

# DMS Series

Goniometer systems for display characterization



We bring quality to light.

# 01 \ DMS series – designed for the perfection of displays



Fig. 1: The diffusing hemisphere is a valuable DMS-accessory for contrast measurement of reflective displays

The DMS series is recognized as a worldwide standard and reference for extensive analyses of electro-optical displays, related materials and components at every stage of the engineering and production process. It consists of four individual goniophotometric systems, varying in size and function.

All DMS systems enable:

- ▲ Measurement of luminance, contrast and chromaticity under different display driving states and viewing directions
- ▲ Determination of flicker and response time
- ▲ Qualification of environmental impacts as ambient illumination and temperatures

The first DMS test units were designed in the 1980s by Autronic GmbH, a spin-off of the Karlsruhe University. The company was responding to the urgent needs of the LCD industry for accurate characterization of LCD contrast variations for different viewing directions. Constantly catering for the demands of the display industry, the company not only promoted the vast development of LC displays to today's large area TV screens, but also triggered the global standardization of display measurement methods in international organizations.

In 2012, the intellectual property of the DMS series was acquired by Instrument Systems GmbH Munich.

The company is market leader for high-quality spectroradiometers and comprehensive light measurement solutions for the display and LED industry. As a highly respected member of various display associations and organizations such as CIE, IEC, ISO, SID, DFF, VESA and ICDM we are actively involved in the design of standards, new methods and metrological fundamentals.

Instrument Systems is continuously improving the performance of DMS goniometer systems, including comprehensive software features and advanced accessories to answer technological challenges in display-related research and quality inspection labs all over the world.

# 02 \ \ Diverse customers, various measurement challenges

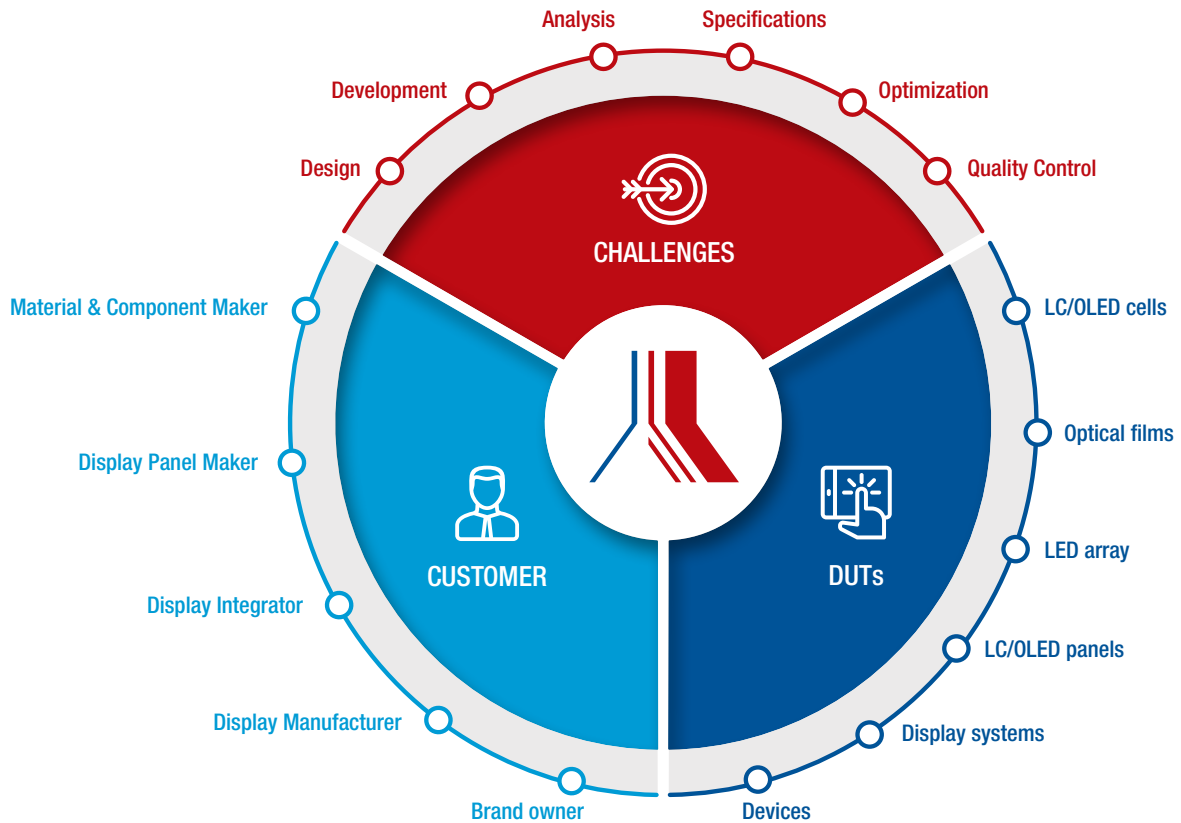


Fig. 2: Applications in the display industry

The versatility of the DMS series is mirrored in the diversity of our customers. Instrument Systems has always the perfect system – for all kinds of DUTs and measurement challenges such as product specification, optimization or quality control.

**Material, component and display panel manufacturers** analyze single LC cells, optical films, LED arrays or LC/OLED panels in different stages of their engineering and production process. They constantly improve display performance and assure the highest quality of the final device.

**Display panel makers and integrators** test the quality of display modules according to industry-specific requirements,

e.g. for the consumer, automotive, military or medical sector. They demand highly automated and comprehensive display characterization tools in their quality control laboratories.

**Brand owners and display manufacturers** want to ensure the quality and constant improvement of the final device itself. They are challenged with measurement tasks over the whole product engineering and production process.

Due to its broad DMS portfolio, Instrument Systems is the leading solution provider for nearly every measurement challenge in the context of goniometric display characterization and testing:

- ▲ Design and optimization of illumination systems for area displays and development of correction filters
- ▲ Analysis of optical parameters as a function of the display and material temperature
- ▲ Analysis of the optical performance under various ambient illumination situations
- ▲ Definition and generation of display specification data as a basis for communication between supply chain, manufacturer, brand owner and end-user
- ▲ Automated quality control and display characterization
- ▲ Incoming and outgoing quality inspection (IQC / OQC) for components, materials, display modules and final devices

# 03 \ Functional principle of DMS systems

The instruments of the DMS series are designed to measure and qualify any electro-optical display under typical application situations representing complex human handling:

- ▲ Control of the viewing direction ( $\Phi$  axis,  $\theta$  axis)
- ▲ Control of the lateral measurement position (X, Y axis)
- ▲ Control of ambient illumination (illuminance level, geometry, spectral distribution, angle of incidence)
- ▲ Control of DUT temperature
- ▲ Control of displayed patterns or electrical driving parameters

In order to obtain accurate and repeatable measurement results, one parameter is varied while all others are kept constant.

The basis of the DMS system is a **high-precision goniometer**. It allows a full viewing direction scan by motorized azimuth-rotation  $\Phi$  and angle of inclination  $\theta$  (Fig. 3). Uniformity scans can be realized by controlling the lateral DUT position (X, Y).

The integrated **DUT driving unit** controls a variety of different samples: e.g. analog signals, source meters or display control interfaces.

A **microscope optic** enables reproducible selection of the measuring spot size. Two **light measurement devices** (LMD), a spectrometer and a photometer, are connected to the microscope via optical fiber. Both are absolutely calibrated.

The spectrometer evaluates the spectral power distribution, from which the CIE tristimulus values and all photometric values are obtained. The photometer measures fast temporal changes in luminance e.g. response time and flicker.

An optional LumiTop spectrally enhanced imaging colorimeter is available for 2D angular resolved measurements.

