CATALOG 2024





# 1.Introduction

DXOMARK Analyzer is the most comprehensive and scientifically rigorous image quality benchmarking solution available on the market. Its extensive testing capabilities make it the most trusted choice for camera equipment manufacturers and industry experts.

Thanks to our participation in international standard organizations and to our collaboration with renowned academic partners, in addition to our own user preference studies, DXOMARK is in a unique position to have deep insights into the impact of new imaging technologies on the user experience.

The DXOMARK Analyzer solution is constantly enriched with new measurement protocols. Our calibrated hardware ensures consistent and accurate results, and our software automates the testing process, minimizing user errors and ensuring repeatability. With DXOMARK Analyzer, you can challenge your device's capabilities through realistic use cases in a fast, precise, repeatable and fully automated fashion.

As the core of DXOMARK's consulting services, benchmarking, and web publications for the last fifteen years, DXOMARK Analyzer has been honed to work with huge volumes of tests and to exploit lab resources in the most efficient way to guarantee the highest possible throughput. One of the unique strengths of the DXOMARK Analyzer solution is its versatility and its range of applications. From DSLRs to drones, from smartphones to automotive cameras, from medical equipment to surveillance systems, our experts and our customers have tested thousands of different imaging systems over the years using DXOMARK Analyzer's extensive array of measurement protocols.

By helping leading image processing actors to continuously challenge and optimize the quality of their products, DXOMARK Analyzer has been on the cutting edge of advancements in digital photography for the last two decades.



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# 2. Analysis software

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The pinnacle of automated image quality evaluation, cutting-edge DXOMARK Analyzer provides a full library of image quality metrics designed to meet the diverse needs of professionals across various domains.

Whether you work in automotive, medical imaging, smartphone development, or other imaging applications, DXOMARK Analyzer empowers you to fine-tune your images with precision and efficiency by offering you a comprehensive suite of tools to enhance your image analysis workflow. DXOMARK Analyzer's modular architecture allows customization to meet your specific needs. Its powerful features are accessible through a user-friendly graphical interface or a flexible Python API called Workflow Manager. With Workflow Manager, you can create and optimize your own measurement protocols. Whether you are evaluating a single image or designing your own benchmark, DXOMARK Analyzer puts you in control of your quality assessment strategy.

Settings About



DXOMARK Analyzer is not limited to static images: it seamlessly handles both photos and videos, making it an indispensable tool for multimedia professionals. With it, you can effortlessly analyze videos frame-by-frame or assess the dynamic elements of an entire video sequence.

DXOMARK Analyzer lifts the burden of manually shooting and measuring the vast number of photos and videos needed for comprehensive image quality evaluation. DXOMARK Analyzer streamlines this process by providing automated shooting and measurement protocols that intelligently detect setups, charts, and regions of interest, executing all the relevant measurements, and then aggregating the results for maximum accuracy, thus saving you valuable time and effort.

DXOMARK Analyzer's advanced and unique proprietary measurements are complemented by measurement results that comply with the latest image quality standards (IEEE, ISO, and CIPA) to ensure reliability, interoperability, and consistency.

## 2.1. Analyzer software GUI



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This software contains a comprehensive set of image quality measurement capabilities related to sensor, lens, and ISP evaluation. Metrics are compliant with most image quality standards; further, DXOMARK's proprietary metrics take you even further in your evaluations.

## Key modules:

- Optics: Distortion, blur, vignetting, lateral chromatic aberration, color fringing, MTF
- · Photo: Texture, white balance, color fidelity, auto-exposure, noise
- $\cdot$  HDR: Tone mapping, color consistency, noise consistency, texture consistency
- $\cdot$  Autofocus: AF accuracy, AF shooting lag
- Stabilization: photo and video
- Timing: Exposure time, electronic rolling shutter, vertical blanking, frame rate
- Video: Texture, noise, timing

## Key features:

- User friendly
- $\cdot$  Measurement waiting list
- $\cdot$  Automatic detection and cropping of interest area
- $\cdot$  Easy export: (detailed or short) Excel, HTML, PDF
- Comprehensive and intuitive

## 2.2. Analyzer video software

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If you want to dig even deeper, Analyzer offers AZ Video — software that is fully dedicated to video analysis. It features a video preview with dynamic visualization of measurements and DXOMARK temporal metrics. Adaptable for any kind of video camera, the software has a distortion compensation tool for ultra-wide-angle cameras.

Still image metrics can be applied to video frames, but for comprehensive video quality evaluation, you must also consider the dynamic aspect of the image quality. Analyzer introduces a package that provides you with the necessary equipment to simulate dynamic lighting changes such as a sudden lux level transition or a slow change in the color temperature. AZ Video is a complete set of video measurements with easy visualization. After you easily compute video spatial and temporal metrics available in Analyzer, the measurements are displayed in a comprehensive and intuitive way and are synchronized with a preview of the video ROI.

DXOMARK has optimized video algorithms to reduce the processing time — up to 10 times faster using a regular laptop, and up to 40 times faster using a multicore computer.



## Key metrics:

- $\cdot$  Auto-exposure convergence
- White balance stability
- · Spatial and temporal visual noise
- $\cdot$  Video texture
- $\cdot$  Video timing
- $\cdot$  Video flickering

## Key Features:

- Video preview
- Easy setting of start and end processing time
- Intuitive and interactive display of measurement
- results
- $\cdot$  Wide-angle and fisheye camera compatibility

## **Recommended accessories:**

- Multispectral Lighting System (MLS\_001 & MLS\_ SUNIR\_001)
- Dynamic lighting system (DLS\_001)
- LED Universal Timer (LED\_TIMER\_FL01)
- DeadLeaves chart (see page 16)
- Color Checker chart (see page 17)
- Visual Noise chart (see page 20)

## 2.3. Python API: Workflow manager and automation

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Two recurrent issues with image quality testing are the time it takes to test and the necessity of dealing with the compability of software and equipment. Most testing workflows require dedicated staff to manually intervene during most stages of testing, which is time-consuming. Moreover, doing so manually makes it very challenging to maintain the same level of consistency and precision. Manager enables greater automation and customization to help you save precious time and resources every step of the way while maintaining high testing standards. Workflow Manager is Analyzer's Application Program Interface (API). It comes with a Python 3.10 x 64 library of all Analyzer measurements, along with full documentation and demo scripts.

Along with our services, Analyzer's Workflow



#### Key content:

- Python libraries for measurement and equipment control
- · Online help and documentation
- Training and coaching

## Additional equipment and software for fullyautomated lab:

- Juke box for charts
- Positioning system for lighting
- Motorized rails for camera positioning
- Robotic arm
- Auto-alignment algorithm

## Key features:

- Customize your workflow to fit your testing needs
  Reduce testing time to 1/30th of what it takes
- manually
- Automate testing protocols and liberate testing resources
- $\cdot$  Create your own measurements
- $\cdot$  Design your own automated lab
- Use Python environment to call measurements and analyze results
- Compatibility with Python 3.10

## 2.4. Protocol automation software

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Camera manufacturers need to perform tests swiftly and efficiently. Camera testing is typically a complex process that requires lab operators to manually intervene and prepare the test setup each time they need to perform a new test.

DXOMARK Protocol Automation provides testing scripts that you can use to automate the testing workflow from data acquisition to test result aggregation, including automated control of lighting and of different equipment such as the Hexapod Shaker, Timer, AMO, and Trigger. Protocol Automation also handles automatic data classification and transfer onto your master computer. You can improve efficiency by freeing up your lab operators' time, as they will need to intervene only at the beginning to prepare the tests. Protocol Automation contains all the testing scripts that DXOMARK uses in its Smartphone Camera test protocols to take all measurements automatically. Using DXOMARK Protocol Automation, camera engineers can automatically replicate all of the protocols' still photo and video objective tests and

This software does not provide a full report, but returns test results in a json file. Because DXOMARK reports also gather perceptual tests and analyses, you can also reproduce them in your lab and testing environment, thanks to DXOMARK services.



measurements.

