custom test procedure if there are certain advancements and requirements within their industry before a modified standard is released.

Once the testing is complete our engineers can analyze the results and provide an objective report on where the camera system under test can improve its image quality.



Unique camera tests

While most of our everyday testing is for magazines or industry specific tests, our lab also performs special tests upon request. Underwater camera testing, drone, machine vision and broadcast cameras are just a few examples of the unique cameras and tests we can do in our test lab.



Underwater camera testing



Testing for camera flare



Image stabilization testing

Image quality testing of automotive cameras and sensors

Automotive imaging is one of the newer industries that the test lab is actively testing for. We are working closely with the IEEE-P2020 working group who is in the process of establishing certain industry wide parameters and key performance indicators (KPI) for autonomous (ADAS) vehicles.

One KPI that we are currently testing in the lab is contrast detection probability (CDP). CDP is an analysis of how well a camera or sensor is able to detect objects and different contrasts in its field of view. We test for CDP and other image quality factors with the DTS and LG3, a few of the latest devices in automotive camera testing.



Image quality testing of security cameras

The lab is also actively testing for security and surveillance cameras as outlined in the IEC 62676-5, the first international standard for image quality testing of security camera systems. Factors outlined in the standard include resolution, dynamic range, signal to noise ratio (SNR), distortion and flare.

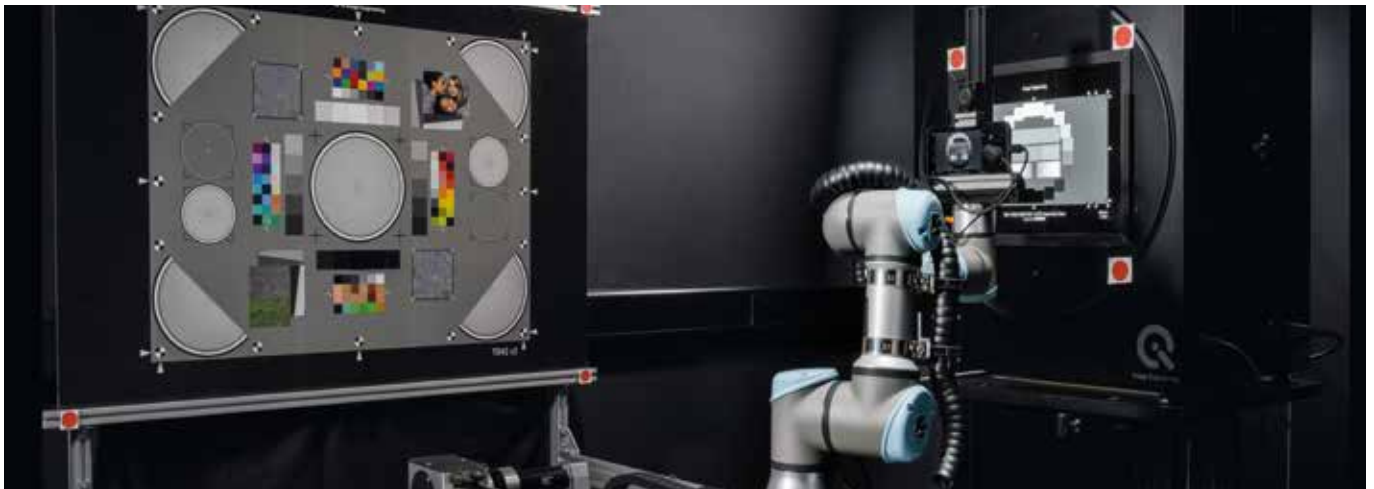
Our lab closely follows the IEC 62676-5 standard and uses uniquely designed test charts to test the image quality factors from the standard. We use iQ-LED illumination devices such as the iQ-Flat-light to create a diverse array of lighting situations including those with low light and those with high intensity to ensure the security system is effective in all different types of environments.



Image quality testing for mobile phone cameras

A mobile phone camera test is one of the lab's most often requested tests. Using specifically designed equipment and following international standards and working groups such as CPIQ, the lab has developed a comprehensive analysis for mobile phone image quality.

As the importance of mobile phone cameras grows, we continue to research and develop more advanced testing techniques. The TE42 is a multipurpose chart for measuring multiple image quality factors in a single image, while the iQ-Automator can perform a fully automatic test with just one click and eliminate human error. These devices as well as others allow the lab to effectively test mobile cameras.



Our lab is a trusted VCX test lab

VCX is a non-profit organization with the goal to provide consumers with a numeric score on the image quality of different mobile phones in the market. The score is determined with an objective test performed by an officially certified lab. An updated list of scores can be found at vcx-forum.com.

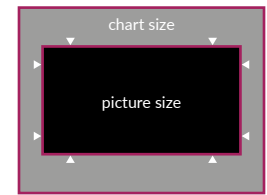
Our test lab is the first of only a few trusted VCX test labs, which means that we are able to perform all of the necessary tests as outlined in the VCX whitepaper. The image quality score is calculated by measuring and combining the sum of six different objective components of the camera. Our lab tests for each component and sends the final score to VCX or to the requesting group.



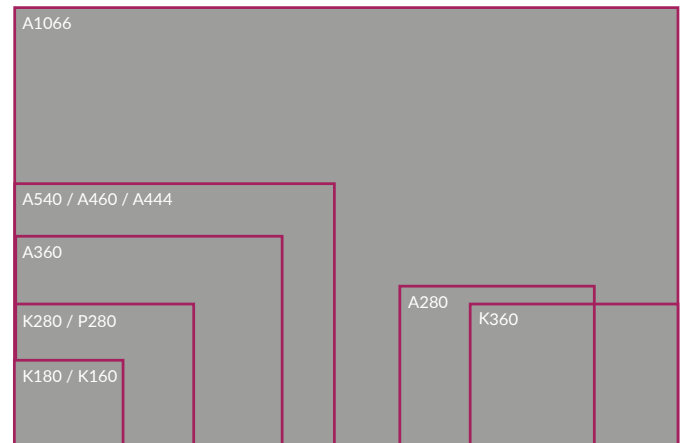
Chart Sizes

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.



Reflective			
Designation	Picture size* w x h [mm]		Chart size w x h x d [mm]
	4:3	16:9	
A1066	800 x 600	1066 x 600	1245 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



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

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

K charts mounted on a black polystyrene plate are only available in combination with test chart folders.