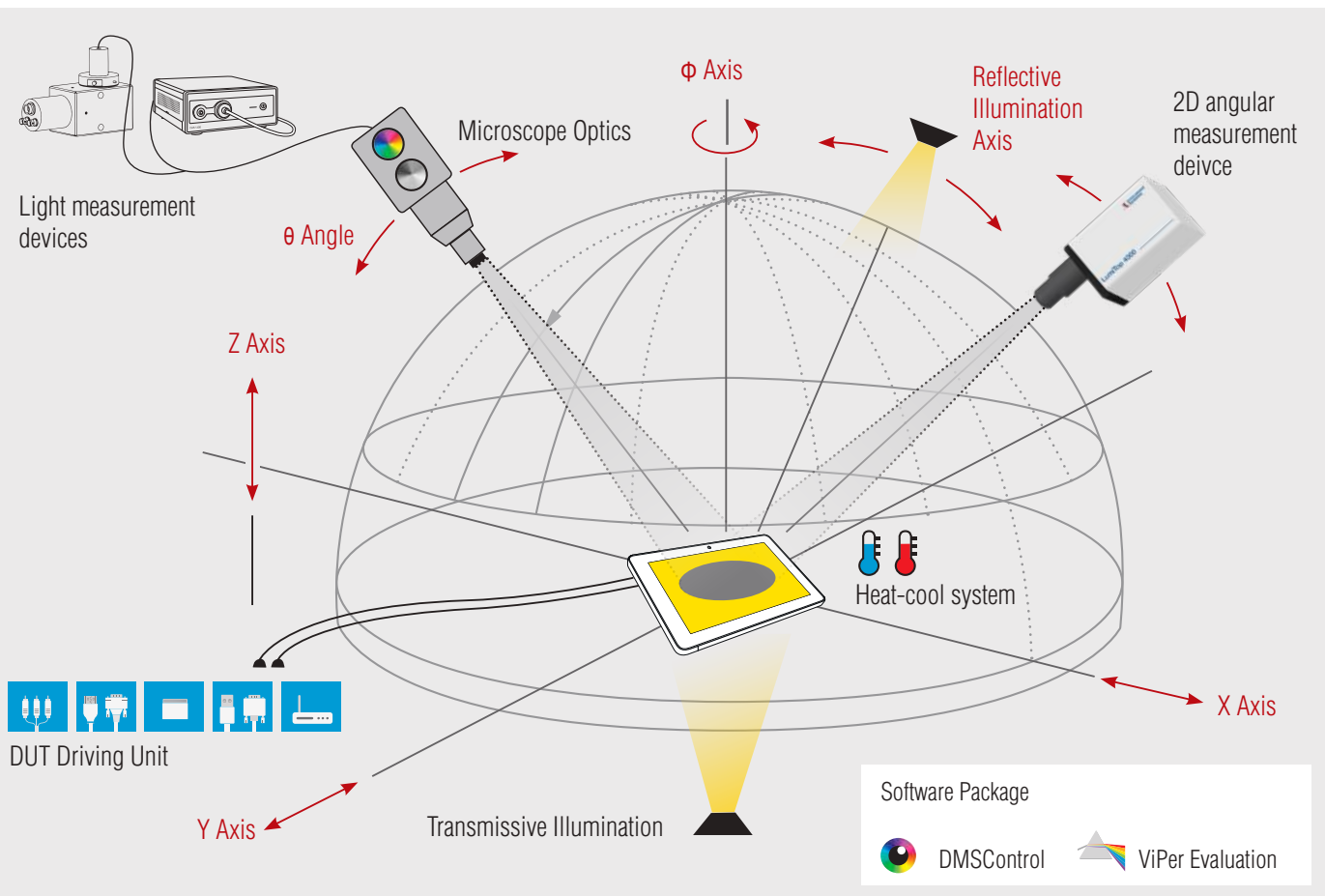


Fig. 3: Display measurement with the DMS systems: Angular characterization of luminance, contrast, chromaticity and related parameters

A **heat-cool system** may be integrated for temperature-dependent measurements and conformance testing as required e.g. for automotive standards.

Different **illumination devices** simulate the disturbing impact of ambient light on displays. A transmissive light source can

be used to qualify passive LC components or polarizer films.

A comprehensive **software package** (DMSControl/ViPer Evaluation) controls automated measurement procedures and generates comprehensive result reports.

### Note:

Each DMS basic system can easily embed customized solutions such as fixtures, additional optics or specific driving devices. Due to this unrivaled flexibility and our broad experience with customer-specific modifications, every DMS system will fit exactly our customers' needs!

## 04 \\ The DMS goniometers

Whether you want to measure small smart watch displays or large TV screens – Instrument Systems has the solution!

Our 5 goniometers DMS 904, DMS 903, DMS 803, DMS 505 and DMS 201 provide 2–7 axes for a

manual respectively fully motorized DUT positioning. A great variety of accessories is available for detailed analysis of the electro-optical and colorimetric characteristics of displays under various environmental and illumination conditions. All our solutions can be configured to

run VESA, ICDM, SAE, TCO, ISO, and other standardized display measurement tests. This makes the systems of the DMS series perfectly suitable for all desired applications in research and development, as well as quality inspection.



### DMS 903 – Large

- ▲ Maximum grade of automation for medium to large sized samples
- ▲ 6 motorized axes for automated measurements
- ▲ Motorized microscope aperture wheel and integrated view finder camera
- ▲ Multiple accessories to test DUT under ambient illumination and different temperatures



### DMS 803 – Reference

- ▲ Maximum versatility for small to medium sized samples
- ▲ 6 motorized axes for automated measurements
- ▲ Multiple accessories to test DUT under ambient illumination and different temperatures



### DMS 201 – Manual

- ▲ 3 manual axes for angular positioning and adjustment
- ▲ Budgetary solution with optional illumination and temperature control accessories

NEW

### DMS 904 – Extra large and variable

- ▲ 7 motorized axes
- ▲ For large and/or curved displays
- ▲ New heat-cool system

### DMS 505 – Cost-efficient

- ▲ Very flexible system for small to medium sized samples
- ▲ 3 motorized axes, 3 manual axes
- ▲ Multiple accessories to test DUT under ambient illumination and different temperatures

## Overview of the DMS basic systems

Component/Feature	DMS 201	DMS 505	DMS 803	DMS 903	DMS 904
<b>Mechanics</b>					
Axis motorized	-	Theta, Phi, Z	Theta, Phi, Z, X, Y, Refl. Illum.	Theta, Phi, Z, X, Y, Refl. Illum.	Theta, Phi, Z, X, Y, Refl. Illum., X+
Axis manual	Theta, Z, Refl. Illum.	X, Y, Refl. Illum.	-	-	-
Microscope spot selection	manual	manual	manual	motorized (SW selectable)	motorized (SW selectable)
Light shielding box	-	●	●	●	●
<b>DUT dimensions</b>					
Max. diagonal	600 mm (23")	600 mm (23")	600 mm (23")	1600 mm x 1300 mm (81")	1800 mm x 1200 mm (85")
Max. diagonal for motorized x-y scanning	-	-	459 mm (18")	1000 mm x 800 mm (50")	1200 mm x 700 mm (54")
Orientation of DUT surface	horizontal	horizontal	horizontal	horizontal	horizontal
<b>LMDs</b>					
CAS 140D - Spectroradiometer	●	●	●	●	●
PMT - Fast photometer	●	●	●	●	●
LumiTop 4000	-	●	●	-	-
<b>Temperature control</b>					
HCS - Heat-cool system	●	●	●	●	●
<b>Illumination</b>					
Diffuse transmissive	●	●	●	●	●
Diffuse reflective - DHS	●	●	●	●	●
Diffuse reflective - SDR	●	● <sup>1)</sup>	●	-	-
Diffuse reflective - VADIS	●	●	●	●	●
Directional reflective - PID	●	●	●	●	●
Directional reflective - PLS	●	●	●	●	●
<b>DUT driving and electrical measurement</b>					
Arbitrary signal generator	●	●	●	●	●
Keithley 2400 sourcemeter	●	●	●	●	●
External Pattern and Video Generators	●	●	●	●	●
Customer specific DUT driving	●	●	●	●	●
<b>Options</b>					
SCAN 300 X-Y scanning range extension	●	●	●	-	-
<b>Software</b>					
DMSControl	●	●	●	●	●
ViPer	●	●	●	●	●
Report Generator	●	●	●	●	●
Advanced Device Control Interface (DCI)	●	●	●	●	●
DMS Octo	●	●	●	●	●

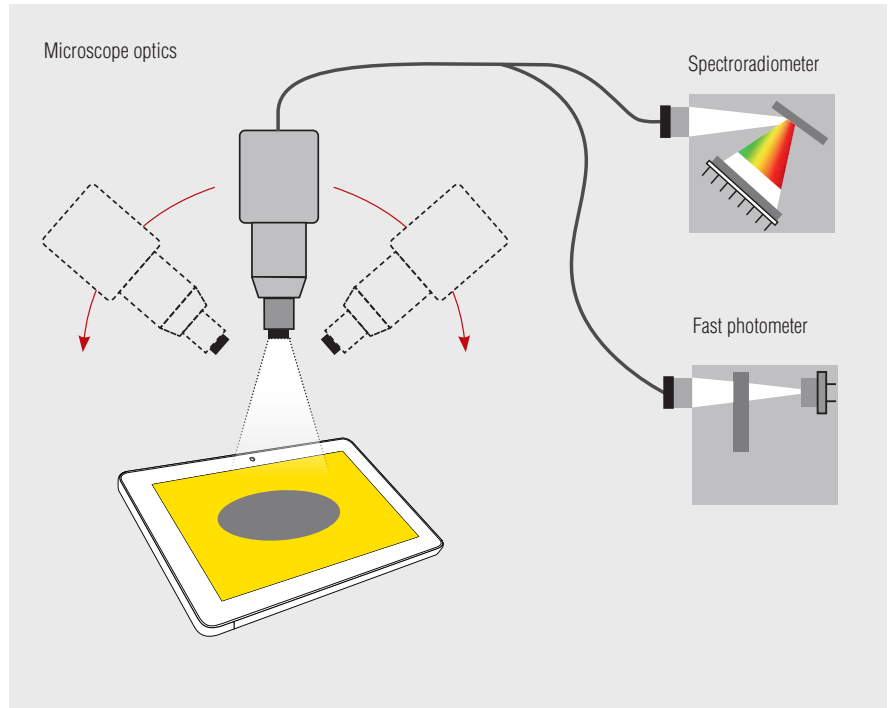
<sup>1)</sup> Limited thickness of DUT. Max. DUT thickness: 15 mm.

