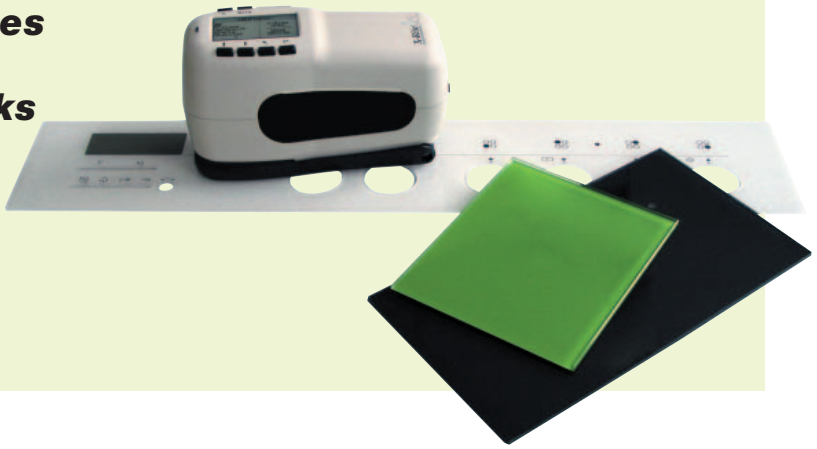
Different Measuring Geometries for Measurement of Colours of Screen and Pad Printing Inks



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Colour Management

The former method of three-way measurements no longer being used, today determination of colour differences and measurement of colour references for matching screen and pad printing inks is usually carried out by spectral process. The colour is measured with the so-called spectrophotometer measuring the reflection* within the spectral range of visible light, i.e. between 400 and 700 nm. The degree of reflection of the light coming from a defined source of light from the object surface is measured within small distances of approx. 10 – 20 nm.

In simple words a 100% reflection will be an absolute white and 0% absolute black. The individual measurement values (16 with a distance of 20 nm and 31 with 10 nm) result in a spectral curve or reflection curve, which serves as a "fingerprint" for the colour.

All measurements of colours viewed from above are best referred to the mat white surface, which reflects the radiation independently from the angle with a reflection degree $\varphi = 1$. As this perfect white standard cannot be achieved for technical reasons an actual standard value has to be determined (normal reflection) for colour measurements (calibration standard; e.g. barium sulphate).

The reflection curve is the base for calculation of colour parameters like standard colour values (X,Y,Z) and the CIELAB-values, which can be calculated from these values.

Decisions should not be made based on reflection curves. It is required to define all conditions of lighting and views during determination of spectral data. These conditions are described by the measuring geometry, i.e. type of spectrophotometer.

Basically there are three different types of measuring geometries for spectrophotometers.

- Sphere measurement (scattered lighting and direct view).
- Angle measurement (direct lighting and view; fixed angles)
- Multi-angle measurement (direct lighting and view; variable angles)

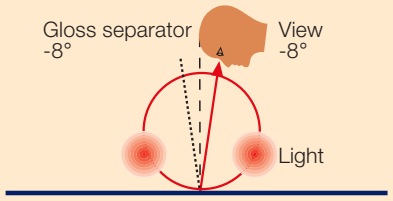
Which of these measuring geometries is used always depends on the application. All three geometries have their advantages and fields of application.

Sphere measurement d/8°

Sphere measurement meters measure the light reflected in one direction from the specimen, which is subjected to scattered lighting. Measurement is carried out at a 8° vertical angle. The advantage is the possibility to attach a so-called gloss separator to a further opening of the sphere, which avoids lighting of the specimen under an 8° thus eliminating the gloss. Measurement with gloss separators is only useful if the specimen show high gloss.

When carrying out measurements with this sphere geometry the surface structure of the specimen does not play a very important role, i.e. measurement values only change to a minor extent when measuring specimen with different surface structures (e.g. textiles, rough plastics etc.).

D/8° = scattered lighting / direct view at 8°
Measurement independent from direction
"Ulbricht sphere" (white coating inside)



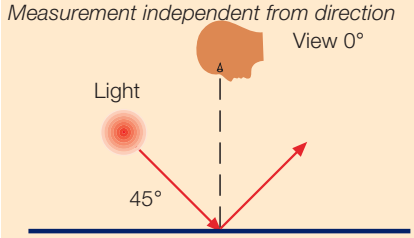
Angle Measurement 45°/0° (0°/45°)

The specimen is directly lit at 45° and the angle measurement meter measures the light reflected in one direction from the specimen at a 0° angle (Also possible vice versa!) This way gloss is excluded and there is a better accordance with the visual impression of the human eye. This can be compared to changing the view angle to avoid disturbing reflections when reading a high gloss magazine in direct sunlight. Contrary to sphere measurement this direct measurement will show the "real" visual difference between a mat and glossy colour swatch specimen (e.g. mat colour swatch ↔ glossy screen ink).

Sphere meters try to imitate this using a gloss separator, however not with the same effective result.

Angle geometry is especially suitable for smooth or only slightly structured surfaces.

45°/0° = direct lighting below 45° / view at 0°
Measurement independent from direction



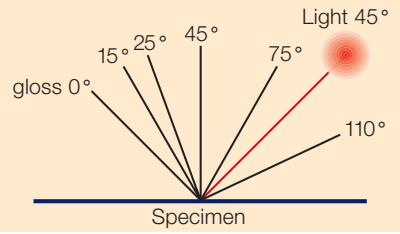
Multi-angle Measurement 45°/15°, 25°, 45°, 75°, 110°

Neither sphere measurement nor the "simple" angle measurement will show satisfactory results when measuring metallic or effect varnishes used e.g. in the automotive industry. Although a 45°/0° measurement will give helpful information, one single angle will not be sufficient.