Transparent			
Designation	Picture size* w x h [mm]		Chart size w x h x d [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
D35	32 x 24	-	50 x 50 x 3-4



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

Suitable transparent charts for the following illuminators

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

TE42

A multipurpose test chart for a quick image quality overview

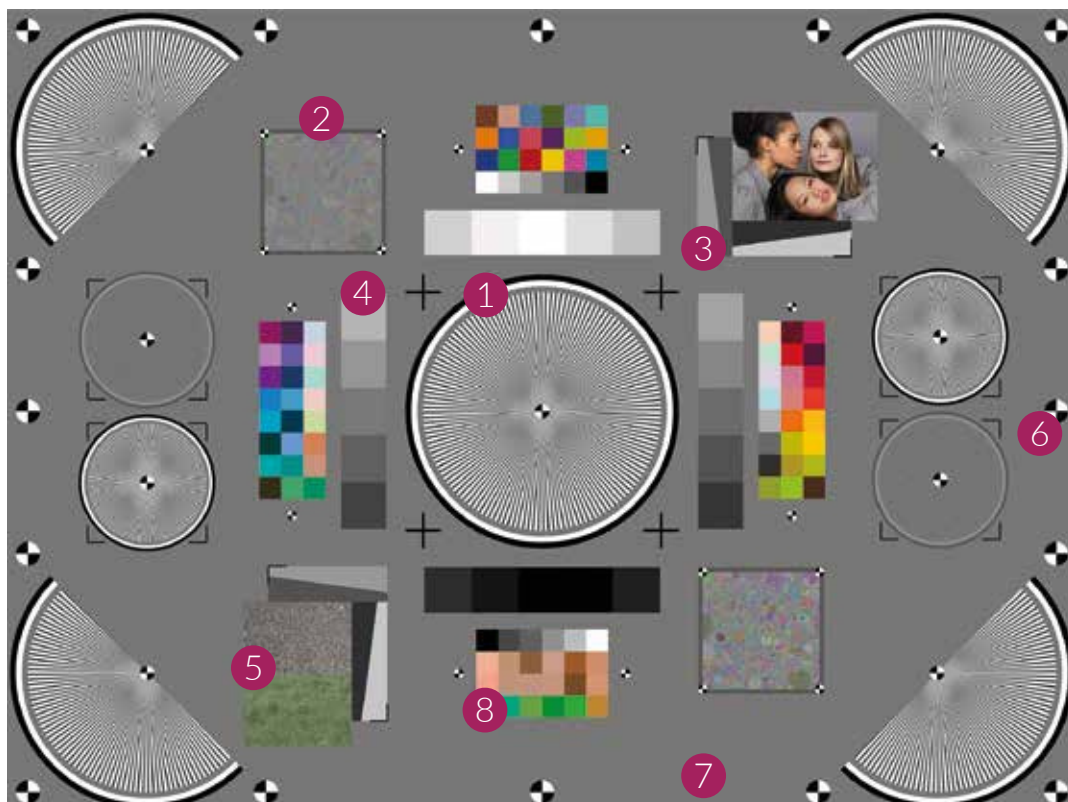
The TE42 chart is a multipurpose test chart that can quickly gather an overview of a camera's image quality performance in a single image. The chart is designed with multiple objects on the same chart plane for testing a wide variety of image quality factors, all of which can be analyzed using the iQ-Analyzer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



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

- | | |
|-------------------------------|----------------------|
| 1 Resolution ISO 12233:2014 | 5 Visual analysis |
| 2 Texture loss ISO 12233:2014 | 6 Distortion |
| 3 Sharpening ISO 12233:2014 | 7 Shading |
| 4 OECF and Noise ISO 15739 | 8 Color reproduction |



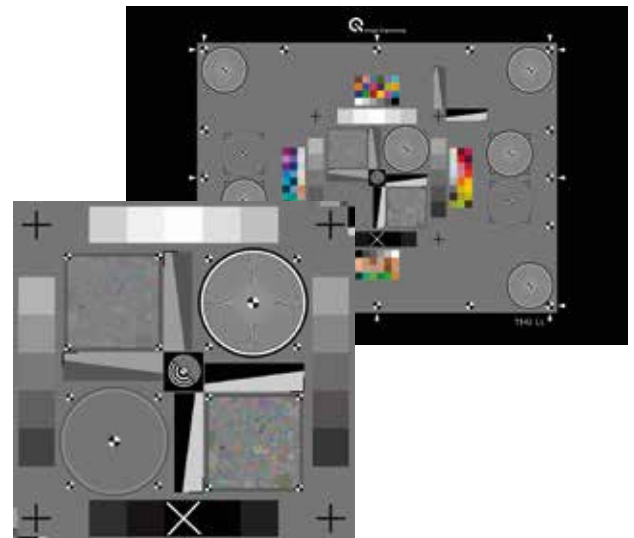
TE42-LL

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 around 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 so as to avoid fall off at the corners.

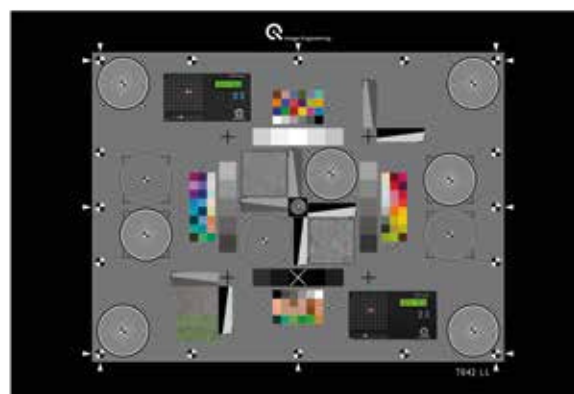
Main Features

- * 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-LL Timing

The TE42-LL Timing chart is the same chart only now it 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 and shutter release time lag.