## 2.5. Analyzer measurement modules

## **Essential module:**

• Sharpness: SFR (MTF), limiting resolution, acutance, ringing, astigmatism, longitudinal chromatic aberration, blur level in BxU, radial MTF

· ISO speed rating: saturation estimation of ISO speed

• Noise: standard deviation and SNR of spatial, raw and column noise, DXOMARK HDR visual noise; grain size, grain asymmetry, noise autocorrelation, noise coloration index

· Color fidelity: CIE L\*a\*b\* values,  $\Delta E$ ,  $\Delta ab$ , exposure compensation, white balance compensation, white point luminance selection

 $\cdot$  Color sensitivity: color sensitivity, sRGB gamut coverage, sensor used color space, mean  $\Delta$ E, mean  $\Delta$ ab metamerism index

Texture preservation: texture loss MTF, acutance

• Tone curve: OECF estimation

• Dynamic range: based on SNR

 $\cdot$  HDR: color fidelity, texture preservation and contrast variation with EV differences

Distortion: distortion map, distortion profile, geometrical distortion, TV distortion, model error map

• Lateral chromatic aberration: LCA profile, min and max, in pixel and print size

• Luminance and color shading: off-centering, max attenuation, max amplification, max color vignetting, fall-off profile, color channel profile, color vignetting map

· Color fringing: average and maximum blue, red, and purple fringing

· Flash: max attenuation, chromatic deviation, off-centering, fall-off profile

 $\cdot$  Dead pixels and Hot pixels: histogram, defective pixel count

• Timing: exposure time and rolling shutter for photos, statistic for exposure time, rolling shutter, vertical blanking, frame time, missing frames, duplicated frames for videos

• RAW and RGB images: all measurements performed on RAW and RGB images, except for color fidelity and texture preservation (RGB images only).

## 3D module

• Stereovision camera calibration: Baseline parameters, rotations and translations, between the cameras (external parameters), focal length, principal point (internal parameters)

## Advanced video evaluation module

• Video color fidelity: values for each frame and statistics for CIE L\*a\*b\* and ∆a\*b\* for each Colorchecker target patch

• Video noise: values for each frame for standard deviation and SNR of spatial noise, DXOMARK HDR visual noise, temporal noise

Video exposure convergence: luminance evolution during transitions; global metrics: luminance before and after convergence, time to convergence, first convergence time, oscillation time, overshoot intensity
Video color stability: color evolution of each patch over time; global color amplitude variation and oscillation intensity of overall color rendering; blue, green and skin tones; variation amplitude and oscillation intensity of white balance

Video texture preservation: values for each frame and statistics for texture-loss MTF, acutance

#### Selfie extension module (requires Essential module)

Close-up texture: texture-loss MTF, acutance, timing metrics

Focus range: SFR KPIs variations for different distances

## Stabilization module

• Stabilization photo: statistics for motion blur and per-image texture loss in different directions, stops and acutance gained when comparing two sets of images

• Stabilization video: statistics for translation, rotation, zoom, keystoning, rolling shutter, motion blur

## AZ Mate module

• DXOMARK Chart measurements: noise levels in non-flat areas (AI metrics), detail preservation (AI metrics), limiting resolution, exposure

- Face detection: position of faces and faces feature in picture (AI metrics)
- · Measurements on realistic heads: face detail preservation (AI metrics), noise level (AI metrics)
- Portrait HDR: face detail preservation (AI metrics), noise level (AI metrics),

## Autofocus Motion and Timing extension module

• AF: average sharpness, sharpness repeatability, average shooting time lag, shooting time lag standard deviation

- HDR: exposure level, entropy
- Motion blur: motion blur, equivalent exposure time

• Timing: exposure time and rolling shutter for photos; statistics for exposure time, rolling shutter, vertical blanking, frame time, missing frames, duplicated frames for videos

## Automotive essential module

• Dynamic range: IEEE P2020 Dynamic Range based on Contrast to Noise Ratio (CNR) and Tonal Contrast Gain (TCG)

• Noise: IEEE P2020 Noise KPIs: dark statistics, photon transfer curve, SNR, fixed-pattern noise, temporal noise, total noise

• SFR: IEEE P2020 SFR KPIs: full SFR curve, SFR10, SFR50, acutance, corner variation SFR50 and acutance, SFRmax, SFR@50%, SFR@25%

 $\cdot$  CPI (contrast performance indicator): IEEE P2020 CSNR and CTA

## Flicker and timing module

• Timing: exposure time and rolling shutter for photos, and statistic of exposure time, rolling shutter,

vertical blanking, frame time, missing frames, duplicated frames for videos

Flicker: IEEE P2020 Modulation Mitigation Probability, Flicker Detection Index, Flicker Modulation Index

## Flare and MTF module

• Flare: Flare attenuation and flare intensity in the whole image for user-selected positions of the source in the field

• MTF using collimator: SFR curves, limiting resolution, acutance for all user-selected positions in the field

## HDR images and video format support module (requires Essential or Advanced video evaluation module)

• Support for more than 8-bit photo input (8- to 16-bit HEIF, AVIF, etc.) and video input (base layer for HLG and PQ)

- $\cdot$  Support for gain map for HDR photo (Android Ultra HDR, Apple HDR gain map)
- $\cdot$  Outputs in ICtCp color space in color measurements, ICtCp values,  $\Delta E$  ITP
- Natively implemented BT2446-1 (a) HDR to SDR tone mapping method



# 3.Lab equipment

Consistency is key in image quality assessment, which is why our labs are designed for repeatability.

The DXOMARK Analyzer solution includes a comprehensive collection of test charts that are meticulously designed and produced, and which undergo rigorous quality assessment and calibration processes before shipping.

In addition to this, DXOMARK Analyzer offers automated lighting and moving equipment designed to precisely control shooting conditions via your lab computer.

Our setups minimize external variables, ensuring that measurements taken across different sessions, in different labs, and by different operators remain consistent. Furthermore, all setups seamlessly integrate with our software for automated Region-of-Interest detection and measurement.

Every piece of equipment and chart we produce has a unique identification number that allows you to track its history, calibration, and usage.





## 3.1. Charts

## 3.1.1. DXOMARK Chart

## 

Our iconic DXOMARK chart is handmade in our lab according to a repeatable process with more than 100 components, including real objects, miniature charts, and portraits that use a variety of colors, textures, and skin tones.

The chart also contains specially designed markers

that let you use Analyzer software to automatically obtain all available objective metrics, some of which use neural networks trained on a diverse data base constructed during 20+ years and with high quality perceptual evaluations done by DXOMARK experts. All the elements, in the chart, are carefully selected and placed to ensure the same results between two DXOMARK charts, and we assign each chart a unique identification number to facilitate high traceability.



## Key features:

• High variety of texture and color

• Designed for both perceptual and objective measurement

## Key metrics:

- Detail preservation
- Noise
- Resolution
- Exposure
- $\cdot$  Perceptual evaluation of details on natural textures
- $\cdot$  Perceptual evaluation of noise on portraits and

highly textured areas

## Technical specifications:

- Size: 1300 x 890 x 18 mm
- · Board material: PVC (polyvinyl chloride)

- DMC\_002
- EASEL\_S0002

## 3.1.2. HDR Noise Chart



This high-end, optically dense chart is made of black metallic plate and is designed to mitigate veiling glare and ghosting. It contains 28 neutral density patches, and has a dynamic of 120 dB.

This chart also contains specially designed markers

that let you use Analyzer software to autonomously obtain all objective metrics. We test and calibrate every HDR Noise chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



#### Key features:

Compliant with Standard: ISO 12232/15739/14524 & IEEE-P2020

• Low flare impact thanks to patch arrangement high temperature range :-20°C to 100 °C

## Key metrics:

- OECF (opto-electric conversion function)
- Dynamic and tonal range
- Tone curve
- $\cdot\,\text{Noise}$  and SNR
- $\cdot$  Noise grain size
- $\cdot$  ISO speed rating
- $\cdot$  Dark signal

## **Technical specifications:**

- Size: 315 x 315 x 23.5 mm
- Material: Aluminum and glass

- · HDR0002
- Light panel: GEMINI\_1x1

## 3.1.3. Dead Leaves Chart

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This IEEE-CPIQ compliant chart lets you evaluate texture preservation and noise. It features the standard dead leaves pattern for assessing texture preservation as well as 12 gray patches for assessing visual noise to help you characterize a device's noisevs-texture tradeoff. Produced by a specialized precision printer, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and all objective metrics. We test and calibrate each Dead Leaves chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key features:

· Compliant to IEEE 1858 (CPIQ) standard.