# 05 \\ Combined light measurement devices (LMD)

A key feature of the optical design of the DMS systems is that photometric parameters and spectral distributions can be determined within one measuring process. This concept allows measurement of multiple parameters within one system.

## Microscope optic

A spectrometer and photometer are connected via optical fiber to a microscope optic, which represents the human observer. The microscope features either a view finding camera or an eyepiece with magnification optics and integrated target crosshairs for accurate set-up and focusing on the DUT surface. It enables reproducible selection, either motorized or manual, of the measuring spot size. The spectrometer and photometer can run either stand-alone or in combination.



▲  
Fig. 4: Light path from display to measuring device

## Technical specifications

Microscope	DMS 201 / 505 / 803	DMS 903 / 904
Measurement spot sizes <sup>1)</sup>	0.5 mm, 1 mm, 3 mm, 8 mm	0.5 mm, 1 mm, 2 mm, 3 mm, 5 mm, 7 mm, 10 mm
Measurement spot selection	Manual	Motorized (SW selectable)
Observation of DUT	Eye piece	View finder camera
Theta inclination	0 – 90°	0 – 80°
Connection to LMD (Light measurement device)	Single optical fiber	Bifurcated optical fiber
LMD selection	Manual	SW selectable
Numerical aperture	0.038 <sup>2)</sup>	0.03 <sup>2)</sup>

<sup>1)</sup> Other spot sizes or configuration with integrated polarisation filters on request.

<sup>2)</sup> Depends on microscope aperture diameter. The aperture diameter is fixed and independent from measurement spot sizes.

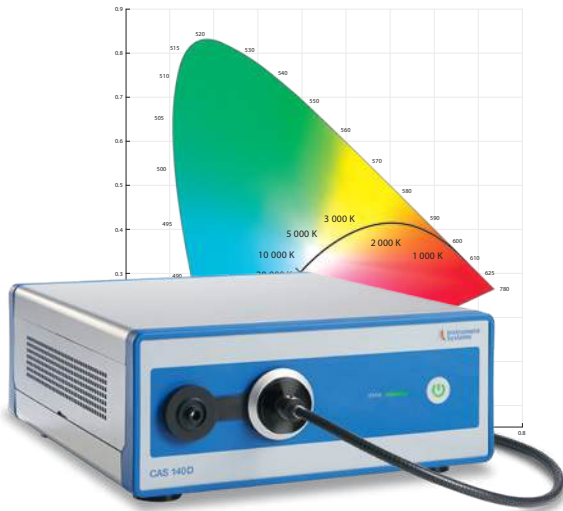


Fig. 5: CAS 140D – Reference spectroradiometer with highest color accuracy

## High-end spectroradiometer CAS 140D

The determination of all photometric and colorimetric quantities results from software calculation of the spectral measurement data. This is why the quality and precision of the spectroradiometer in action is extremely important. The CAS 140D, which is recommended for the DMS systems, combines highest measurement accuracy, reliability, and stability.

Its excellent technical specifications and high optical throughput make it an extremely versatile device for usage in reference laboratories as well as in production lines.

In particular the CAS 140D provides some essential attributes for display characterization:

- ▲ The optical design results in outstanding sensitivity and allows measurement of extremely small luminance values e.g. OLED.

The broad dynamic range of the instrument can easily measure low and high light intensities.

- ▲ The excellent stray light properties ensure accurate spectral measurement.
- ▲ Color accuracy of  $\pm 0.0015$  guaranteed by our DIN EN ISO 17025 accredited laboratories.

## Technical specifications

Spectroradiometer	VIS (CAS140D151U1A) <sup>1)</sup>					
Spectral range	360 – 830 nm					
Spectral resolution	2.2 nm <sup>2)</sup>					
Integration time	4 ms – 65 s					
Sensor dynamic range	37,000 : 1					
Non-Linearity	$\pm 0.5\%$					
Cooling	$-10^{\circ}\text{C}$					
Polarization sensitivity	$< 1\%$					
<b>Sensitivity</b>	<b>DMS 201/505/803</b>			<b>DMS 903/904</b>		
Measuring range luminance	0.0006 cd/m <sup>2</sup> – 1000 kcd/m <sup>2</sup>			0.002 cd/m <sup>2</sup> – 1000 kcd/m <sup>2</sup>		
<b>Accuracy and precision<sup>3)</sup></b>	<b>Luminance</b>		<b>Color coordinates (x,y)<sup>4)</sup></b>		<b>Dominant wavelength</b>	
<b>DMS model</b>	<b>201/505/803</b>	<b>903/904</b>	<b>201/505/803</b>	<b>903/904</b>	<b>201/505/803</b>	<b>903/904</b>
Instrumental precision (single system)	$\pm 0.1\%$	$\pm 0.1\%$	$\pm 0.0001$	$\pm 0.0001$	0.02 nm	0.02 nm
Accuracy	$\pm 3\%$	$\pm 3\%$	$\pm 0.0015$	$\pm 0.0015$	0.5 nm	0.5 nm
<b>Stray light</b>						
Broadband for Illuminant A radiation	$5 \times 10^{-4}$					
For LED	$1 \times 10^{-4}$					
Accredited calibration	DIN EN ISO / IEC 17025 / ISO 11664 in-house and on-site on request					

<sup>1)</sup> Other models on request.

<sup>2)</sup> Spectral range of DMS 803 is limited to 360-800 nm by DMS Software.

<sup>3)</sup> Minimum achievable, extended relative measuring uncertainty applied to a twofold standard deviation.

Only applies to the measuring and ambient conditions used for calibration (e.g. without density filter, optimum spectral range, sufficient signal level, etc.).

<sup>4)</sup> For white LEDs.



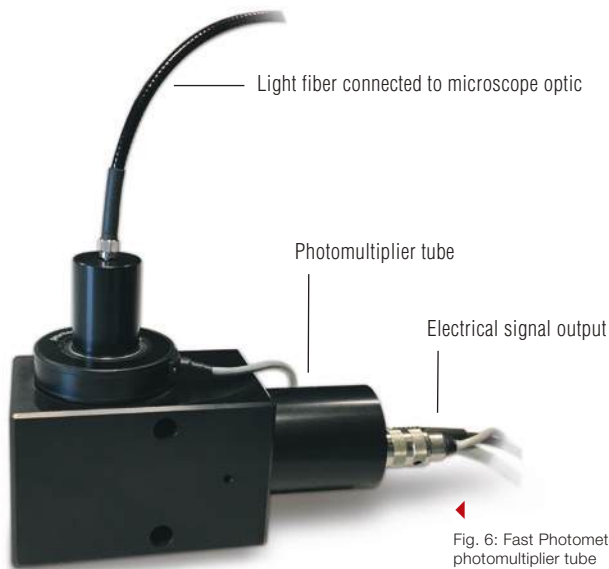


Fig. 6: Fast Photometer PMT 3 with photomultiplier tube

### Fast photometer PMT 3

High-quality displays need fast transitional periods to visualize moving images. Thus, rapid temporal changes in luminance have to be measured, necessitating an extremely fast-performing measurement device. The PMT 3, a fast photometer with photomultiplier tube, has been optimized for this application.

Due to its high sensitivity, the PMT 3 is also suited to light detection of very weak signals. Transfer and extremely fast switching characteristics e.g. of OLED cells or light artefacts as flicker can be measured in the microsecond range. Internal low pass filters allow disturbing frequencies to be cut off. Two photometer models are available with different bandwidths for LCD and OLED applications (100/500 kHz).

### Note:

The unique DMS design with a high-class spectroradiometer from our CAS series and a specially designed photometer, optimized for measuring extremely fast luminance changes, guarantees prompt, accurate and reliable measurement results that are, universally applicable for any display technology.