TE262 / TE263

A universal test target (UTT) for archiving

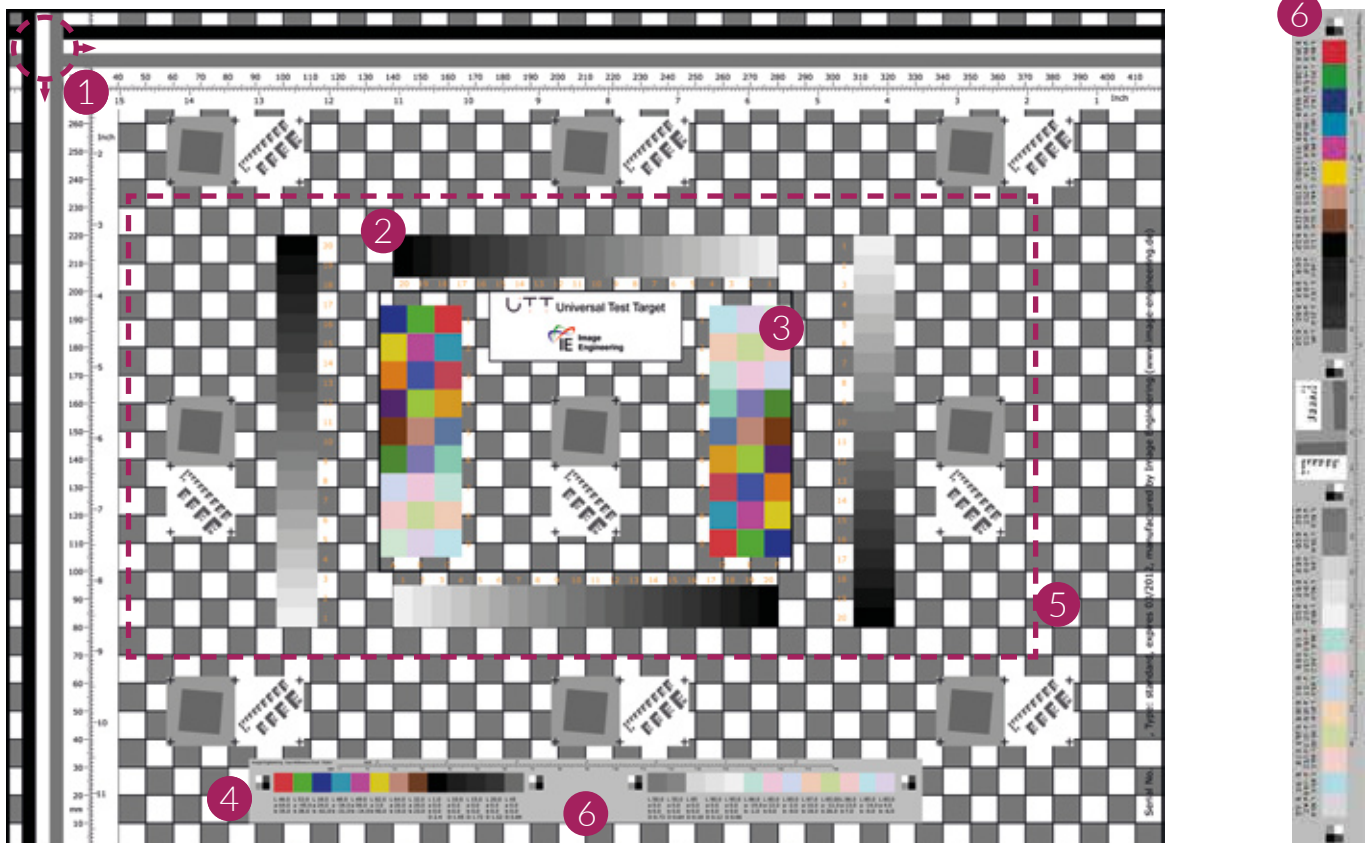
The UTT chart is a multipurpose test chart that is designed to evaluate the image quality of scanners and other digital input devices for the archiving industry. It is available in various sizes ranging from A4 to A0. The iQ-Analyzer software (not included with chart) can automatically analyze the image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

This chart can be used in accordance to 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
- 2 Dynamic range, OECF and Noise
- 3 Color reproduction
- 4 Resolution (slanted edge and visual)
- 5 Shading and Distortion
- 6 Additional chart TE263



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.

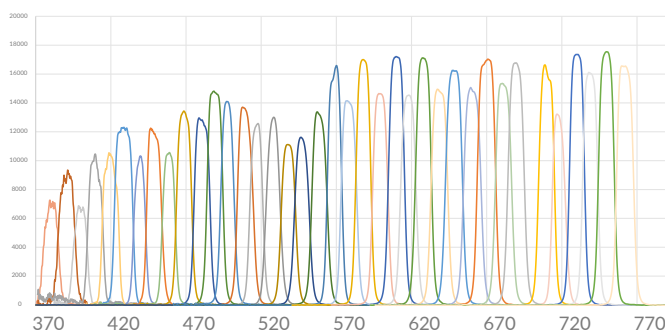
Main Features

- * 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.** iQ-LED technology consists of a spectrally tunable light source that uses 20 individual spectral channels to generate custom spectra for more accurate camera characterization and calibration. The LE7 includes iQ-LED control software and we also offer a C or C++ API as a separate option.



Wavelengths [nm] of the TE292 filters



LE7 with TE292 XL

*See iQ-LED flyer 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

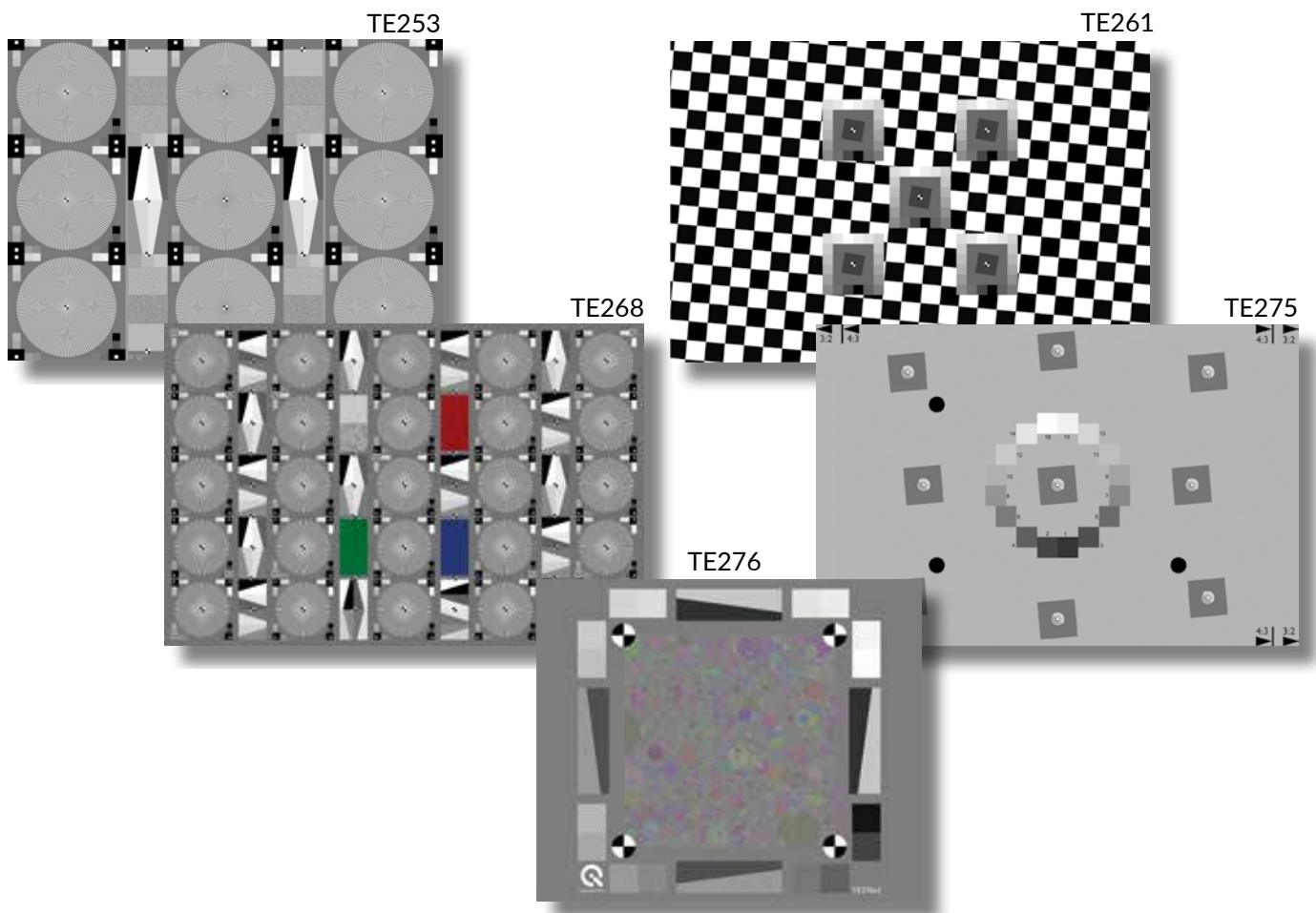
Uniquely designed test charts for measuring camera resolution