• High resolution print on matte paper to avoid reflexions

## Key metrics:

- Photo and video texture preservation
- $\cdot$  Texture and edge acutance
- Ringing
- Visual noise
- · Photo and video stabilization

## Technical specifications:

- Size: 785 x 603 x 3 mm
- Material: matte paper glued on White Dibond

- •TU0003\_78\_P
- TF0003\_78 (chart frame)
- · EASEL\_0003\_MK2

## 3.1.4. Color Checker



Whether it pertains to skin tones in video calls or scenery in landscape panning shots, color is an integral part of photo and video quality. You can use this chart to evaluate white balance amplitude and intensity as well as color rendering amplitude and intensity. These charts have a specific frame that contains markers so you can use Analyzer software to autonomously obtain ROI placement and all available objective metrics.



## **Key Features:**

 $\cdot$  Markers for automatic detection and analysis

· Compliant with Standard ISO 17321-1

- Material: PVC, cardboard and paper • 3 available sizes:

Technical specifications :

- CC\_MINI\_001 : 150 x 100 mm
- · X-RITE\_COLOR\_CHART : 215.9 x 279.4mm
- CC\_XL\_01 : 785 x 603mm

White balanceColor fidelity

Key metrics:

- · Color rendering
- Color sensitivity (from RAW data)
- Exposure
- Noise
- Auto-exposure convergence
- ISO speed rating
- $\cdot$  White balance stability

- · CC\_MINI\_001
- · X-RITE\_COLOR\_CHART
- FRAME\_CC002
- TF0003\_78 (chart frame)
- · CCF0003\_78P (mounting frame)
- CC\_XL\_01
- TF0003\_78 (chart frame)

## 3.1.5. Realistic Mannequins

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These hyper-realistic mannequins are designed to facilitate image quality evaluation, each having a specified spectral response for skin tone and all the details of a real human face. Due to the static nature of these mannequins (compared to a real person who moves), test scenes using these mannequins are absolutely identical, making resulting measurements repeatable and reliable. Further, using a mannequin can save precious testing time for a lab operator. We have three mannequins, each with a different skin tone, produced by a specialized French provider. We calibrate each realistic head in our labs before shipping to ensure the same quality, and assign each mannequin a unique identification number to facilitate high traceability. Analyzer software can automatically output Albased face detail preservation metric on the realistic mannequins thanks to our neural networks trained on our extensive image database.



## Key features:

- · High detailed realistic heads.
- True hair and hairs
- Neutral grey shirt

## Key metrics:

- Exposure
- Noise
- Face detail preservation
- Perceptual analysis

#### **Technical spécifications:**

• Material:

- Polyurethane foam
- Proprietary skin-like pigmentation
- Silicon
- Real hair
- Glass eyes
- Size : 500 x 300 x 470 mm

#### **References:**

- Eugene : REALMAN\_001
- Sienna : REALMAN\_002\_1
- · Diana : REALMAN\_003

Add-on: Support trolley (SUPPORT\_REALMAN) 895 x 445 x 1290mm Add-on: Motorized rotation system for realistic mannequins (ROT\_ REALMAN\_001)

#### 3.1.6. Background Mountain Bokeh Setup

## .

To analyze the quality of bokeh blur, DXOMARK has developed a setup with two planes — one on the right and one on the bottom — which are almost parallel to the optical axis. We add to this setup a portrait subject (mannequin head) or a macro object (vase with plastic flowers) in the foreground. Both planes are covered with regular patterns and extend in front of the subject. At the far end, we have placed tiny LEDs to help you analyze the shape

#### of the bokeh.

This setup allows you to evaluate the equivalent aperture of the bokeh and the smoothness of the blur gradient on the regular patterns on the bottom and along the line of black and white squares on the right plane. Having the same pattern at all distances in the setup can reveal even the smallest inconsistencies that would go unnoticed in many real-world scenes. The setup also makes it possible to analyze noise consistency by comparing the grey patches on the in-focus area and on the background. Any difference in grain will be the result of computerized bokeh processing.



## Key features:

• Point light sources at several distance for Bokeh analysis

• Complex patterns and texture for bokeh smoothness analysis

## Key metrics:

· Perceptual analysis of computational bokeh

## **Technical specifications:**

- Background
- Mountain side chart
- 2700 x 4000 mm
- •1420 x 750 x 5 mm
- Printed fabric, Aluminum
- $\cdot$  Feather board
- $\cdot$  LED lights, mannequin head, and vase with flowers not provided

## **References:**

· BOKEH\_BGMT\_001

## 3.1.7. Visual Noise Chart



This chart is composed of seven large grey patches designed specifically for measuring visual noise on video. These measurements complement those taken using the grey chart. You can also use this chart to evaluate various important video quality metrics related to temporal analysis, spatial analysis, and noise chromaticity.

Produced by a specialized provider, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and all objective metrics. We test and calibrate every Visual Noise chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## **Key Features:**

High quality print : no visible pattern visible.
Big square size for accurate low resolution vidéo analysis

## Key metrics:

- Video visual temporal noise
- Video visual spatial noise

## Technical specifications: VNU0001 200 P:

- Size: 2000 x 1350
- Material: matte paper glued on Dibond

## VNU0002\_140\_P:

- Size: 1400 x 970
- Material: matte paper glued on Dibond

- ·VNU0001\_200\_P
- EASEL\_0001
- VNU0002\_140\_P
- · EASEL\_S0002

## 3.1.8. Dot Chart

The very flat surface of this glass-supported dotpattern chart ensures precise optical measurements of shading, sharpness, lateral chromatic aberration, distortion, and focal length from one shot. It is available in various sizes and is compatible with most types of cameras. Produced by a specialized provider, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and all objective metrics. We test and calibrate every Dot chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key features:

#### Standards:

- · IEEE-CPIQ 1858 compliant
- ISO 17850/17957/19084 compliant

• Glass or Honeycomb to ensure perfect flatness (recommended for 3D calibration)

## Key metrics:

High productivity, field-wide optical aberration measurements in one shot

- Luminance and color shading
- Sharpness
- $\cdot$  Lateral chromatic aberration
- Distortion
- $\cdot$  Focal length

## Technical specifications:

- DU0002\_120:
  - Size: 1200 x 900 x 10 mm
  - Material: Safety glass

## DU0001\_200\_V2:

- Size: 2010 x 1360 x 25 mm
- Material: Aluminum honeycomb

## DU0002\_120\_D:

- Size: 1200 x 890 x 3 mm
- Material: White Dibond

## DU0003\_60 & DF0003-60 (frame):

- Size: 600 x 470 x 6 mm
- Material: Safety glass

- DU0002\_120
- · EASEL\_D0102
- · DU0001\_200\_V2
- EASEL\_0001
- · DU0002\_120\_D
- · EASEL\_D0102
- · DU0003\_60 & DF0003-60 (frame)
- · EASEL\_0003\_MK2

## 3.1.9. MTF Chart

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Available in various sizes, including those that support measuring fisheye lenses up to 190° FOV, and high-resolution cameras up to 50 MPix, this chart features a grid of slanted-edge patterns for measuring SFR maps across the field, astigmatism, longitudinal chromatic aberrations, and ringing all in one shot. The MTF chart lets you use Analyzer software to autonomously obtain all objective metrics. We calibrate Analyzer software to remove the chart resolution from the SFR measurements, and we test every chart in our labs before shipping to ensure the same results between two charts. We also assign each chart a unique identification number to facilitate high traceability.



## Key features:

High resolution on matte paper to avoid reflexions.
High contrast for better MTF accuracy using RAW images

· Compliant with Standard ISO 12233

#### Key metrics:

- SFR
- Acutance
- Astigmatism
- Axial chromatic aberration
- Ringing artifacts

## Technical specifications: SU0001 :

- Size: 2000 x 1350 x 3mm
- Square size: 120 x 120 mm

## SU0002:

- Size: 1400 x 970 x 3 mm
- Square size: 70 x 70 mm

## SU0007:

- Size: 2000 x 1350 x 3 mm
- Square size: 40 mm

#### SU0008:

- Size: 300 x 200 mm
- Square size: 16 mm

- · SU0001\_200
- · EASEL\_0001
- · SU0002\_140
- · EASEL\_S0002
- SU0007\_200
- · EASEL\_0001
- SU0008\_32\_HRP
- · EASEL\_0003\_MK2

## 3.1.10. Radial MTF Compliant Chart



This 140 cm SFR chart is designed to be compliant with the IEEE 1858 standard, also called CPIQ. You can use Analyzer software to autonomously obtain all objective metrics. We calibrate Analyzer software to remove the chart resolution from the MTF measurements, and we test every MTF Compliant chart in our labs before shipping to ensure the same results between two charts. We also assign each chart a unique identification number to facilitate high traceability.