A series of measurements is made in a time-consuming measurement process using several view angles (usually 15°, 25°, 45°, 75°, 110°) giving clear results. As this is a very time-consuming process with expensive equipment and this multi-angle measurement does not give very clear results with low layer thicknesses screen and pad printers partially still rely on visual inspection.

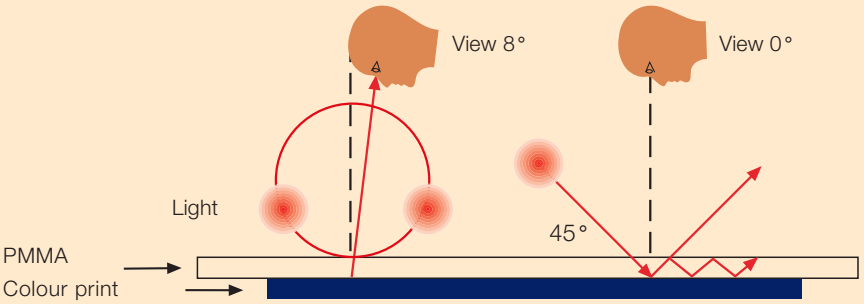
* Transmission measurements are also possible, however we are not going to report about them in this article

45°/15°; 25°; 45°; 75°; 110° = direct lighting at a 45° with scattered view at 15°; 25°; 45°; 75°; 110° respect to gloss angle



Which measurement is used for which application?

When checking measurement quality of individual spectrophotometers in reference to accuracy in repeated use there are generally no disadvantages or advantages in reference to the measuring geometry. The main criterion for the choice of measurement geometry is the field of application.



When carrying out angle measurement of a colour print there is an inner reflection due to the material. The "lost" not directly reflected light is interpreted as "black" and therefore the colour swatch seems darker as it really is.

Measurement	Angle Measurement 45°/0° (0°/45°)	Sphere Measurement D/8°	Multi-Angle Measurement
Application	Smooth, slightly structured surfaces (e.g. self-adhesive foils for metallic shades)	Higly structured surfaces e.g. textiles, rough plastics, keyboard foils, scale printing	metallic and pearl gloss for screen and pad printing!

There is a great variety of applications of special colours of screen and pad printing inks for any type of substrate. Prints have to correspond to the requirements given by the designer and show best possible visual correspondence to the colour swatch. In that case angle measurement 45°/0° (or 0°/45°) is the most suitable method.

Visual colour differences due to gloss differences (mainly with dark shades) can best be measured using angle meters. Sphere meters only have a limited consideration of these differences. Even for metallic shade formulations the angle geometry is a good aid. In addition spectrophotometers with angle geometry are quite small.

The advantage of sphere meters is measuring of colour swatches with rough surfaces like textiles or rough plastics. Not direct, scattered lighting avoids surface scattering due to material as well as inner reflection. Angle geometry on the other hand has an undesired incalculable "loss of light" because of the direct lighting.

This advantage is of special importance when the print is viewed through the material like key foils or front panels of kitchen appliances.

Spectrophotometers of the C-MIX-COMP Range.

For some years now we have been offering the spectrophotometer 530 (spectrophotometer + densitometer) of X-Rite GmbH. This portable angle meter (45°/0°) is compact and has small measuring openings (2.0 and 3.4 mm).

In addition to the X-Rite 530 we still have been offering the former sphere meter COLORFLASH of Optronik (a subsidiary of X-RITE GmbH). Despite of the high reliability of this stationary equipment we have now decided to use the portable sphere meter X-RITE SP62. Due to the smaller built (measuring diaphragms either 4, 8, 14 nm) this equipment can also be used for quality control during the printing process in machine production).

NEW in our program

Spectrodensitometer X-RITE SP62 with angle measurement d/8°

- Shock and temperature proof construction
- Scattered lighting with Wolfram halogen lamp
- Measuring diaphragms of 4 mm, 8 mm or 14 mm
- Large, easy to read colour display
- Simultaneous measurement of specimen with and without gloss
- Spectral scope of measurement 400 nm – 700 nm
- Spectral measurement in 10 nm intervals
- Spectral data output in 10 nm intervals
- Photometric measurement scope 0-200 %
- 1024 reference colour memory
- 2000 colour measurements memory
- Standard light types: C, D50, D65, D75, A, F2, F7, F11, F12
- Colorimetric functions, opacity, colour strength
- Foldable measuring clip
- Bi-directional patented data interface
- Rechargeable NiMh battery pack
- adapter/charger for 230 V, 50 HZ
- White and black calibration standards
- Operation manual
- Transport case

Spectrodensitometer X-RITE 530 with angle measurement 45°/0°

- Shock and temperature proof construction
- Gas-filled lamp 2856 K
- Interchangeable measuring diaphragms of 4 mm, 8 mm or 14 mm
- Measurement with and without polarisation filter (interchangeable)
- Scope of measurement 0,00D – 2,5D; 0-160% reflection.
- Spectral scope of measurement 400 nm – 700 nm
- Spectral measurement in 10 nm intervals
- Spectral data output in 10 nm intervals
- Standard light types: C, D50, D65, D75, A, F2, F7, F11, F12
- Densitometric functions
- Colorimetric functions, opacity, colour strength
- Foldable measuring clip
- Rechargeable NiMh battery pack
- Adapter/charger for 230 V, 50 HZ
- White calibration standard
- Operation manual
- Transport bag

Information given by supplier

For further information about spectrophotometers, colour matching and colour measurement please contact our colorimetric department.

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