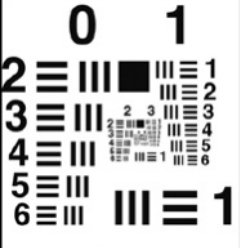
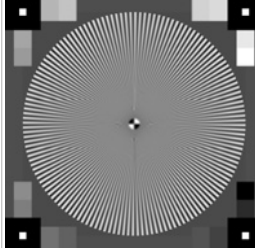
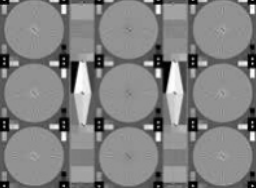
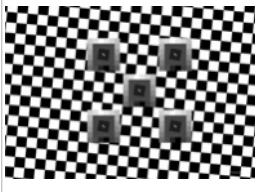
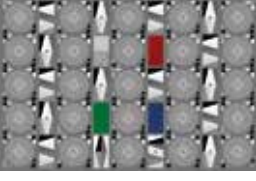
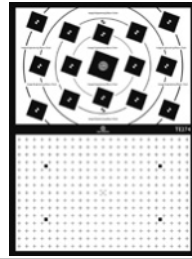

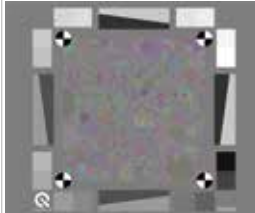
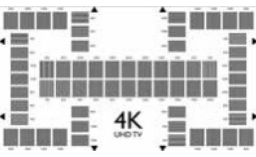
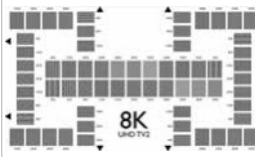

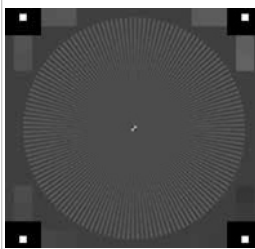
Image resolution is the ability of a digital camera to reproduce the fine details of a scene. In other words, how clear an image is perceived by a human observer is based on the resolution of the camera system. As a result, it is vital to thoroughly test and analyze the resolution of a camera system.

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 in them 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.



TE250 35 mm  <ul style="list-style-type: none"> • USAF resolution chart • Evaluate scanner resolution • Measurements up to 10,000 ppi • Transparent 	TE253 4:3  <ul style="list-style-type: none"> • Modulated sinusoidal Siemens star • Evaluate camera resolution • Reflective
TE253 9x 4:3 / 16:9  <ul style="list-style-type: none"> • Follows ISO 12233:2014 • Nine sinusoidal Siemens stars • Slanted edges and white noise patches • Transparent/Reflective 	TE261 16:9  <ul style="list-style-type: none"> • Slanted edge chart • Evaluate camera SFR • Includes low contrast slanted edges • Reflective
TE265 4:3  <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 • Transparent/Reflective 	TE274 3:2  <ul style="list-style-type: none"> • Macrochart 13 x 13 cm • Slanted edges for resolution • Crosses for distortion • Special alignment frame for positioning • Reflective
TE275 4:3 / 3:2 (on chart)  <ul style="list-style-type: none"> • Slanted edge chart • Evaluate camera resolution • ISO 12233:2014 • Reflective 	TE276 287 x 287 mm (picture size)  <ul style="list-style-type: none"> • Dead Leaves chart • Evaluate texture loss • Circles in all sizes and colors • Reflective
TE277 16:9  <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 	TE278 16:9  <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
TE279 16:9  <ul style="list-style-type: none"> • 4k (UHD TV) universal chart • Quick analysis of transmission characteristics • Multiple gray scales and resolution wedges • Transparent 	TE280 334 x 271 mm  <ul style="list-style-type: none"> • Evaluate texture loss • ISO 19567 • Sinusoidal Siemens star • 18% and 48% modulation available • Reflective