## Key features:

Compliant with Standards: IEEE 1858 CPIQ and ISO 12233

• High resolution on matte paper to avoid reflexions

## Key metrics:

- $\cdot$  Sagittal and tangential SFR
- Acutance
- CPIQ subjective quality (JND)

## **Technical specifications:**

- Size: 1400 x 970 x 3 mm
- Pattern size: 1315 x 805 mm
- Square size: 80 x 80 mm

- ·SRU0002\_140
- Easel : EASEL\_S0002

## 3.1.11. Composite Chart

## 

The Composite chart contains three main patterns — greyscale, 24-color matrix, and dead leaves. The chart lets you verify your camera's ability to accurately reproduce colors, manage noise, and preserve contrast and texture in comparison with an objective reference. Using recommended lighting, you can simulate a dynamic range of up to 15 EV in the test scene.

Produced by a specialized provider, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and all objective metrics. We test and calibrate every Composite chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key features:

- High quality transmissive chart
- $\cdot$  Composite chart to speed up camera analysis

## Key metrics:

- Temporal noise reduction (TNR)
- HDR tone mapping
- Dual-cam
- Large sensor
- Texture preservation
- Contrast preservation
- Color consistency

## **Technical specifications:**

- Size: 292 x 583 x 3 mm
- Material: Film on glass

- CT002
- Light panel: GEMINI\_2x1
- Easel : easel\_0004\_GM

## 3.1.12. Natural Scene Chart



Containing a detailed real-life scene for performing lab-based perceptual analyses under controllable HDR conditions, this chart facilitates evaluation of texture loss, moiré, aliasing, color shift, and sharpness. Using recommended lighting, you can simulate a dynamic range of up to 15 EV in the test scene.

This chart is produced by a specialized provider. We test and validate every Natural Scene chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key features:

High quality print

## Key metrics:

Perceptual evaluation of color in HDR conditions

## Technical specifications:

• Size: 292 x 583 x 3 mm

 $\cdot$  Material: Film on glass

- NS002
- Light panel : GEMINI\_2x1
- Easel : easel\_0004\_GM

## 3.1.13. Color Fringing Chart



This transmissive chart consists of a square pattern positioned on a uniform light table. You can use this for measuring color inaccuracies caused by chromatic aberration — a flaw that is especially visible in highly saturated areas. Produced by a specialized provider, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and color fringing metrics. We test and calibrate each Color Fringing chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key metrics:

 $\cdot$  Color fringing

## Link to accessories:

- CF0002\_MASK (chart mask)
- Lighting system: GEMINI\_2x1

## Technical spécifications:

- Size: 320 x 290 x 5 mm
- Material: Aluminum

#### **References:**

·CF0002\_32

## 3.1.14. Gray Chart

## 

This uniform gray-colored chart is designed for evaluating exposure, shading, defective photosites, flash, and video noise.

Consistency of video performance during recording is critical for producing quality results. Analyzer's Video & Stabilization module comprises an extensive set of tests to perform when recording a uniform background so as to help you characterize your camera's video stability. These tests include measuring variations in exposure and white balance, as well as color shifts, and temporal and spatial noise (including row and column noise). You can also use the Gray chart to evaluate other video metrics such as exposure stability and convergence.

Produced by a specialized provider, this chart lets you use Analyzer software to autonomously obtain all objective metrics. We test and calibrate each Gray chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## **Key Features:**

· Certified neutral gray chart

## Key metrics:

- Luminance and color shading
- Noise
- $\cdot$  Defective photo sites
- Flash

## Technical specifications:

- Size: 1400 x 970 x 3 mm (GU002) 600 x 220 x 3 mm (GU003)
- $\cdot$  Material : paper glued on Dibond

- GU0002\_140\_P
- GU0003\_60\_P

## 3.1.15. Focus Range Chart

## 💼 🖻 💿 🖍 🛛 🖏 😓

The Focus Range portrait chart helps you evaluate a device's ability to focus on faces at various distances by measuring edge acutance and MTF. Our measurement software calibrates the MTF measurement from the chart resolution. Produced by a specialized provider, this chart with specific markers lets you use Analyzer software to autonomously obtain ROI placement and all objective metrics. We test and calibrate each Focus Range chart in our labs before shipping to ensure the same results between two charts, and assign each chart a unique identification number to facilitate high traceability.



## Key features:

• 4:1 contrast slanted edge compatible with ISO 12233

- Calibrated chart.
- Automatic measurement with Analyzer

## Key metrics:

- Sharpness
- Depth of field

## Technical specifications:

- Size: 420 x 297 x 3 mm
- $\cdot$  Material: White Dibond

## **References:**

• ROF001\_30



## 3.2. Lighting and Equipment

![](_page_29_Picture_1.jpeg)

## Key features:

- · Flicker-free (DC-driven)
- · Light level closed loop
- Custom Spectrum
- · Computer control & API software
- Flicker mode
- Short raise time (<30 ms)
- Daylight (0.1 to 50K lux), IR (700 to 980 nm)

## **General specifications:**

- Size: 785 x 203 x 1590 mm
- Material: Aluminum
- $\cdot$  Weight: 45 Kg for each fixture of MLS with SUNIR option

## 3.2.1. Multispectral Lighting Systems

![](_page_29_Picture_15.jpeg)

## Standard Multispectral Lighting System

The Multispectral Lighting System (MLS) is designed to illuminate test charts of up to a width of 2 meters with more than 90% uniformity for image analysis. This new lighting system uses 32 LED channels that can be fully controlled independently and can automatically fit a spectrum (standard spectra are pre-calibrated). The LED channels are DC-driven, ensuring flicker-free light, although LED flicker can be activated. This lighting system can reach very low light (down to 0.1 lux with 10% precision).

An illuminance feedback loop automatically stabilizes light levels, and the entire system is computer-controlled so that you can program your own lighting scenarios, including the color temperature. The software ensures perfect repeatability of your illumination conditions.

## Sunlight-Near Infrared Multispectral Lighting System

This lighting system has the same basic characteristics as the standard MLS product, but comes with 4 additional LED channels in nearinfrared (NIR) and one additional LED channel in visible light. This creates an unprecedented ability to mimic daylight by reaching light levels up to 50K lux with a spectrum that goes through the full range of visible light and NIR.

#### **Technical specifications:**

- From 0.1 to 50 000 lux
- Spectrum: 360–980 nm
- Flicker mode: 50–1000 Hz (50% duty cycle)
- Ethernet connection
- ·100-240V 50-60Hz
- Max consumption : 2500 W

- · MLS\_001 & MLS\_SUNIR\_001
- SPECTRUM\_SETUP
- LIGHTING\_SETUP\_MLS
- Easel: MLS\_SUPPORT or Frame: M0001\_300

## 3.2.2. Hexapod Stabilization Platforms

![](_page_30_Picture_1.jpeg)

Camera motion and subject motion are two of the hardest aspects of video quality to measure in an accurate and repeatable way. Analyzer's Video and Stabilization module works seamlessly with our purpose-built hexapod shake table and control software to ensure that you're testing your device against different kinds of camera movement. This high-precision shaking platform for image stabilization testing provides repeatable motions that simulate real-life movements.

Our two main models of stabilization platforms, called Hexapods, can help you simulate movement on your camera sensor or module.

![](_page_30_Picture_5.jpeg)

![](_page_30_Picture_6.jpeg)

#### Key features:

- · High velocity and dynamics
- Precise path tracking
- Friction-free voice coil drive

## **Technical specifications H840:**

- Brushless motors
- Max load : 3000 g
- $\cdot$  Travel ranges up to 100 mm and 60°
- $\cdot$  Max speed up to 5.1°.Hz and 23 mm.Hz
- $\cdot$  Velocity up to 50 mm/s
- $\cdot$  Repeatability to ±0.4  $\mu m$

## Technical specifications H860:

- · Voice coil Drives to produce very smooth
- movement without any vibrations
- max load : 1000g
- max speed up to 15°.Hz and 30 mm.Hz
- Velocity up to 250 mm/s

- · HEXAPOD\_H860
- NEWPORT\_STA\_H860
- DEVICE\_HOLDER\_860
- HEXAPOD\_H840
- NEWPORT STA H840
- · DEVICE\_HOLDER\_840

## 3.2.3. Motorized Rotation System for Realistic Mannequins

![](_page_31_Picture_1.jpeg)

A motorized platform designed to rotate realistic mannequins at controlled speeds and acceleration, simulating realistic head rotation.