### Technical specifications

Fast photometer	PMT 3/100	PMT 3/500
Bandwidth	100 kHz	500 kHz
Rise time / Decay Time (10 – 90%)	4 $\mu$ s	750 ns
Min. sample period	0.5 $\mu$ s	0.5 $\mu$ s
Max. number of samples	31999	31999
Low-pass filter cutoff frequencies	None (=100 kHz), 30 kHz, 3 kHz, 300 Hz, 30 Hz, 10 Hz	None (=500 kHz), 100 kHz, 10k kHz, 1 kHz, 100 Hz, 10 Hz
Measuring range	0.025 cd/m <sup>2</sup> – 400 kcd/m <sup>2</sup>	
Analog-to-digital converter	12 bit AD converter, 2 MHz bandwidth	

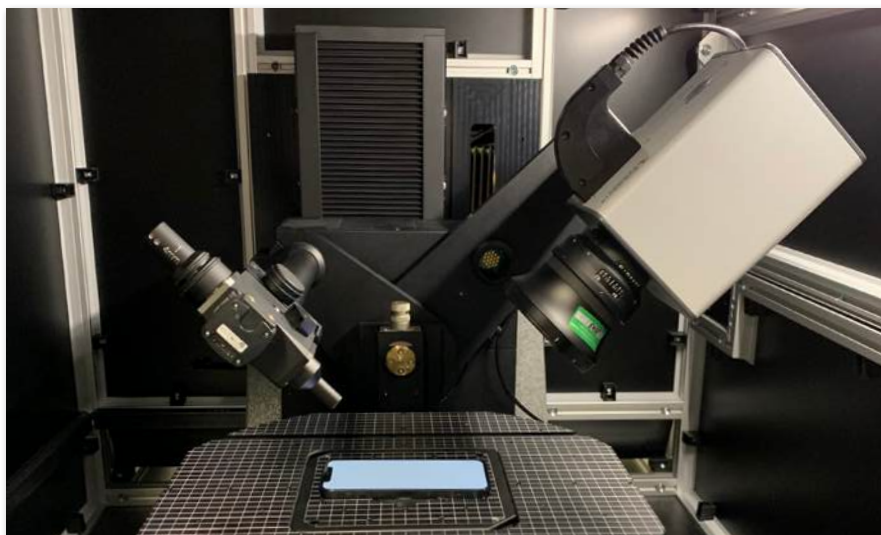
# 06 \\ DMS series customized for different applications

The DMS series is used in a wide range of applications. Each application has its own requirements, and needs different modification. If the application calls for highly accurate, repeatable angular measurements, the DMS series is the best choice.

The modular concept of the DMS series makes this special customization possible, saving time and effort.

The DMS 904 with extra big chamber and heat-cool system gives even more flexibility concerning DUT dimensions, e.g. for large curved automotive displays.

## Examples of customized solutions



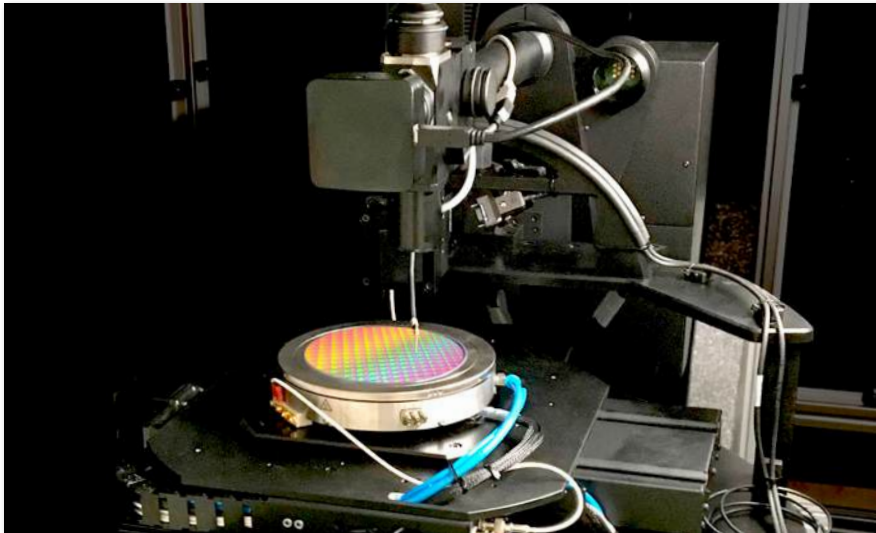
### 2D angular characteration with LumiTop imaging colorimeter

- ▲ Uniformity of color and luminance
- ▲ Diffraction of Ambient light
- ▲ Mura



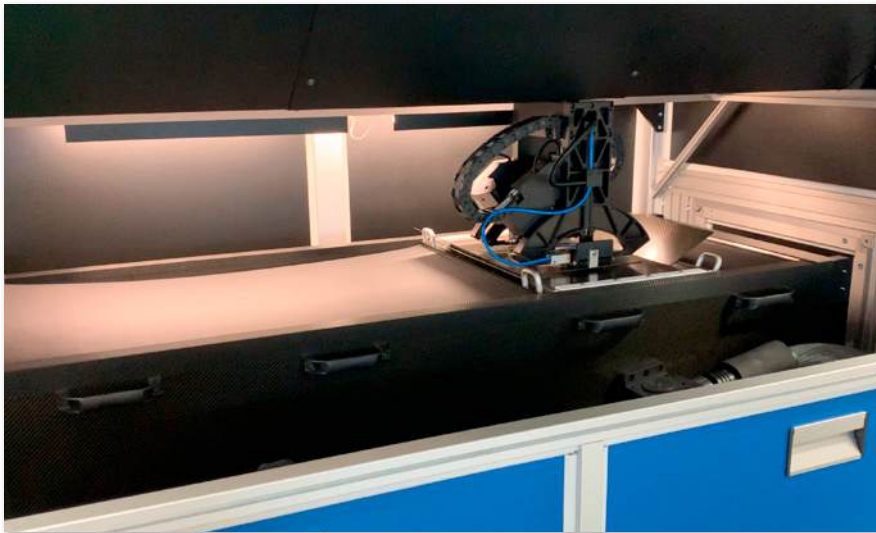
### AR/VR measurement

- ▲ Luminance
- ▲ Color
- ▲ MTF
- ▲ Eye box mapping at varying eye relief distances
- ▲ Gaze or FOV scan



### Wafer testing

- ▲ Angular distribution of luminous intensity
- ▲ Dominant wavelength shift
- ▲ NA adaption for high angular resolution
- ▲ Motorized probes for DUT driving
- ▲ Temperature controlled



### Large scale Automotive display testing (DMS 904)

- ▲ Additional motorized x-axis for curved displays
- ▲ Extra big chamber and heat-cool-system for large devices

**Our system experts will be pleased to provide competent advice on your particular application. Together we will find the right solution for your application.**



# 07 \\ HCS Heat-cool system

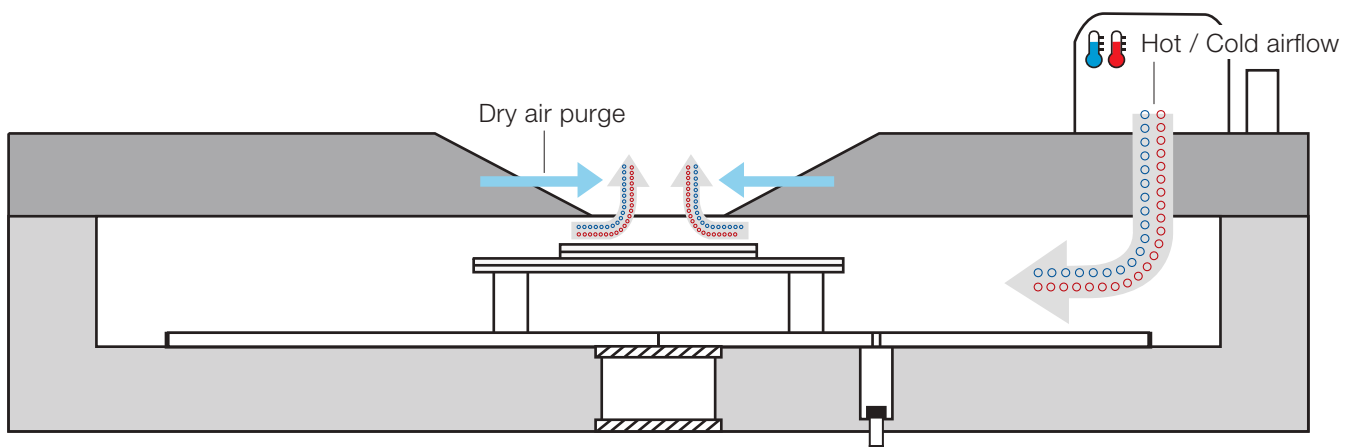


▲ Fig. 7: The heat-cool system HCS-6 exposes the DUT to temperatures from -40 °C to 105 °C.

Each DMS system can be extended with an appropriate heat-cool system to take temperature-dependent measurements of optical display properties and conformance testing. Since only the DUT is exposed to the airflow, the microscope, LMDs and goniometer remain constant at room temperature. Precise airflow control allows measurement of the test specimen at stabilized temperatures in the range -40 °C to +105 °C.