Grayscale charts

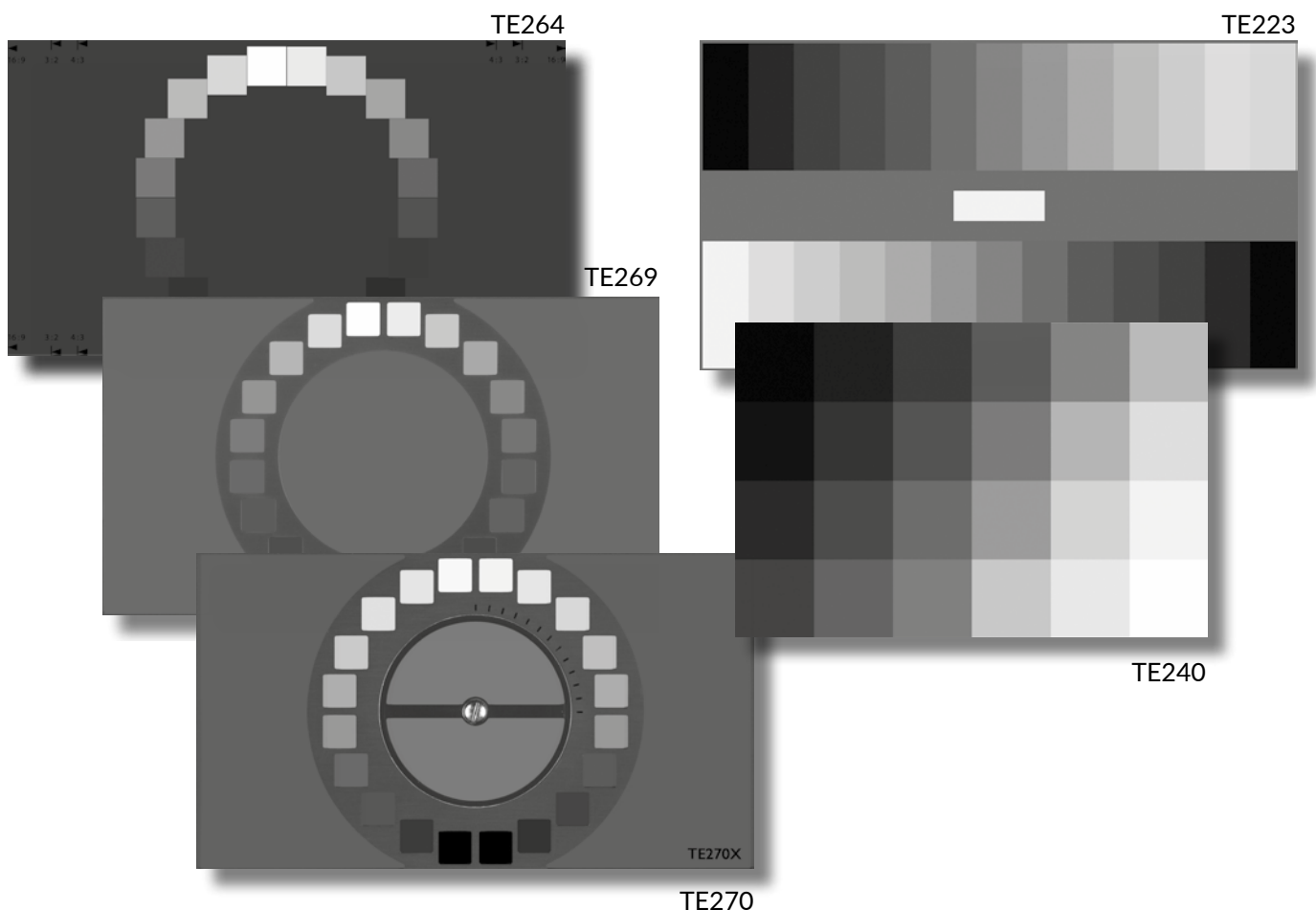
Test charts for analyzing the different grayscale factors

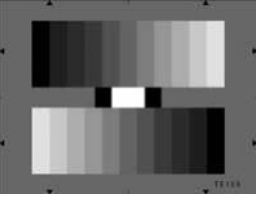


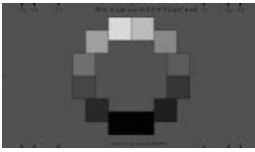
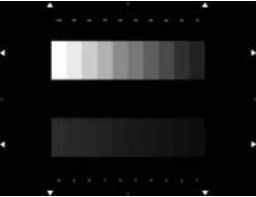

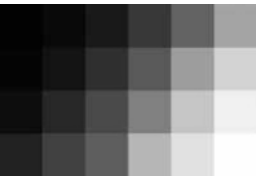

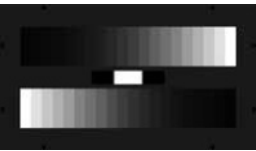



Grayscale refers to the various shades of gray that are present throughout the image. Many different image quality factors are important when measuring how well a camera reproduces the tonal value of an image including: OECF, dynamic range, gamma and noise.

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 on 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 that is 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 high sensitivity settings of the camera.

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



TE153 4:3  <ul style="list-style-type: none"> • Log. grayscale chart (11 steps) • Evaluate halftone reproduction • Two 11-graduated counter current grayscales • 40:1 contrast range of grayscales • Transparent/Reflective 	TE165 16:9  <ul style="list-style-type: none"> • Log. grayscale chart (11 steps) • Evaluate halftone reproduction • Two 11-graduated counter current grayscales • 40:1 contrast range of grayscales • Transparent/Reflective
TE182 9x 4:3 / 16:9  <ul style="list-style-type: none"> • Evaluate exposure control • 18% remission • Transparent/Reflective 	TE197 16:9  <ul style="list-style-type: none"> • ISO 14524 • Evaluate OECF • 12-step gray scale • Multiple contrasts • Transparent/Reflective
TE205 16:9  <ul style="list-style-type: none"> • Gamma measurement chart • Ten gray steps from 1-10% transmission • Ten gray steps from 10-100% transmission • Transparent 	TE223 16:9  <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 grayscales • Transparent/Reflective
TE240 32:24 mm (transparent) / 100:150 mm (reflective)  <ul style="list-style-type: none"> • Evaluate dynamic range of 35 mm scanners • ISO 21550 • 24 gray patches • 4.0/6.0 density range (transparent) • 2.4 density range (reflective) 	TE241 16:9  <ul style="list-style-type: none"> • OECF and noise chart • Evaluate the characteristic curve of a camera • 20 gray patches • Transparent
TE259 16:9  <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 	TE264 16:9  <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
TE269 16:9  <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 	TE270 X 16:9  <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