![](_page_31_Picture_3.jpeg)

## Key features:

- Accurate simulation of head rotation : smooth movement with controlled accelleration and jerk.
- · Controlled by python API

## **Technical specifications:**

- Size: 520 x 140–376 x 68 mm
- Material: Aluminum
- Rotation range : 360°
- Accuracy : 0.04°
- $\cdot$  Max rotation speed : 115°/s
- Input : 100 240 VAC, 50 / 60Hz, 2.0A max

## **References:**

• ROT\_REALMAN\_001

## 3.2.4. Automated Moving Object - AMO

## and the second s

Autofocus testing requires defocusing multiple times during each photo session, which can be tedious and laborious. AMO's automated Defocusing Object makes taking measurements easy and rapid with PC-controlled synchronization of the AF setup and automated image capture using a touchscreen digital trigger. Using AMO, you can fully automate autofocus testing from image capture in various lighting conditions to highly repeatable and accurate output.

## Two components:

- Moving Background: Continuously moving chart that simulates scene motion at adjustable speed.
- Defocusing Object (foreground): Self-moving chart for resetting cameras to their reference setting. It can move outside of the camera FOV in less than 100 ms.

![](_page_32_Picture_7.jpeg)

## Key features:

- Made with industrial motors and linear axis.
- · Low maintenance required.
- Real time controlled with close loop whith a embedded industrial computer.
- · Computer controlled from python API.

## **Technical specifications:**

- Max travel : 600mm
- Max speed : 2m/s
- ·200-240V 50 / 60Hz 8.0A max
- References:
- ·AMO\_004R

![](_page_33_Picture_0.jpeg)

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## 4.1. Industrial camera / Machine vision

Machine vision cameras can be set up in production lines or mounted on moving parts such as robot arms in order to acquire images in industrial settings for such purposes as checking manufacturing tolerances, localization and geometrical measurement of objects, remote monitoring, etc. Such cameras can be integrated into an environment with external lighting or provide their own light source, and may cover different spectral bandwidths (RGB, IR, UV, etc) and sensitivities to light. They are typically expected to be powered on and available at all times for extended timespans measured in years, sometimes in difficult conditions (extreme heat or cold, vibrations, etc). Controlling the image quality of the camera system is critical to guaranteeing accuracy and repeatability of the installation, as well as to quickly identifying failure modes over time and thus avoiding productivity losses.

Analyzer's flexible testing charts come in different sizes, from close-range inspection charts that

can be integrated inside an inspection line to large-scale charts mounted on walls or on easyto-move wheeled easels. The positioning markers on such charts facilitate obtaining automated measurements of sharpness, noise, color rendering, geometrical distortion, and frame rate (among many other metrics) in any condition.

The Analyzer measurement software suite provides plenty of options for evaluating precise image quality metrics at any resolution, and in both still image and video formats. By integrating our Python API into your systems or even by building custom testing solutions with our unitary measurement tools, you can test your existing cameras with easyto-use measurement reports and documented numerical guidelines; evaluate, check and compare specifications for off-the-shelf camera systems with standards-compliant measurements; and automatically receive alerts whenever image quality parameters deviate from their nominal values.

![](_page_34_Picture_5.jpeg)

## Use cases

- Calibration and tuning in situ require "small" targets like the P2020 SFR chart
- $\cdot$  High precision of pixel positioning requires a highly
- accurate distortion model with error estimation • Noise evaluation according to the emval288
- standard

## Measurement and KPIs

• Precise distortion calibration (Brown-Conrady models compatible with OpenCV and Matlab) with error map for accuracy evaluation

Chromatic aberrations

- MTF
- Noise
- Tone curve
- Color fidelity

- $\cdot$  Analyzer Essential module
- $\cdot$  MTF chart
- $\cdot$  DOT chart
- Options:
  - $\cdot$  HDR Noise chart
  - $\cdot$  Universal LED Timer

## 4.2. AR/VR/MR/XR

Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), and Extended Reality (XR) technologies have continued to gain popularity in industries and applications such as entertainment, healthcare, automotive, education, etc. However, the productization of AR/VR equipment faces many challenges, as image quality is paramount for acceptable AR and VR experiences.

VR gaming headsets require high-quality images to provide realistic and clear virtual scenes. To improve the user immersion experience, eye tracking using cameras is commonly used to tune the images according to the eye positions. The difficulty comes from requiring high enough contrast for accurate eye detection and high enough camera FPS to track eye movements fast enough.

AR gaming glasses generally integrate Simultaneous Localization and Mapping (SLAM) technology, connecting users to the real world by mapping their surroundings in real time. For this purpose, DXOMARK Analyzer solution offers a precise initial calibration of the camera's intrinsic and extrinsic parameters.

In healthcare, AR/VR headsets with see-through technology aid in surgery by capturing and

displaying the real-world environment using a stereo camera. The reproduction of the real world should be as authentic as possible to achieve high accuracy during the operation. Such cameras generally use short exposure times and small apertures to achieve a large depth of field, resulting in a low number of captured photons. Achieving optimal image quality involves judicious Image Signal Processing (ISP) tuning to find the best tradeoff between noise reduction and texture preservation. Moreover, reducing latency is crucial for matching VR scenery to head movements, that is why DXOMARK Analyzer provides a series of measurements that assesses the performance of cameras in terms of noise reduction, texture preservation, and timing. Analyzer also assesses such key image quality attributes as contrast, color fidelity, HDR capabilities and distortion to enhance high precision during surgeries.

DXOMARK Analyzer solution includes the Multispectral Lighting System (MLS) to simulate diverse lighting conditions by reproducing corresponding light spectra and intensities. This allows for assessing the image quality of AR/VR devices across various use cases.

## Use cases

Headsets can use the following technologies:
SLAM (simultaneous localization and mapping) using multiple cameras. It requires extrinsic and intrinsic calibration of all the cameras.
Vision through: a stereocam is used to capture the real world and display it in the headset. The cameras use a short exposure time and a small aperture (to get a high Depth of Field), so the number of captured photons is low. The quality of the images projected needs a lot of ISP tuning to handle the better compromise between noise and texture preservation.

• Eye tracking with camera: to improve the experience, the headset is using the eye position to tune the images.

## Measurement and KPIs

Vision through:

- Image quality: MTF, texture preservation, color
- fidelity, visual noise, HDR, Distortion.
- DXOMARK RAW: a good HW is necessary to get a good RGB images
- Calibration 3D
- Timing and flickering mitigation
   Flare

#### Starter kit and KPIs

- Vision through:
- AZ Essential module
- Associated charts

![](_page_36_Picture_0.jpeg)

## 4.3. 3D Cameras (Stereovision, ToF, Structured Light)

3D cameras are widely used nowadays, making possible 3D image reconstruction (for example, creating a 3D model of a room or a monument), and 3D estimation of a scene (of particular relevance for robotics and automotive applications).

Several technologies build 3D models of a scene from images. Photogrammetry does 3D reconstruction by capturing many different images from different angles. NeRF (Neural Radiance Field) is based on the same principle, but uses AI to reduce the number of images required. Stereovision estimates 3D from a calibrated set of two cameras. Some "active" systems include a projector to add texture to flat areas. Time-of-flight (TOF) sensors are also commonly used for 3D estimation.

The smooth functioning of image-based 3D estimation depends greatly on precise calibration of intrinsic and extrinsic parameters, and on optical defects of the cameras. More generally, very good

image quality is important for constructing an accurate 3D model. For example, a high signalto-noise ratio (SNR) is required for a good image matching. 3D reconstruction devices often require working in various environments, from low light to sunlight, and in scenes with high dynamics.

Our testing solution includes a comprehensive hardware and software protocol for testing 3D estimation devices, based on ISO and IEEE standards. DXOMARK Analyzer makes it possible to measure all important image quality factors with great precision, including noise, dynamic range, optical parameters. The geometry bench allows for precise calibration and performance measurement of stereo cameras. DXOMARK also provides 3D targets as well as realistic mannequins for testing the quality of 3D models and 3D reconstruction. The multispectral lighting system (MLS) adjusts the impact of lighting on active and passive systems.