HCS systems can be complemented with the following accessories:

- ▲ Extension rings for testing different DUT heights
- ▲ Rotary stage for smaller LC test cells to measure up to 8 test cells within one temperature ramp (HCS-3B)
- ▲ Manual x, y, z stage for DUT height and position adaption,
- ▲ Internal motorized positioning stage with 15" travelling range (HCS-4)



▲ Fig. 8: Airflow inside the "HCS chamber"

## Technical specifications

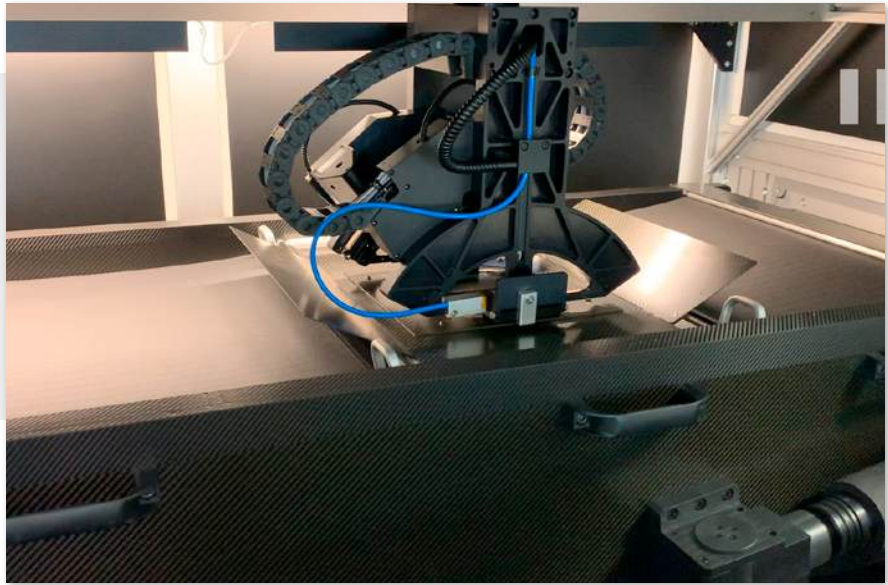
DMS model	DMS 803, DMS 505, DMS 201		
Heat-cool system	HCS-3	HCS-3B	HCS-6
Temperatures			
Temperature range	-35 °C to +85 °C	-40 °C to +105 °C	-40 °C to +105 °C
Temperature accuracy	±1 °C	±1 °C	±1 °C
Temperature resolution	0.1 °C	0.1 °C	0.1 °C
Typical transition time <sup>1)</sup>	Ambient to -35 °C: 30 min Ambient to +85 °C: 45 min	Ambient to -40 °C: 30 min Ambient to +100 °C: 45 min	Ambient to -40 °C: 30 min Ambient to +100 °C: 45 min
Dimensions			
Usable internal diameter	365 mm / 14"	370 mm / 14"	720 mm x 340 mm
Usable internal height	29 mm	41 mm max. 146 mm with extension	115 mm
Travel range			
Theta inclination	0° to 60°	0° to 60°	0° to 70°
Phi rotation	0° to 360°	0° to 360°	No phi rotation possible
X- and Y-axis of base mechanism	-5 mm to 5 mm	-5 mm to 5 mm	-5 mm to 5 mm
x- and y-axis of internal stage	-	-50 mm to 50 mm	-
z-axis of internal stage	-	16 mm	-
z-axis of base	-	-	-
Illumination			
Illumination options	Transmissive, DHS, VADIS, PLS	Transmissive, DHS, VADIS, PLS	-
DMS model	DMS 903		DMS 904
Heat-cool system	HCS-4	HCS-5	HCS-7
Temperatures			
Temperature range	-35 °C to +85 °C	-40 °C to +105 °C	-40 °C to +105 °C
Temperature accuracy	±1 °C	±1 °C	±1 °C
Temperature resolution	0.1 °C	0.1 °C	0.1 °C
Typical transition time <sup>1)</sup>	Ambient to -35 °C: 40 min Ambient to +85 °C: 80 min	Ambient to -40 °C: 50 min Ambient to +85 °C: 40 min	Ambient to -40 °C: 90 min Ambient to +105 °C: 90 min
Dimensions			
Usable internal dimensions	720 mm x 568 mm	1500 mm x 400 mm	1600 mm x 600 mm
Usable internal height	110 mm without xy-stage max. 180 mm with extension 70 mm with xy stage	150 mm	200 mm
Travel range			
Theta inclination	0° to 70°	0° to 70°	0° to 60°
Phi rotation	0° to 360°	0° to 360°	0° to 360°
X- and Y-axis of base mechanism	-5 mm to 5 mm	-2 mm to 2 mm	-350 mm to 350 mm (only X-axis)
x- and y-axis of internal stage	300 mm x-axis and 225 mm y-axis	-	-
z-axis of internal stage	-	-	-
z-axis of base	-	-	200 mm
Illumination			
Illumination options	DHS, PID, VADIS	PID, VADIS	PID, VADIS

<sup>1)</sup> For empty chamber.

## Extra large HCS-7

NEW

- ▲ Optimized for automotive curved display applications with DMS 904
- ▲ Enables x and z movement during temperature control
- ▲ Temperature range from -40 °C to +105 °C
- ▲ Extreme flexible travelling range



## 08 \\ SCAN 300 Scanning stage

The SCAN 300 x-y scanning stage is an optional accessory for use with DMS 803, DMS 505 and DMS 201. This motorized positioning stage extends the existing x-y travelling range of the basic mechanism to 300 x 300 mm, allowing full scans of displays up to 16". With the manual DMS 201 system it enables motorized positioning and automated scanning.

The SCAN 300 is integrated into the DMSControl software to maintain the usual comfort level of fully automated measurements of any type of display, optical components, back light units, etc.

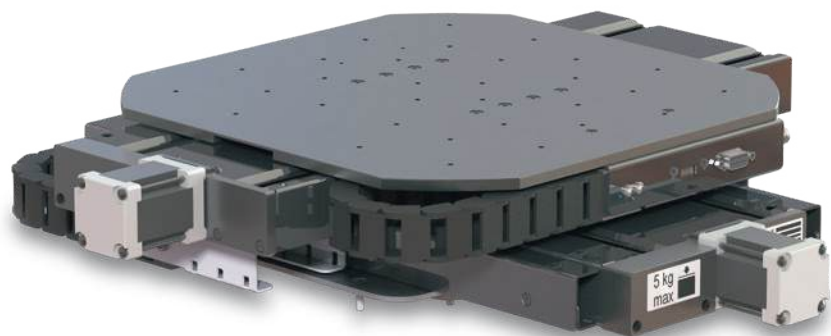
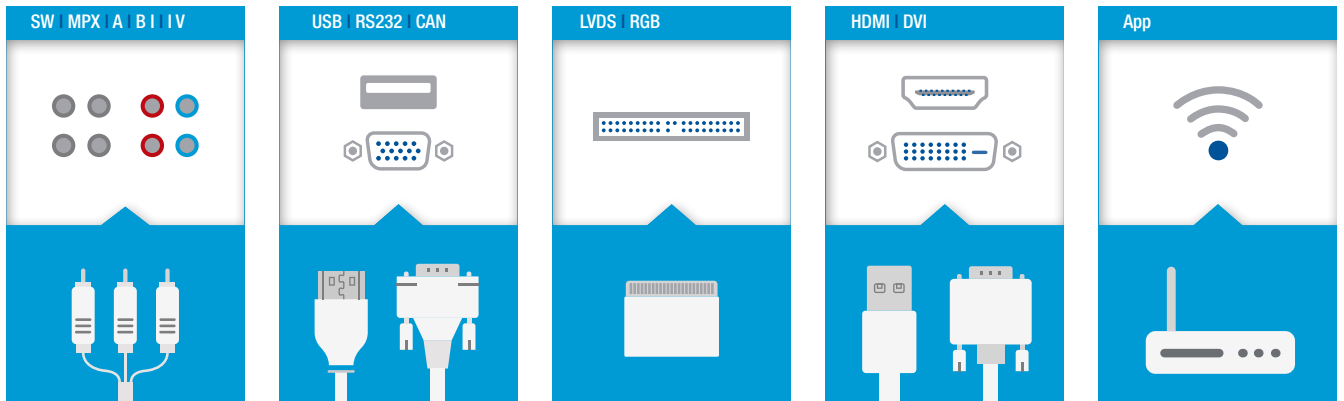


Fig. 9: The motorized SCAN 300 extends the field of measurement for displays up to 16"

# 09 \\ DUT driving unit



▲ Fig. 10: Schematic diagram showing the different DUT connections of the DMS driving unit

DMS systems include an efficient DUT driving unit. It is required for measuring an optical parameter (i.e. luminance) as a function of a driving condition (i.e. electrical driving parameter or test pattern) or in order to automate display testing procedures.

The driving unit is used for connecting and driving different devices and DUTs.

A variety of DUT connection types are compatible, e.g. analog signals, RJ45 Ethernet, RS232, USB, 230 V power connection or SUBMIN D9 customizable connectors.

For **LCD cells** the DMS systems provide an optional 1 to 4 channel arbitrary signal generator for analog standard signals (e.g. DC, square-wave, MPX-A/B, user defined signals).

For **display modules** the DMS systems offer an advanced display control software interface (DCI Advanced) that permits the integration of any customer specific driving equipment via standard interface.

For **standard signals such as HDMI, DVI**, the interface permits the integration of video driving units, pattern generators, source meters and other external hardware devices.