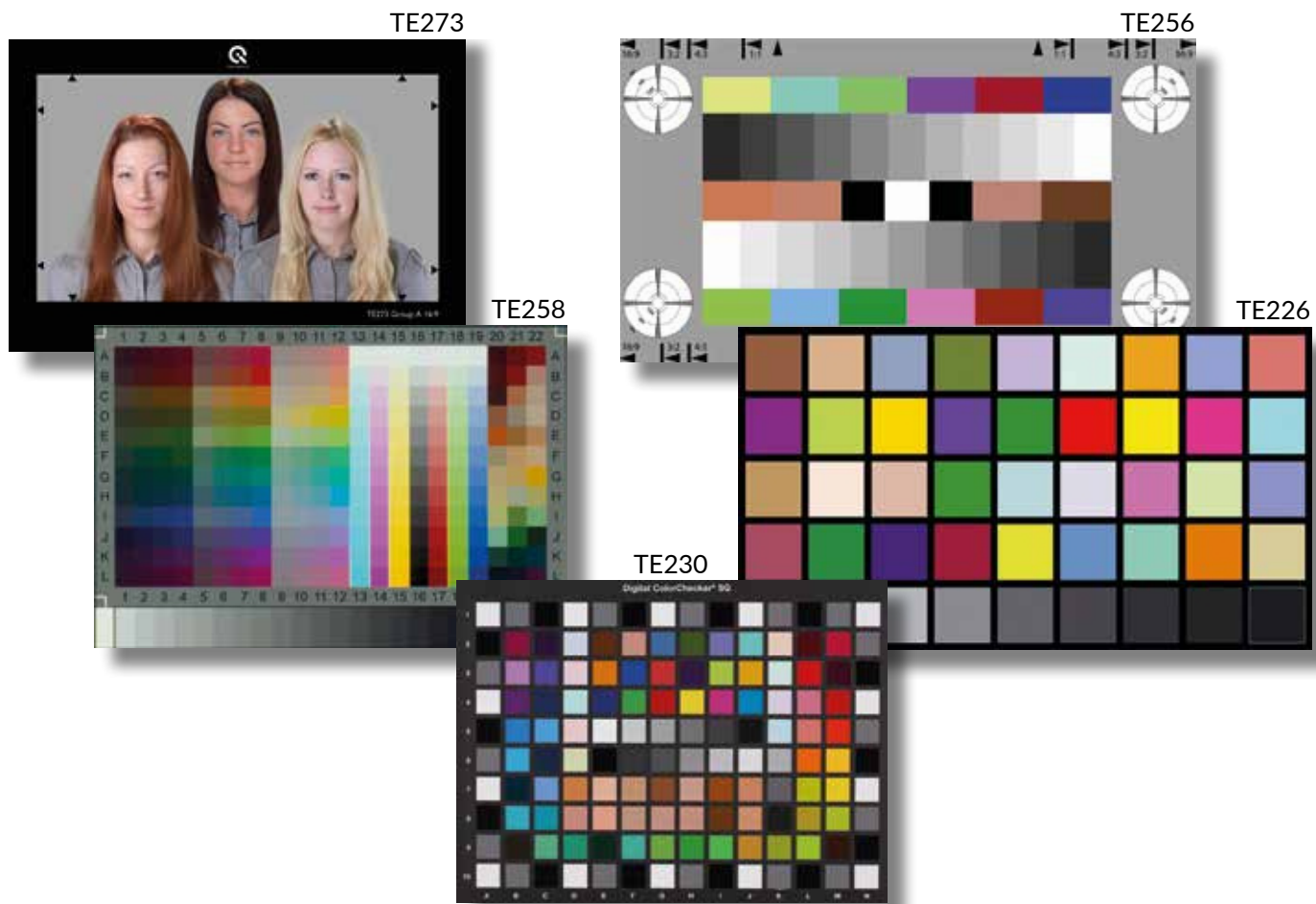
Color charts




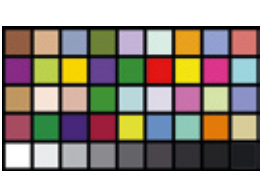


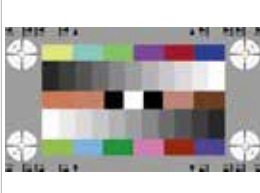
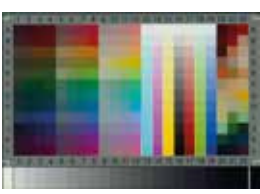

Test charts for analyzing the color reproduction of a camera

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.



BBC61A 4:3 	<ul style="list-style-type: none"> Flesh tone reference chart BBC approved Reflective 	TE106 / TE106 4:3 / 16:9 	<ul style="list-style-type: none"> Evaluate color rendition Primarily for TV cameras 6 color bars Transparent/Reflective
TE169 4:3 	<ul style="list-style-type: none"> EBU/CAM chart (EBU Tech. 3237) Evaluate color reproduction 18 color patches Six white to black patches Transparent/Reflective 	TE188 / TE188 16:9 (X-Rite ColorChecker) 	<ul style="list-style-type: none"> Evaluate color rendition 18 color patches 6-step grayscale Transparent/Reflective
TE226 16:9 	<ul style="list-style-type: none"> HDTV color rendition 36 color patches 9-step grayscale Transparent 	TE230 (X-Rite ColorChecker SG) 	<ul style="list-style-type: none"> Evaluate color rendition 140 color patches 14 skin-tone patches Reflective
TE233 16:9 	<ul style="list-style-type: none"> Evaluate color reproduction 24 color patches 4 skin tone patches Reflective 	TE234 16:9 	<ul style="list-style-type: none"> Evaluate color gradation Check for quantization errors Reflective
TE235 500 x 1800 mm 	<ul style="list-style-type: none"> Surveillance camera chart On-site testing Chart roughly the size of a person Reflective 	TE256 16:9 	<ul style="list-style-type: none"> Evaluate color and calibration Color align HD cameras Reflective
TE258 35 mm film / 5 x 7-inch paper 	<ul style="list-style-type: none"> IT8 scanner characterization chart Create color management profiles Transparent/Reflective 	TE273 16:9 	<ul style="list-style-type: none"> Natural skin tones Single image varieties Group image varieties Transparent/Reflective

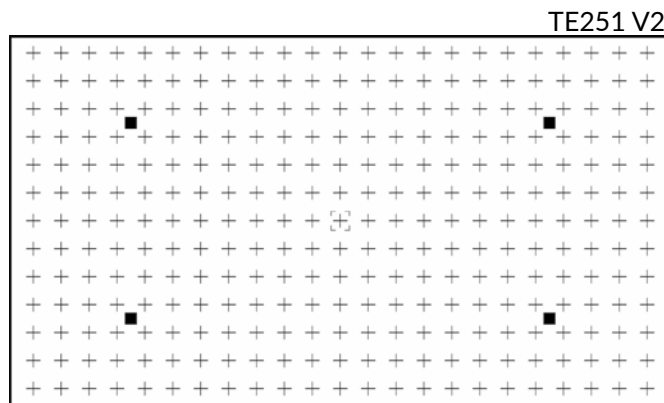
Lens performance charts

Test charts for measuring the performance of a lens

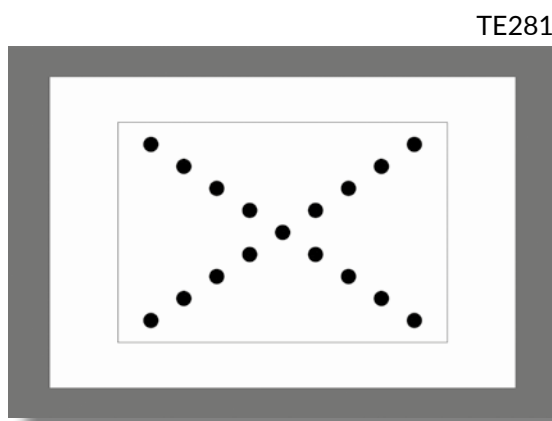
The performance of a lens depends on how the image is affected by different image quality factors including lens distortion, shading/vignetting and flare. These factors are frequently a result of optical aberrations and light reflections from the optical components within the lens and are oftentimes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

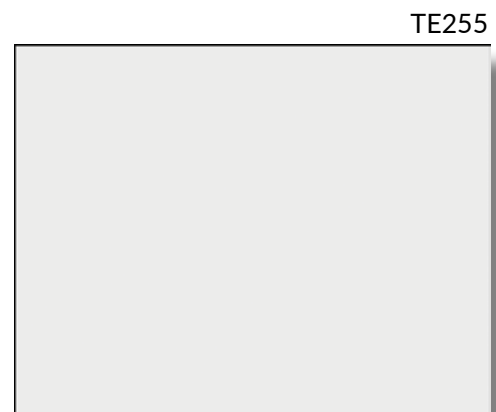
While these factors often depend on the surrounding environment, they can also be tested using specifically designed test charts. We have developed a wide variety of test charts to test for distortion, shading/vignetting and flare.