![](_page_37_Picture_6.jpeg)

## Use cases

- Photogrammetry and NeRF
- Active and passive stereo
- Time-of-Flight (TOF)
- Structured light
- SLAM

#### Measurement and KPIs

• 3D geometry: calibration of intrinsic and extrinsic parameters for stereovision cameras

- Distortion and chromatic aberration
- Noise and SNR
- $\cdot$  Texture and sharpness

- $\cdot$  DOT chart
- $\cdot$  Dead Leaves chart
- HDR Noise chart"

## 4.4. Medical

Medical imaging allows medical professionals to diagnose and treat diseases with minimal need for invasive surgical interventions. However, to improve diagnosis and therapy, it is crucial the imaging tools provide the highest quality.

One of the most widely used tools in medical applications is the endoscope. Specific names exist for endoscopes targeting specific organs (otoscope, colonoscope, etc.), but the general purpose of any endoscope is the same: to allow a medical professional to visually inspect the inside of the patient's body.

While optical endoscopes have existed since the early

1800s, a modern endoscope comprises a miniaturized camera module with an integrated lighting system and a rigid, semi-rigid, or flexible rod used to drive the system inside the patient's body.

With DXOMARK Analyzer, it is possible to evaluate the images taken by the endoscope using precise KPIs that allow medical professionals to select, validate, or certify their equipment. As medical imaging is a critical and highly regulated domain, DXOMARK Analyzer relies on internationally recognized standards (for example, ISO and IEEE) in the evaluation of its KPIs.

![](_page_38_Picture_6.jpeg)

#### Use cases

- $\cdot$  Otoscopes, rhinoscopes, and other types of
- medical endoscopes;
- Industrial endoscopes for nondestructive testing
   of medical equipment
- Robot assisted surgery
- AR/VR assisted diagnosis

#### Measurement and KPIs

- Field of view
- $\cdot$  Distortion
- · Lighting uniformity / shading
- Resolution / SFR
- SNR
- $\cdot$  Color rendering

- · DXOMARK Essential module
- Mini DOT chart
- Mini SFR chart
- $\cdot$  Mini ColorChecker chart

## 4.5. Automotive

Today's cars are more and more autonomous and need more cameras and displays to help us drive, or to drive for us, which is why testing image quality is now essential in the automotive sector. To define our dedicated automotive testing methodology, we at DXOMARK consider all different kinds of camera applications, along with their related imaging challenges.

Automotive cameras are used in vehicles to capture rear, front, road-facing, and side views; as an integral part of mirror replacement systems (CMS); and to provide in-cabin monitoring. They can be targeted to human viewers, or machine vision algorithms. Typical automotive scenes are challenging for cameras, as they can include LED flicker, night vision, moving objects, lens flare, very high dynamics, and so on. Automotive cameras include certain specificities to meet these challenging conditions — for example, a wide variety of fields of view (from fisheye cameras to very long range cameras thanks to orientable LED panels, software optimization, ...), and high dynamic range (HDR) sensors that can offer dynamics above 24 bits.

We have built an array of objective, laboratorybased measurements covering different lighting conditions and scenarios. As members of the IEEE P2020 standards committee, our experts have helped the industry match the needs of end-users; and our flare, flicker, and 170 dB dynamic range solutions have been used to define the metrics of the standard.

![](_page_39_Picture_5.jpeg)

## Use cases

- Front camera
- Surround view
- $\cdot$  Rear view
- In-cabin monitoring, RGB-IR sensors
- · CMS (replacement of mirrors)

## Measurement and KPIs

- IEEE P2020 Flare
- IEEE P2020 Noise
- IEEE P2020 Dynamic Range
- · IEEE P2020 SFR
- IEEE P2020 Flicker

- · Automotive essential module
- DR170dB setup
- Noise chart
- $\cdot$  Flare bench
- $\cdot$  Universal LED Timer
- Options:
  - Integrating sphere
  - Dot and SFR chart
  - P2020 SFR chart
  - MLS

## 4.6. Video Conference

Over the past few years, meetings have gone massively online. People are using smartphones, laptops, webcams on computers, and professional videoconference systems to share their voices and video images all around the world. The quality of the videoconference experience can be very different depending on the hardware used.

The places for a camera and microphones are very

limited in a laptop, even more than in a smartphone, and the result is sometimes a very poor quality video stream.

It is crucial to have the right tools to assess the image quality delivered by the video conference system camera. DXOMARK has developed some specific setups that allow users to quickly and accurately evaluate video quality for two use cases.

![](_page_40_Picture_5.jpeg)

#### Use cases

• One-person videoconference in various lighting situations

• Two-person videoconference in various lighting situations

## Measurement and KPIs

- $\cdot$  Face detail preservation
- $\cdot$  Noise level on face

• White balance accuracy and convergence (speed, overshoot, oscillation)

- Color accuracy during time
- Autoexposure convergence (speed, overshoot, oscillation)
- Shutter time and frame rate

- Single Person Videocall
- Options:
  - DXOMARK Chart
  - MLS
  - Realistic mannequins Diana and Sienna

# 5.Examples of Setups & solutions

![](_page_42_Picture_0.jpeg)

## 5.1. HDR Autofocus motion and timing

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Analyzer lets you characterize your camera's autofocus effectiveness with the greatest depth and precision. Using this setup, your device's autofocus capability can be challenged by HDR lighting, shaking, and background moving objects.

This module includes such essential hardware as moving objects, dead leaves charts, and LED timer box, along with software for performing a suite of timing and autofocus performance tests for digital cameras. You can analyze autofocus performance (sharpness, speed, repeatability), electronic rolling shutter (ERS), exposure time, vertical blanking, frame rate, missing frames, and both positive and negative time lags such as shooting time lag and shutter release time lag. Further, you use can perform multiple measurements using the same image or video, along with HDR measurements using the composite chart slide on light panels with a LED lighting system.

In addition, our software can compute objective metrics for motion blur evaluation using the background moving chart. All the laboratory instruments can be computer controlled to automate the following condition changes : lighting conditions, objects movement speed, HDR slides light levels, Led Timer configuration, etc.

You can perform all of these evaluations in various simulated conditions, such as handheld shooting, using our stabilization platforms.

![](_page_43_Picture_7.jpeg)

#### Key metrics:

- Autofocus speed
- Motion blur and equivalent exposure time
- Autofocus accuracy
- Autofocus repeatability
- Repeatability
- Visual noise
- Texture preservation
- · Electronic rolling shutter characterization
- Frame rate
- Missing frames
- Vertical blanking
- Exposure time
- Shutter release
- Shooting time lags
- · Entropy and dynamic range metrics

#### **Required components:**

- Dead leaves chart: TU0003 78 P
- LED Universal Timer: LED\_TIMER\_FL01
- Digital trigger with touchscreen probe: TRIGGER\_D2
- Composite charts : 2x CT002

- · Led panels : 2x GEMINI\_002
- Stabilization Platform H860: HEXAPOD\_H860
- Automated Moving Object: AMO\_004R
- Multispectral Lighting System: MLS\_SUNIR\_001
- Spectrum regulation setup: SPECTRUM\_SETUP
- Lighting autoregulation setup: LIGHTING\_SETUP

#### **Recommended accessories:**

- White background paper: PAPER\_BD\_129
- Paper background system: PAPER\_BACK\_SYS
- Device holder: DEVICE\_HOLDER\_H860
- Newport working station: NEWPORT\_STA\_H860
- Dead leaves chart frame: TF0003\_78
- · Dead leaves easel: EASEL\_0003\_MK2
- DMX controller for Led panels: DMX\_CELEB250
- Easel support for Led panels: AF\_HDR\_KIT
- MLS stand: MLS\_SUPPORT

#### Standards:

• ISO 12233, ISO 15781, ISO/TS 20490, IEEE CPIQ P1858, DXOMARK Camera V5

## 5.2. HDR Portrait

![](_page_44_Picture_1.jpeg)

## 🚵 🖻 🗠 🛛 🗟 🛄

This setup enables assessment of the balance between face and background rendering in terms of exposure, face detail preservation in various ambient exposure and dynamic range conditions. The provided software also enables native comparison between device screen preview and final capture image.