▲ Fig. 11: Generation of test and alignment patterns by connecting pattern and video generators through the native device control interface (DCI advanced)

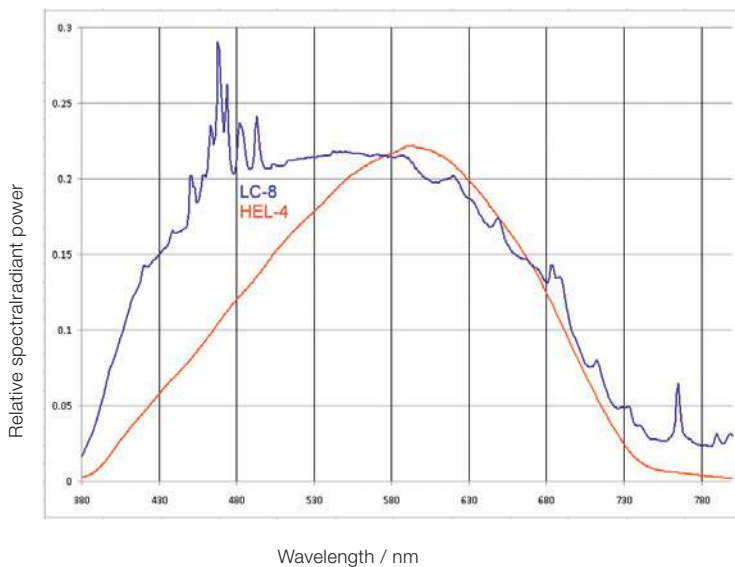
# 10 \\ Light sources and illumination devices

It is important to measure the effect of ambient illumination on displays under well-defined geometric conditions. Due to the open structure of DMS systems, a broad selection of different illumination devices can be easily integrated. A HEL-4 halogen light source and an LC8 xenon discharge lamp are optionally available (application example see Fig. 9).

Moreover, five additional illumination devices will cover all important display measurement applications (for details see overview on page 13). They deliver light from incandescent, discharge, luminescent and other sources. Directional illumination devices can be provided with additional adjustable polarizers (linear and circular, absorptive film and birefringent crystal types).

This unique flexibility makes our DMS systems the best choice for:

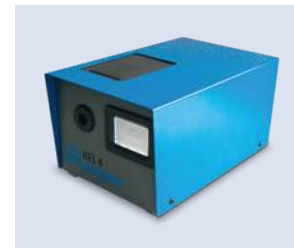
- ▲ systematic optimization of anti-glare treatments (e.g. scattering layers) and
- ▲ non-scattering anti-reflection measurements based on dielectric interference coatings and circular polarizers.



LC8



HEL-4



Source: Hamamatsu Photonics K.K.

Fig. 12: Typical spectral power distribution of HEL-4 (incandescent tungsten halogen lamp, red curve) and LC8 (xenon discharge lamp, blue curve) light sources

## Impact of ambient light on display performance

Displays are used under different ambient illumination conditions. Ambient illumination causes reflections on the display which have an impact on performance. Contrast and saturation may be reduced, fusion conflicts and glare effects can occur. For the observer, this may lead to a loss of perceptibility

of the displayed visual information but may also cause headaches. It is therefore important to qualify the display's performance under ambient illumination.

Equipment with high repeatability and stability is required for simulating different ambient light conditions. The set-up of light-source, detector and device under test must be standardized in order to generate

consistent measurement data. IEC 62341-6-2 ("Measuring methods of visual quality and ambient performance") provides detailed guidance.

The overview on page 13 shows in detail Instrument Systems light sources and illumination devices that allow complete characterization of display performance under various ambient illumination conditions.



## Overview of illumination devices for DMS series

Geometric Condition	Illumination Device & Application	
 <p>The diagram shows a Light Measurement Device (LMD) positioned above a sample surface. A light beam is directed downwards, creating a dark spot on the surface. The reflected light is captured by a detector, forming a semi-circular pattern of light rays.</p>	<p><b>DHS - Diffusing Hemisphere</b></p> <p>Measurement of contrast in reflective mode of operation</p>	 <p>A photograph showing the DHS setup in a laboratory environment. A microscope is mounted on a grid stage, with a diffusing hemisphere placed on the surface. The LMD is positioned above the hemisphere.</p>
 <p>The diagram shows a Light Measurement Device (LMD) positioned above a sample surface. A light beam is directed downwards, creating a dark spot on the surface. The reflected light is captured by a detector, forming a semi-circular pattern of light rays. A 'gloss-trap' is shown to prevent specular reflection from being captured. 'light input' is also indicated.</p>	<p><b>SDR – Integrating Sphere for Diffuse Reflectance</b></p> <p>Measurement of spectral reflectance and evaluation of display performance under ambient illumination</p>	 <p>A photograph showing the SDR setup in a laboratory environment. A microscope is mounted on a grid stage, with an integrating sphere placed on the surface. The LMD is positioned above the sphere.</p>
 <p>The diagram shows a Light Measurement Device (LMD) positioned above a sample surface. A light beam is directed downwards, creating a dark spot on the surface. The reflected light is captured by a detector, forming a semi-circular pattern of light rays. A 'Vadis' source is also shown.</p>	<p><b>VADIS - Variable Aperture Diffuse Source</b></p> <p>Measurement of surface scattering and evaluation of display performance under ambient illumination</p>	 <p>A photograph showing the VADIS setup in a laboratory environment. A microscope is mounted on a grid stage, with a variable aperture diffuse source placed on the surface. The LMD is positioned above the source.</p>
 <p>The diagram shows a Light Measurement Device (LMD) and a Parallel Illumination Device (PID) positioned above a sample surface. A light beam is directed downwards, creating a dark spot on the surface. The reflected light is captured by a detector, forming a semi-circular pattern of light rays.</p>	<p><b>PID – Parallel Illumination Device</b></p> <p>Measurement of BRDF (Bidirective Reflectance Distribution Function)</p>	 <p>A photograph showing the PID setup in a laboratory environment. A microscope is mounted on a grid stage, with a parallel illumination device placed on the surface. The LMD is positioned above the device.</p>
 <p>The diagram shows a Light Measurement Device (LMD) and a Point Light Source (PLS) positioned above a sample surface. A light beam is directed downwards, creating a dark spot on the surface. The reflected light is captured by a detector, forming a semi-circular pattern of light rays.</p>	<p><b>PLS – Point Light Source</b></p> <p>Measurement of BRDF, specular reflectance factor, luminance factor, etc.</p>	 <p>A photograph showing the PLS setup in a laboratory environment. A microscope is mounted on a grid stage, with a point light source placed on the surface. The LMD is positioned above the source.</p>

# 11 \\ Software package for control & evaluation

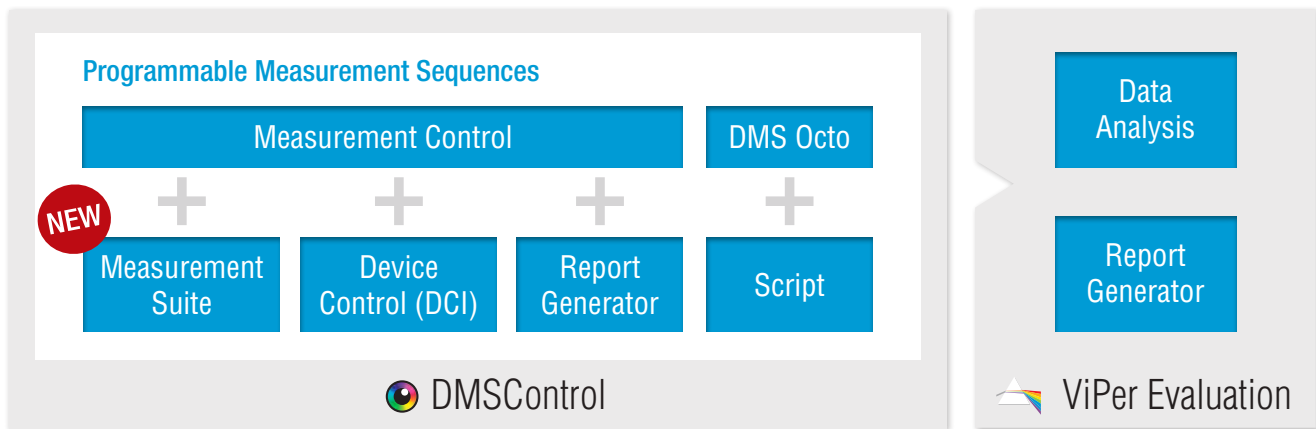


Fig. 13: Comprehensive software package DMSControl and ViPer Evaluation for device and DUT control, measurement sequence automation, evaluation and reporting

All measuring instruments in the DMS series are supplied as a standard with a software package consisting of the DMSControl™ software for operating the instruments and the ViPer Evaluation software for powerful visual performance analysis of the test results.

## DMSControl™

The DMSControl™ software enables comfortable control of all hardware devices connected to the DMS system. It consists of three modules.

The **Measurement Suite** module permits the execution of application-oriented measurement functions, such as contrast, flicker, cross-talk, response time, angular or area scans and reflection measurements. Furthermore, it is possible to configure your own combinations of both variable and fixed parameters. This gives you the freedom to adapt the system to your specific application.

Single measurement steps can be combined in measurement programs, which can be saved and recalled. Each measurement can be executed repeatedly, and user-defined limits can be set to obtain live pass/fail analyses during the sequence. This enables automated measurements for maximum efficiency in R&D and quality control laboratories.

The module **DCI Advanced** (Device Control Interface) controls external devices. DUT driving and measurement must be synchronized in order to realize automated measurement sequences. DCI Advanced provides an Python interface for the integration and control of external hardware, e.g. video driving units, pattern generators, source meters or customer specific control boards.