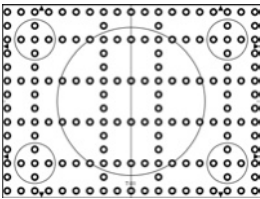
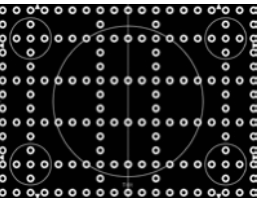
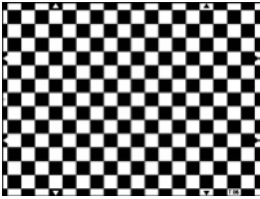
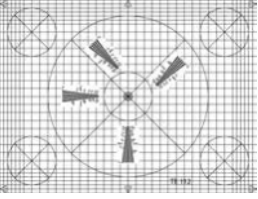
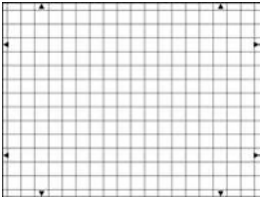
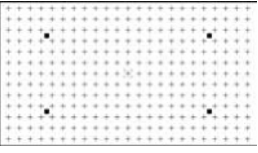

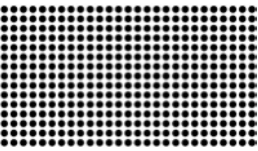
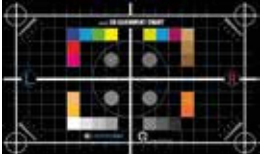
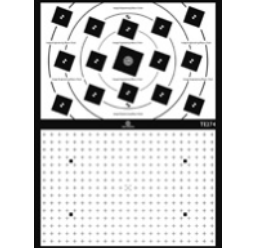
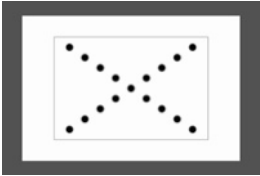
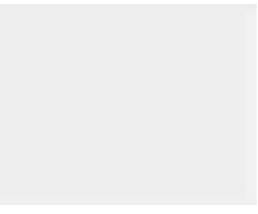
Geometry grid to measure lens distortion



Flare chart based on ISO 18844



Diffuser plate to measure vignetting

T01W 4:3 / 16:9 	<ul style="list-style-type: none"> • Geometry ring chart • Measure geometry of cameras and monitors • Rings arranged on grid with white surrounding • Transparent/Reflective 	T01B 4:3 / 16:9 	<ul style="list-style-type: none"> • Geometry ring chart • Measure geometry of cameras and monitors • Rings arranged on grid with black surrounding • Transparent/Reflective
T06 4:3 / 16:9 	<ul style="list-style-type: none"> • Chess board chart • Evaluate geometry and resolution • Transparent/Reflective 	TE112 4:3 	<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
TE183 4:3 	<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 	TE251 V2 16:9 	<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
TE255 4:3 / 16:9 	<ul style="list-style-type: none"> • Diffuser plate • Evaluate shading/vignetting • 61% transmission • Transparent 	TE260 16:9 	<ul style="list-style-type: none"> • Dot chart • Two charts different charts on front and back sides • Evaluate distortion and chromatic aberration • Reflective
TE271 16:9 	<ul style="list-style-type: none"> • 3D alignment chart • Align and adjust 3D cameras • Combination of 2D and 3D structures • Reflective 	TE274 3:2 	<ul style="list-style-type: none"> • Macrochart 13 x 13 cm • Slanted edges for resolution • Crosses for distortion • Special alignment frame for positioning • Reflective
TE281 3:2 	<ul style="list-style-type: none"> • Flare chart • ISO 18844 • 17 light traps (super black holes) • Evaluate scattering light • Reflective 	TE282 4:3 / 16:9 	<ul style="list-style-type: none"> • Matt diffuser plate • Evaluate vignetting • Transmission 84% • Transparent