## Components:

- Realistic mannequin : REALMAN\_001
- Composite chart : CT002
- Led panel: GEMINI\_002
- Software comparison tool

## Recommended accessories and lighting:

- White background paper: PAPER\_BD\_129
- Paper background system: PAPER\_BACK\_SYS
- Device holder: DEVICE\_HOLDER\_H860
- $\cdot$  Newport working station: NEWPORT\_STA\_H860
- Spectrum regulation setup: SPECTRUM\_SETUP
- $\cdot$  Lighting autoregulation setup: LIGHTING\_SETUP
- Stabilization Platform H860 (HEXAPOD\_H860)
- Automated Moving Object (AMO\_004R)
- Multispectral Lighting System (MLS\_001 & MLS\_ SUNIR\_001)

## Key metrics:

- $\cdot$  Entropy to evaluate the clipping in hight tones
- Contrast preservation (Local Contrast Indicator)
- $\cdot$  Exposure of the face
- $\cdot$  Perceptual facial detail preservation robust to noise and sharpening

## Standards:

• DXOMARK Camera V5

## 5.3. HDR Tone mapping

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This setup is composed of two Litepanels Gemini 2xl Soft with their Composite charts. The Composite chart contains three main patterns — greyscale, 24-color matrix, and dead leaves. The setup lets you verify your camera's ability to consistently reproduce colors, manage noise, and preserve contrast and texture in comparison with an objective reference. Using recommended lighting, you can simulate a dynamic range of up to 15 EV in the test scene.

![](_page_45_Picture_4.jpeg)

#### Key metrics:

- Tone mapping
- Dynamic and tonal range
- Signal-to-noise ratio
- Artifact analysis: texture loss, moiré, aliasing, color shift
- Texture MTF and acutance
- Edge MTF and acutance
- Visual noise at 50%
- Exposure (grey level at 18%)
- Histogram
- Entropy for each channel
- Color fidelity
- White balance
- · Metrics:  $\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$ ,  $\Delta ab^*$ ,  $\Delta E$ ,  $\Delta C$ ,  $\Delta H$

#### Components:

- Composite charts : 2x CT002
- Led panels : 2x GEMINI\_002

#### **Recommended accessories:**

- DMX controller for Led panels: DMX\_CELEB250
- Easel for led panels: EASEL\_0004

## Standards:

• ISO 17321-1

## 5.4. MTF at infinity and flare evaluation Bench

![](_page_46_Picture_1.jpeg)

## (고) 🔂 🖻 👗 💿 🛒 쇼 🛛 🗣 🏵 🗖

The Flare Bench is a measurement setup that can generate sun-like flare images in a lab setup. The compact, automated, and easy to move table-top setup incorporates a bright light source, close in apparent size and color temperature to the sun. Analyzer measures flare intensity by processing RAW images taken by the device under test.

With a motorized rotation capacity of the source from -130° to +130° and a manual rotation capacity of the camera from 0° to 360° on two axes, you can measure flare from all possible angles with a precision of up to 2 arcmin. The MTF collimator is a versatile piece of equipment designed to be compatible with a wide range of cameras and lenses. Equipped with our collimator, the COMPASS bench can be used to measure MTF at infinity.

With a motorized rotation capacity of the source from -160° to +160° and a manual rotation capacity of the camera from 0° to 360° on two axes, this add-on allows you to perform measurements over the entire field of view, with a precision up to 2 arcmin.

## Collimated Flare Sources:

- Visible >10k lux (Flare\_Source\_001)
- NIR 940 nm >40 W/m2 (Flare\_IR94\_001)
- NIR 850 nm >20 W/m2 (Flare\_IR85\_001)

## Collimators:

- MTF collimator f50 mm (COL50\_001)
- MTF collimator f100 mm (COL100\_001)

#### Components:

Motorized goniometer platform: COMPASS\_001

## Recommended accessories:

- Luxmeter: GOSSEN\_5032B
- NIR Spectrometer: SPECTRUM\_SETUP

## Standards:

· IEEE P2020, ISO 12233

![](_page_46_Picture_21.jpeg)

Flare Evaluation Bench

![](_page_46_Picture_23.jpeg)

Click or scan

![](_page_47_Picture_0.jpeg)

## 5.5. Flickering mitigation and timing

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Handling flicker is a serious challenge that camera manufacturers face. This challenge is even more crucial for the automotive camera industry, where flickering can lead to severe consequences. The Analyzer Flicker module is a test setup ideal for performing flicker measurements based on upcoming IEEE / P2020 standards. The module contains the LED Universal Timer Mark II, which has software support and updated hardware for 5 rows of LED lights that can be programmed

#### Key metrics:

- Flicker detection index
- Flicker modulation index
- MMP (modulation mitigation probability)
- · Electronic rolling shutter characterization
- Frame rate
- Missing frames
- Vertical blanking
- $\cdot$  Exposure time

to perform 5 tests simultaneously, allowing for automation and improved efficiency. Tests measure camera sensitivity to LED flicker, which is essential to automotive cameras that need to accurately ascertain and compensate for flickering.

The software suite provided with this setup offers a unique and proven efficient workflow for flickering evaluation. The software allows to test a high number of flickering conditions, including frequency, duty cycle, light intensity, and phase within a short amount of time.

#### **Reference:**

• LED Universal Timer (LED\_TIMER\_FL01)

#### Accessories:

• Multispectral Lighting System (MLS\_001 & MLS\_ SUNIR\_001)

#### Standards:

· IEEE P2020, ISO 15781

![](_page_47_Picture_22.jpeg)

Click or scan

## 5.6. 170dB Dynamic range

## 

The image sensor sector is booming, especially in new markets such as autonomous cars. Such applications require increased performance for example, handling very high dynamic range. However, obtaining repeatable and rigorous measurements of these new capabilities is very complex.

We at DXOMARK follow these improvements by participating on scientific committees such as IEEE and ISO. In close collaboration with the industry and with the IEEE P2020 committee, we have developed a dynamic range measurement setup that can measure 150 dB or higher in one frame, thus meeting the requirement of the standard.

Our setup consists of 4 light panels whose intensity and spectrum can be controlled separately. The 170dB dynamic range setup can support wide angle fish-eye camera thanks to the orientable LED panels. Highquality test patterns complement the light panels and allow for high-precision measurements. The brightest panel can reach 1.5 million cd/m<sup>2</sup>, saturating all sensors currently on the market.

## Key metrics:

- Observed & real relative luminance
- Contrast-to-noise ratio (CNR)
- Tonal contrast gain (TCG)
- Contrast dynamic range (CDR)

## General specifications:

- Size: 1200 x 1200 x 800 mm
- Power supply: 100–240 V, 50–60Hz
- Total maximum power: 1800 W

## Technical specifications:

- · 4 separated light panels
- Dynamic range: 0.002 to 1 500 000 cd/m2
- Max luminance: adjustable between 40 000 cd/m2
- and 1 500 000 cd/m2
- CCT: 5600 K
- ·CRI>95

## Key features:

- Up to 177 dB
- Flicker-free (DC-driven)
- Computer control (DMX or Arnet)
- $\cdot$  Full automatic measurements
- $\cdot$  Support for RAW/RGB images up to 32 bits/pixels

## Components:

- $\cdot$  DR testing bench including charts, lightings, and easel: DRP2020\_001
- Standards:

• IEEE P2020

![](_page_48_Picture_31.jpeg)

## 5.7. Camera hardware evaluation

## 

Selecting the right components plays an important role in the ultimate performance of a camera module. DXOMARK RAW is a new standard for camera modules that can help component makers design better parts and can help phone and other imaging device manufacturers select better modules for their products. The test protocol is based on objective measurements of sensor, lens, and module sensitivity on RAW data. This new addition to the Analyzer testing suite contains a dedicated testing setup and RAW scripts that generate an overall score for module performance, as well as a detailed report containing test data for various attributes of image quality.

ISO standards ensure good communication between OEMs and suppliers. Until now, however, no report has gathered objective metrics and reflected the entire hardware performance with one single scalar metric. The new DXOMARK RAW standard allows a comprehensive comparison of camera modules, is based on hardware specifications (focal length of optics, sensor size, etc.) and on objective measurements (distortion, luminance, color shading, etc.).The better the imaging hardware, the better the final processed image and the less effort needed for ISP. Tradeoffs between IQ attributes define the limits of the ISP — for example, noise versus detail. DXOMARK provides the lab tools, the software, and the protocol automation to allow you to automatically compute the DXOMARK RAW score and generate a full and comprehensive report. We can also provide a wide range of services such as benchmarks, full test reports, and training sessions. DXOMARK RAW provides a single-score system for camera hardware evaluation based on RAW images.