This is how simple your measurement will be:

- ▲ Place your sample in position.
- ▲ Choose a pre-defined measurement program
- ▲ Press START
- ▲ Software routines for complex display characterization sequences will be performed automatically
- ▲ Report and export results will be generated in the desired format.

A **Report Generator** module is supplied as an option for exporting data into Excel.



Fig. 14: DMSControl Software

## ViPer Evaluation

The ViPer Evaluation software provides a wide range of evaluation functions, visualizations and data export options for the DMS measurement data, e.g.:

- ▲ Angular or area scan graphs
- ▲ Flicker graphs
- ▲ Electro-optical characteristics (gamma)
- ▲ Spectrum graphs
- ▲ Chromaticity graphs

Appealing graphical views can be created with various scales and coordinate systems. The coordinate system used in a graph can be modified in appearance. Different data sets can be combined into one graph for comparison. A direct connection between DMSControl™ and ViPer software supports real time colorimetric evaluation and evaluation of measurement data.

ViPer Evaluation also provides a number of numerical calculation tools to convolute measured spectral data to user defined illuminance levels and illumination spectra e.g. D65.

Plots, graphics and related measurement data can be easily exported to MS Office applications by just a few clicks.

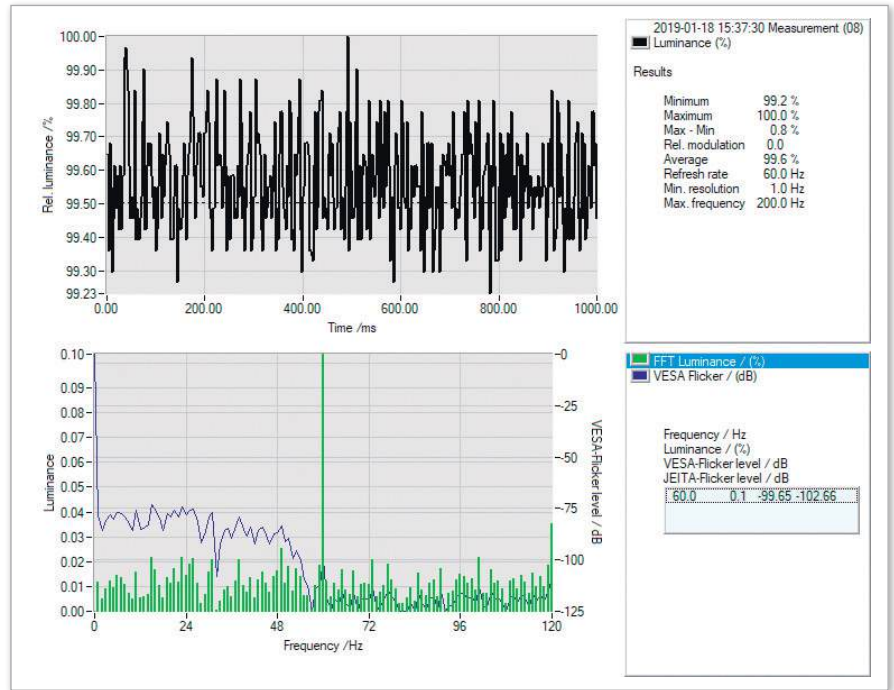


Fig. 15: The Flicker Graph view shows luminance fluctuations of a photometer measurement as a function of time, FFT flicker luminance and VESA resp. JEITA flicker curves as a function of wavelength and flicker evaluation results.



## DMS turnkey solution

The software package DMSControl + ViPer in combination with the Device Control Interface and Report Generator completes the DMS turnkey solution. Seamless integration of hardware and software assures high usability and an application-oriented workflow. Repetitive measurement tasks can easily be automated for maximum efficiency.

Fig. 16: Overview ViPer Evaluation

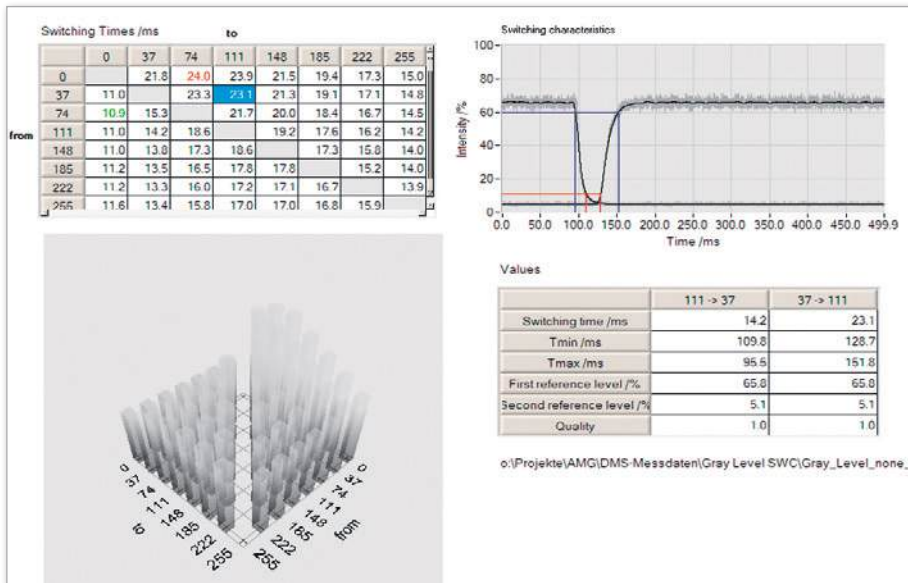


Fig. 17: The SWC Series Grey Level view shows photometric intensities derived from photomultiplier measurements as a function of time for different grey level combinations.

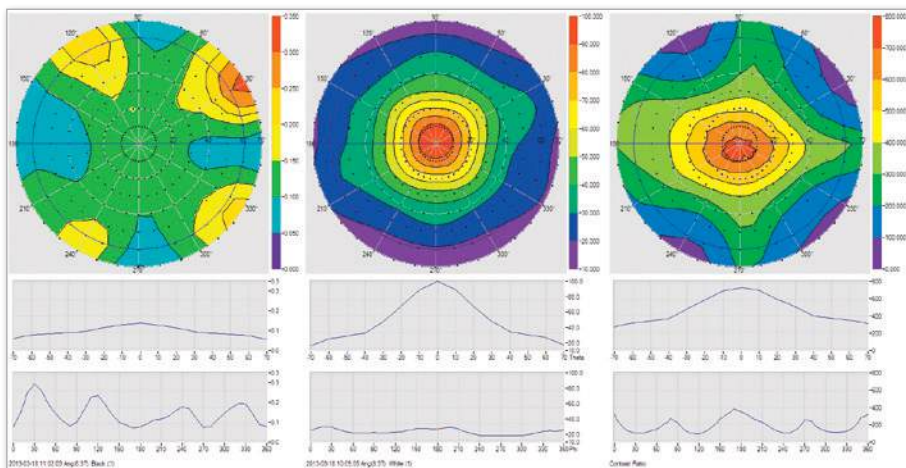
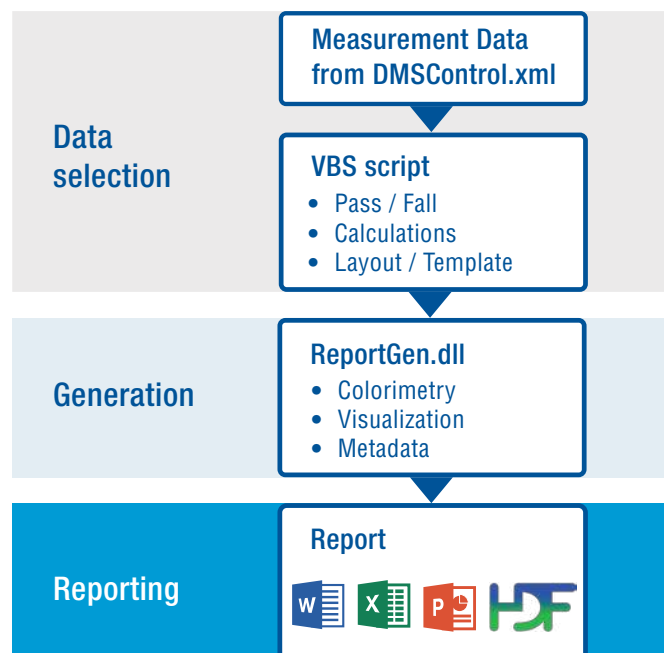


Fig. 18: The angular scan graph view shows luminance or color as a function of the viewing direction in a polar coordinate system. DUT measured in black state (left) and white state (middle) will automatically be combined to a polar plot of the contrast ratio (right).

## ViPer Report Generator

Create your customized report easily with the Report Generator. This tool allows you to export measurement data from ViPER data into any customized report format. The colorimetric calculations and ViPER's complex graphical visualizations are made available within ReportGen.dll. These are the steps to generate a report, which are also shown in the video below:

- ▲ Choose the measurements to export data in ViPER
- ▲ Choose the VBS script which defines data calculation, export and template format
- ▲ Electro-optical characteristics (gamma).