Custom Charts

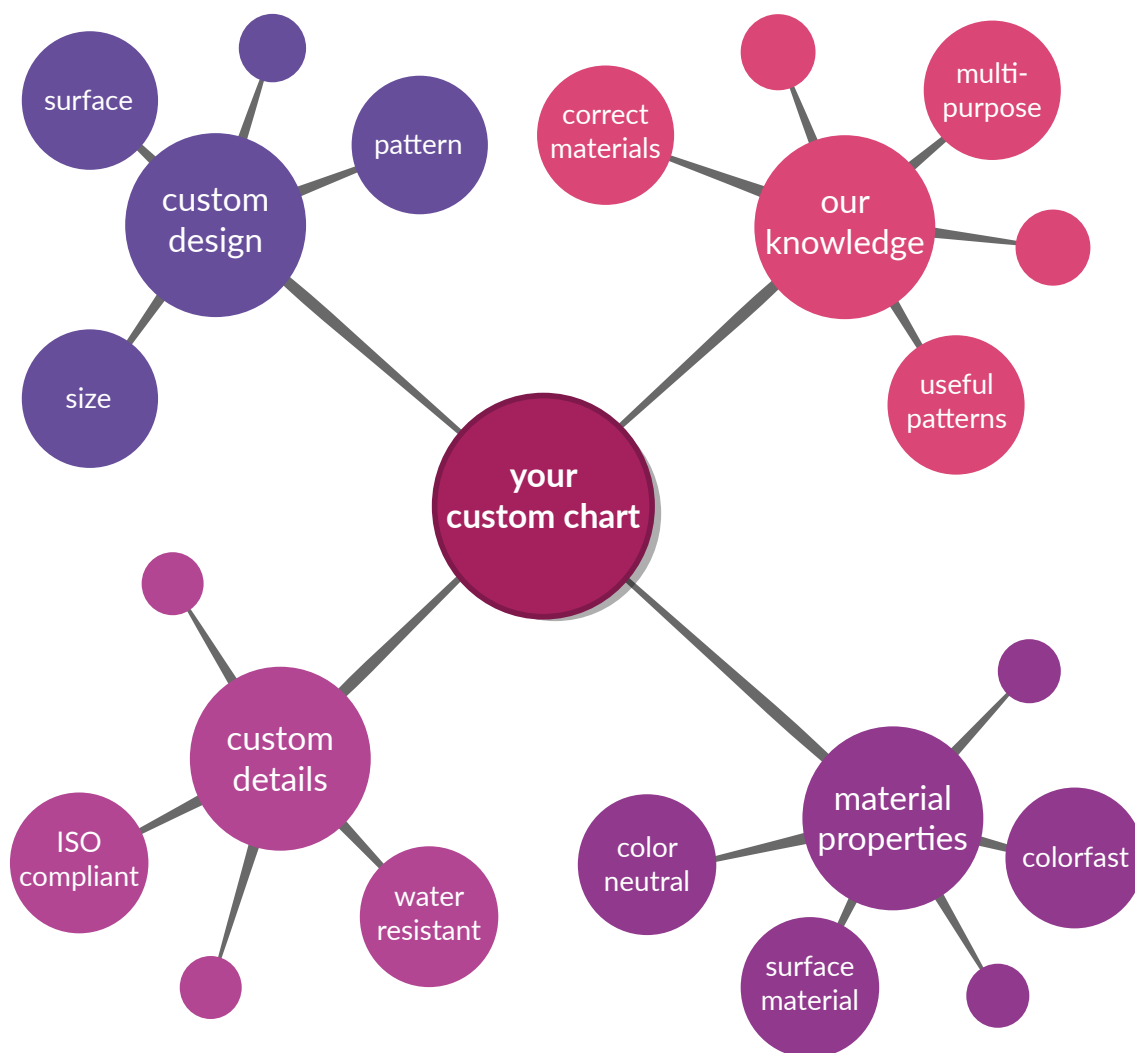
We can help you design a custom test chart

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 create it.



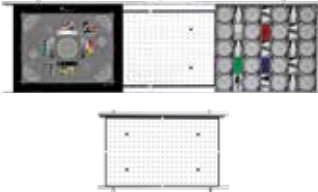





During the customization process, you can choose a custom chart design, select different specifications and use a diverse range of materials for creation.

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.

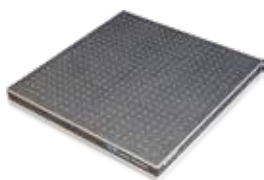
Accessories

<p>iQ-Tripodmount frame for test charts in size A280 / A360 / A460</p> 	<p>iQ-Foldermount frame for Studio Kits</p> 	<p>iQ-Tablemount frame for reflective charts A280 / A360 / A460</p> 	<p>iQ-Wallmount frames for reflective test charts in size A1066</p> 
<p>chartBOARD has a magnetic, neutral gray surface with special alignment marks.</p> 	<p>magneticTAPE can be fixed on the backside of all reflective charts.</p> 	<p>iQ-Chartmount-V for easily changing charts, manually or automatically.</p> 	<p>iQ-Chartmount-H V2 for quickly changing charts manually.</p> 
<p>Support with wheels and precise height adjustment for the LE6/LE7 series.</p> 	<p>Tripods for the LE6, LG3 and LG4 series.</p> 	<p>iQ-Mobilemount Tripod mount for mobiles and tablets.</p> 	<p>iQ-Monopod Tripod for a professional, quick and exact camera positioning.</p> 
<p>Manfrotto 055X Pro3 Tripod</p> 	<p>Manfrotto 410-3-Way-Head</p> 	<p>iQ-Anchor A stabilizing stand with a flat surface for image stabilization measurements.</p> 	

Accessories

Honeycomb Breadboard

A stabilizing surface for securely mounting STEVE-6D.



Restan

PTFE (polytetrafluoroethylene) white reference.



Hedler Tungsten Halogen Light Unit



Studio Lights LED lights with adjustable correlated color temperature.



Gossen Mavo-Monitor USB

Usable for precise measurements of luminance levels of transparent test charts.



Gossen Digipro F2

An exposure meter for high precision incident light measurement. Ensures the illumination uniformity of reflective test charts.



Gossen Mavolux 5032 B USB

Digital luxmeter and luminance meter classified according to DIN 5032-7 and CIE 69.



PRC Krochmann Radiolux 111

The RadioLux 111 is a precision hand held instrument for photometric measurement.



Cases for storage, protection and transport

- Chart cases for transparent test charts available in all sizes
- Chart cases for reflective test charts available in all sizes
- Cases for spherical illuminators LE6/LE7/CAL3
- Cases for illumination devices LG3/LG4



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

Glossary

Selected Definitions

2D/3D-MLUT	Multi-Look Up Table	HDR	High Dynamic Range
ADAS	Advanced Driver Assistance Systems	ICC	International Color Consortium
AF	Autofocus	iQ	Image Quality
API	Application Programming Interface (C language)	iQ-LED	A Multispectral Light Source
CAN	Controller Areas Network	IR	Infrared
CCM	Color Correction Matrix	KPI	Key Performance Indicator
CTT	Correlated Color Temperature	MTF	Modulated Transfer Function
CIECAM	International Commission on Illumination - Color Appearance Modelling	ND	Non-Diffuser (filters)
CIPA	Camera & Imaging Products Association	NIR	Near Infra-Red
CLI	Command Line Interface	NIST	National Institute of Standards and Technology
CRI	Color Rendering Index	OECF	Opto Electronic Conversion Function
DUT	Device Under Test	ROI	Regions of Interest
ESF	Edge Spread Function	SFR	Spatial Frequency Response
FOV	Field of View	SMD	Surface Mount Device
FWHM	Full Width at Half Maximum	SNR	Signal to Noise Ratio
		UTT	Universal Test Target
		VCX	Valued Camera eXperience
		VIS	Visual Area of Spectrum

International Standards

IEC 62676-5 – Data specifications, measuring methods and performance values for security and video surveillance cameras
IEEE P1858 CPIQ – Objective and subjective test methods for cell phone image quality
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 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 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 17321-1 – Methods for measuring the color characterization of digital cameras in photography and graphic technology
ISO 17850 – Geometric distortion measurements of digital and mobile phone cameras
ISO 18844 – Image flare definition and measurements of digital cameras
ISO 19093 – Methods for measuring low light performance of digital cameras
ISO 19264 – Methods for analyzing the image quality of archiving systems
ISO 21550 – Dynamic range measurements for electronic scanners

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