#### **Key metrics:**

- Color depth
- Dynamic range
- Low-light ISO
- Aperture
- •SNR10
- Distortion
- · Lateral chromatic aberration
- Vignetting
- Color lens shading
- Best sharpness
- Sharpness in the field
- Flare

![](_page_50_Picture_0.jpeg)

![](_page_51_Picture_0.jpeg)

## 5.8. Stereovision camera

## (주)) 👗 와 🔂 🔂 🖻 💿

Analyzer's Dual Camera & 3D module help you calibrate the intrinsic and extrinsic parameters for a variety of setups that use an array of imagers or a pair of cameras to provide a 3D view of the world or a depth map for advanced gesture-based user interfaces.

Our 3D Bench integrated solution includes essential hardware and software for analyzing stereoscopic devices and camera arrays. Thanks to the very accurate glass chart associated with a mechanical setup for controlling camera movement, you can perform all these measurements and achieve highprecision results with just two shots of the target, thus allowing you to calibrate the intrinsic and extrinsic parameters quickly and easily.

## Key metrics:

## $\cdot$ Camera pose

- $\cdot$  Distortion curves
- Focal points & focal lengths

## Measurement descriptions:

## Intrinsic calibration

Intrinsic calibration measures the geometrical distortion of the lens, but it also delivers the accuracy of the distortion profile. Several distortion models can be computed:

- OpenCV 5 parameters
- $\cdot$  OpenCV 12 parameters
- $\cdot$  Internal polynomial 14 degree XY

## **Extrinsic calibration**

The relative position and orientation of the two cameras are computed with very high accuracy using a minimal number of shoots. The result is a set of parameters compatible with the OpenCV stereovision model.

#### Components:

- Dot chart: DU0002\_120
- $\cdot$  3D Bench for camera and chart positioning with translation stage: 3D\_CAM\_BENCH
- Accessory kit for 3D bench: 3D\_CAM\_BENCH\_ACC

## **Recommended accessories:**

Multispectral Lighting System (MLS\_001 & MLS\_SUNIR\_001)

![](_page_52_Picture_23.jpeg)

Click or scan

## 5.9. DXOMARK Camera V5 setups

![](_page_53_Picture_1.jpeg)

## 

Our Analyzer solution allows you to reproduce all our lab tests in your own laboratory. Further, we offer a unique solution of protocol automation that allows you to automatically reproduce the totality of the shots and obtain all the measurements as stipulated in our Camera v5 protocol. Our software suite automatically detects areas of interest on charts and setups, and then processes all objective and Albased measurements. To optimize measurement repeatability, we calibrate and test each chart and every piece of equipment before shipping them from our facilities in Paris.

The necessary tools for perceptual analysis, such as our famous DXOMARK chart, are also available and we can provide training in perceptual evaluation to help you perform your own assessments. As for testing using natural scenes, we can help you create your own shooting plan accompanied by image quality metrics in line with our protocol.

## Starter kit

· Analyze basic image quality attributes based on objective and perceptual measurements.

#### HDR Portrait

Analyze portrait rendering performance in various HDR conditions.

#### HDR Autofocus, Motion & Timing

· Analyze combined autofocus, timing, HDR, and motion blur performance in a single setup.

#### Bokeh setup

· Analyze bokeh rendering in a repeatable and consistent way.

## 5.10. Bokeh setup

## .

Evaluating the quality of a device's computational bokeh requires a lab setup that ensures accuracy and repeatability in your testing procedure. Our Bokeh setup contains a movable foreground apparatus mounted on a rail that you can adjust according to a device's FOV. You can use this setup to perceptually assess background and foreground blur, sharpness, artifacts, and detail preservation.

![](_page_54_Picture_4.jpeg)

## Elements:

- Background
- Head
- Easel
- Chart
- Lights

## Dimensions:

- •2700 x 4000 mm
- 490 x 385 x 200 mm
- 1600 x 1050 x 520 mm
- •1050 x 630 mm
- 310 x 80 x 80 mm

## Materials:

- Printed fabric, aluminum
- · Dibond, plastic, rubber, aluminum
- · Aluminum, laminated Resin impregnated
- Dibond
- $\cdot$  Plastic case, 2 LED lights

## **Reference:**

· BOKEH\_001

## Standards:

· DXOMARK\_Camera\_V5

## 5.11. Single Person Videocall

The Single Person Videocall setup simulates a real use case of a person interacting in a video conference call, and lets efficiently you test face exposure, color, and timing in multiple static and dynamic lighting conditions.

The setup can also be equipped with additional audio speakers for assessing the device's audio quality in office conditions (voice + background noise).

Additional compatible options include a second realistic mannequin (Deep or Asian), REALMAN\_002\_1 or REALMAN\_003; Transmissive bright chart (CT002); and perceptual evaluation tools & training. We recommend using the Multispectral Lighting System MLS\_001 for complete automation of the system.

## Materials:

- Realistic mannequin: REALMAN\_001
- ColorChecker: X-RITE\_COLOR\_CHART and FRAME\_CC002
- LED Universal Timer: LED\_TIMER\_FL01

## Key features:

- Automated testing in both static and dynamic conditions
- Compatibility with DXOMARK laptop & computing protocols

## Key metrics:

- · Chart & face exposure: static + dynamic
- (convergence, overshoot, oscillation)
- · Color accuracy (convergence, overshoot, oscillation)
- · White balance (convergence, overshoot, oscillation)
- Shutter time & latency

![](_page_55_Picture_17.jpeg)

![](_page_56_Picture_0.jpeg)

![](_page_57_Picture_0.jpeg)

# 6.Services & support

Analyzer is the leading provider of turnkey image quality assessment laboratory solutions, with a wide range of services and support to cover all customers' needs. Full support includes the camera lab installation, setup, training and technical support. We also offer measurement services in our certified laboratories around the world as well as individualized test solutions for hardware and software to meet the unique challenges of each customer.

#### Support for Analyzer includes:

#### Installation

DXOMARK engineers and technicians are available for the complete on-site installation of your laboratory, from overall layout planning to the customization and set up of lighting, placement markers, framing structure, and chart mounting.

#### Training

DXOMARK's scientists, engineers and technicians will help you obtain a perfect understanding of your new lab and software environment. As image quality experts, they can offer you in-depth training on both objective and perceptual image quality evaluation. They will also provide on-site or remote training and guidance on every aspect of Analyzer from its hardware to its imaging-software suite.

#### Support

DXOMARK client support is always available for any technical and software issue you might experience using Analyzer. Our team will provide you with tips and advice about the measurements and results you share with us. Our support team will respond to any query within 48 hours.

All Analyzer hardware equipment is fully guaranteed for 12 months after the purchase, and spare parts are available for several years after the purchase. In addition, software updates are included.

#### Optimized Analyzer Development/ Consulting

**Custom development:** Analyzer's engineers have a full understanding of the workings and limitations of all kinds of imaging systems. For more than 20 years, Analyzer's engineers have been successfully developing test solutions for various applications on devices such as computervision cameras, DSLRs, smartphones,

drones, autonomous driving cameras and others. They are ready to answer questions and build new setups and measurements to address their customers' unique requirements, either through co-funded projects or customized developments. They will work with you to define your specific targets to improve your product and its user experience.

**Measurement services:** If the extensive range of established Analyzer tests is not the best solution for your product, the Analyzer team also offers individualized measurement testing services, which can include a full evaluation report and debrief session with our experts. Analyzer will evaluate only what you need tested, and test reports will be fully adjusted to reflect the defined key performance indicators of the camera modules.

## Test like DXOMARK at your own facility:

In collaboration with DXOMARK's protocoltesting score teams, Analyzer engineers will certify laboratories so that you can reproduce DXOMARK's in-house protocols. This certification program is a joint product of DXOMARK's two activities, namely the provision of test and measurement solutions and the establishment of complete test protocols.

To ensure the uniformity of results obtained by DXOMARK laboratories around the world, these services include detailed training on the correct calibration of each set up that uses reference devices and training on photo-taking techniques.

Automated laboratory setups: Analyzer's automated laboratories are modular solutions, allowing them to be custom assembled in a variety of ways. To improve the use and efficiency of these labs, we propose the use of our Python API, which allows each piece of equipment to be automatically controlled from a remote computer using a script.

However, we can also assist in designing a fully automated multi-modular laboratory that will control all aspects of testing, including changing the device under test, setups (test patterns or set of elements), lighting conditions, etc. This particular option is done in conjunction with DXOMARK's authorized partners, who are familiar with our labs and testing methodology.

# 7.Contacts

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![](_page_58_Picture_11.jpeg)

## DXOMARK