# 12 \\ Technical information

## Overview of DMS basic systems

Component / Feature	DMS 201	DMS 505	DMS 803	DMS 903	DMS 904
<b>Main system</b>					
<b>Mechanics</b>					
Scan range theta inclination	0° to 90° <sup>1), 4)</sup>	0° to 90° <sup>1)</sup>	0° to 90° <sup>1)</sup>	0° to 80°	0° to 80°
Scan range phi rotation	-	0° to 360°	0° to 360°	0° to 360°	0° to 360°
Reflective Illumination angle	0° to 90° <sup>1), 4)</sup>	0° to 90° <sup>1), 4)</sup>	0° to 90° <sup>1)</sup>	0° to 70°	0° to 70°
Min. step Theta/Phi/ Refl. Illumn.	1° <sup>4)</sup> / - / 1° <sup>4)</sup>	0.1°	0.1°	0.01°	0.01°
Positioning accuracy Theta/ Phi/Refl. Illumn	1°	0.1°	0.1°	0.1°	0.1°
Resolution Theta/Phi/ Refl. Illumn	-	0.01°	0.01°	0.01°	0.01°
Scan range X/Y translation	-	±10 mm <sup>4)</sup>	±50 mm	X: ±300 mm; Y: ±225 mm	X: ±300 mm; Y: ±225 mm
Scan range X+	-	-	-	-	±700 mm
Scan range Z	300 mm <sup>4)</sup>	114 mm	250 mm	280 mm	320 mm
Min. step X/Y/Z	-	0.1 mm	0.1 mm	0.1 mm	0.1 mm
Positioning accuracy X/Y/Z	-	Z: 0.05 mm	X/Y: 0.005 mm; Z: 0.05 mm	0.05 mm	0.05 mm
Resolution X/Y/Z	-	Z: 0.005 mm	X/Y: 0.001 mm; Z: 0.005 mm	0.01 mm	0.01 mm
Sphere of confusion (all axis)	-	100 µm	100 µm	300 µm	300 µm
<b>DUT dimensions</b>					
Max. diagonal	600 mm (23")	600 mm (23")	600 mm (23")	1600 mm x 1300 mm (81")	1800 mm x 1200 mm (85")
Max. diagonal for motorized x-y scanning	-	-	459 mm (18")	1000 mm x 800 mm (50")	1200 mm x 700 mm (54")
Orientation of DUT surface	horizontal	horizontal	horizontal	horizontal	horizontal
<b>Dimensions</b>					
DMS mechanics (L x W x H)	790 mm x 500 mm x 580 mm	1500 mm x 1080 mm x 2030 mm	1500 mm x 1080 mm x 2030 mm	1895 mm x 1465 mm x 1855 mm	2250 mm x 1350 mm x 1950 mm
Electronics rack	19" table rack	715 mm x 555 mm x 1025 mm	715 mm x 555 mm x 1025 mm	715 mm x 555 mm x 1250 mm	715 mm x 555 mm x 1250 mm
Thermostream temp. control	1000 mm x 725 mm x 1240 mm	1000 mm x 725 mm x 1240 mm	1000 mm x 725 mm x 1240 mm	1000 mm x 725 mm x 1240 mm	1000 mm x 725 mm x 1240 mm
<b>Weight</b>					
DMS mechanics	35 kg	405 kg	405 kg	700 kg	800 kg
Electronics rack	10 kg	105 kg	105 kg	120 kg	120 kg
Thermostream temp. control	230 kg	230 kg	230 kg	230 kg	230 kg
<b>Facility Requirements</b>					
Power Main system <sup>2)</sup>	200 - 250 VAC (230 V nominal), 50/60 Hz, 16 A, 1 phase	200 - 250 VAC (230 V nominal), 50/60 Hz, 16 A, 1 phase	200 - 250 VAC (230 V nominal), 50/60 Hz, 16 A, 1 phase	200 - 250 VAC (230 V nominal), 50/60 Hz, 16 A, 1 phase	200 - 250 VAC (230 V nominal), 50/60 Hz, 16 A, 1 phase
Space (footprint) <sup>3)</sup>	-	4000 mm x 2800 mm	4000 mm x 2800 mm	5000 mm x 3000 mm	6000 mm x 4450 mm
Operating temperature	23 °C (±5 °C) relative humidity 0-60%, non-condensing				

<sup>1)</sup> 70° for all automated measurements, 90° for operator control.

<sup>2)</sup> Additional transformer available for 100-115 V, 50/60 Hz, 20A.

<sup>3)</sup> Includes DMS mechanism, electronics rack, PC, Thermostream and operation space.

<sup>4)</sup> Manual movement without motorization.

# 13 \\ Order information

Order number	Description
<b>Basic system</b>	
DMS201-100	Model DMS 201-1 comprising: Goniometer with 2 manual axes; Microscope viewing optics
DMS505-100	Model DMS 505-1 comprising: Goniometer with 3 motorized and 3 manual axes; microscope viewing optics; transmissive illumination; light shielding box; PC with table; DMSControl and ViPer software
DMS803-100	Model DMS 803-1 comprising: Goniometer with 6 motorized axes; microscope viewing optics; transmissive illumination; light shielding box; PC with table; DMSControl and ViPer software
DMS903-100	Model DMS 903-1 comprising: Goniometer with 6 motorized axes; microscope viewing optics; transmissive illumination; light shielding enclosure; PC with table; DMSControl and ViPer software
DMS904-100	Model DMS 904-1 comprising: Goniometer with 7 motorized axes; microscope viewing optics; transmissive illumination; light shielding enclosure; PC with table; DMSControl and ViPer software
<b>Options - LMD</b>	
CAS140D151U1A	CAS 140D Array Spectrometer; VIS; USB, 100µm slit, OD VIS 1-2-3-4
DMS-1-20	Fast Photometer PMT 3/100 with photomultiplier, PMC control electronics, ADC A/D converter. Bandwidth 100kHz; compatible with all DMS models
DMS-1-21	Fast Photometer PMT 3/500 with photomultiplier, PMC control electronics, A/D converter ADC. Bandwidth 500kHz; compatible with all DMS models
<b>Options - Control electronics</b>	
DMS-2-10	Keithley 2400 series source meter set for DMS, including cabling; programmable current and voltage source with digital multimeter (e.g. for driving OLEDs)
DMS-2.20	SCG Interface to DUT control electronics and data acquisition; 19" enclosure, power supplies, wiring, GPIB connection unit
DMS-2-30	ASG-1 Arbitrary Signal Generator, with power amplifier PA-3/60, 1 channel
<b>Options - Temperature control</b>	
DMS-3-10	HCS-3 temperature chamber with ThermoStream control unit
DMS-3-30	HCS-3B temperature chamber with ThermoStream control unit
DMS-3-50	HCS-4-32 temperature chamber with ThermoStream control unit (903)
DMS-3-60	HCS-5 temperature chamber with ThermoStream control unit for large Displays up to 1500 mm x 400 mm x 130 mm (l x w x h); compatible with DMS 903
DMS-19970	HCS-6 temperature chamber with ThermoStream control unit for large Displays up to 720mm x 320mm x 115mm; compatible with DMS 803
DMS-3-70	HCS-7 temperature chamber with ThermoStream control unit for large Displays up to 1600 mm x 600 mm x 200 mm (l x w x h); compatible with DMS 904
<b>Options - Light sources and illumination systems</b>	
DMS-5-10	HEL-4 light source with 150 W tungsten halogen lamp
DMS-5-12	LC-8 xenon light source for higher light output
DMS-5-20	PID-800 parallel illumination device (collimated beam) (201/505/803)
DMS-5-21	PID-903 parallel illumination device (collimated beam) (903/904)
DMS-5-30	VADIS-800 variable aperture diffuse illumination source for reflective measurement (201/505/803)
DMS-5-31	VADIS-903 variable aperture diffuse illumination source for reflective measurement (903/904)
DMS-5-40	DHS diffusing hemisphere for reflective displays
DMS-5-41	DHS-HC diffusing hemisphere for evaluating the contrast of reflective displays; illumination geometry similar to HCS-3 source
DMS-5-42	DHS-HC9 diffusing hemisphere for evaluating the contrast of reflective displays; illumination geometry similar to HCS-3 source (903)
DMS-5-50	SDR integrating sphere for diffuse reflectance
DMS-5-60	PLS LED point-light source illumination for measurement of BRDF; compatible with DMS 505/803
DMS-5-61	PLS LED point-light source illumination for measurement of reflectance characteristics including BRDF; compatible with DMS 903/904

<b>Options – Software</b>	
DMS-SW-10	DMSControl, Measurement Suite and ViPer software for control, measurement, evaluation and illustration.
DMS-SW-35	DCI device control interface for external devices (for DMSControl)
DMS-SW-40	Report generator for data export to Excel spread sheets
DMS-SW-36	DMS Octo – measurement sequencer as plugin for DMSControl
DMS-SW-37	Curved motion software module
DMS-SW-38	SDR ambient contrast evaluation according to IEC 62341-6-2

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Detailed information about the individual facility requirements of each DMS system can be found in our data sheet:





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