



The world's true measure of color

HunterLab

Agera L2™

The Reference
Grade Standard for
Color and
Appearance
Measurement.



Color. Confidence. Connected



Redefining accuracy, reliability, and appearance in
every measurement



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

What Makes Agera L2 Reference-Grade?

- Standards-conforming geometry and illumination
- CIE-calibrated D65 daylight simulation
- High signal integrity, low noise, and statistical stability
- Traceable, repeatable performance across sites and time

A reference-grade instrument is one that conforms to standards, correlates with human vision, minimizes uncertainty, and produces repeatable, traceable results—Agera L2 is engineered to meet all four.



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

1. Standards-Conforming Geometry

Industry Expectation (Reference-Grade):

- Measurement geometry must be defined, repeatable, and aligned with accepted standards for visual correlation.

Standards Language:

- CIE Publication 15 / ISO 11664 - Defines standard geometries for color measurement
- ASTM E1164 - Specifies measurement geometry and illumination conditions for colorimetry of opaque materials

Agera L2 Alignment:

- Uses 0° illumination / 45° circumferential viewing geometry, consistent with ASTM E1164 practices for visually correlated color measurement of textured and semi-gloss materials.



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

2. Accurate CIE D65 Illumination (Not Nominal D65)

Industry Expectation (Reference-Grade):

- illumination must spectrally conform to CIE D65, not merely approximate it.

Standards Language:

- CIE 15 / ISO 11664-2 - Defines CIE standard illuminants, including D65 spectral power distribution
- ASTM E308 / E1164 - Requires illumination conformity for valid tristimulus computation

Agera L2 Alignment:

- Uses CIE-calibrated D65 illumination, supporting visual-instrumental correlation under standard daylight conditions—an essential requirement for reference instruments.



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

3. Signal Integrity, Noise Control, and Measurement Uncertainty

Industry Expectation (Reference-Grade):

- Reference instruments must minimize noise, maximize usable signal, and produce statistically stable data.

Standards Language:

- ASTM E2214 / E691 - Addresses precision, repeatability, and reproducibility
- ISO 5725 - Defines accuracy, trueness, and precision of measurement methods

Agera L2 Alignment:

- Dark Performance Mode reallocates dynamic range for low-reflectance samples, reducing noise and tightening repeatability, confidence intervals, and ΔE stability—hallmarks of reference-grade performance.



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

4. Fluorescence and UV Control

Industry Expectation (Reference-Grade):

- Reference instruments must control UV content to correctly measure optically brightened materials.

Standards Language:

- STM E313 / ASTM E308 - Addresses whiteness, yellowness, and fluorescence effects
- CIE Publication 15 - Notes UV influence on color measurement

Agera L2 Alignment:

- Incorporates controlled UV LED illumination, enabling consistent and traceable measurement of fluorescent and OBA-containing materials.



Spectrophotometer Reference-Grade Criteria

Mapped Explicitly to CIE / ISO / ASTM Language

5. Traceability, Repeatability, and Cross-Site Reproducibility

Industry Expectation (Reference-Grade):

- Results must be stable over time and transferable across instruments and locations.

Standards Language:

- ISO 9001 / ISO 17025 principles - Emphasize traceability and measurement consistency.
- ASTM E691 - Interlaboratory reproducibility expectations.

Agera L2 Alignment:

- Delivers traceable, repeatable performance with integrated software, calibration rigor, and complete appearance data—supporting use as a site-to-site reference.





Understanding CIE D65 Illumination Quality and Grades

Why daylight accuracy matters for appearance-critical measurement

What is **cie** D65?

- CIE D65 is the internationally defined spectral representation of average daylight, published by the Commission Internationale de l'Éclairage (International Commission on Illumination)
- It is the industry standard illumination source for most all manufacturers of spectrophotometers.



International Commission on Illumination
Commission Internationale de l'Éclairage
Internationale Beleuchtungskommission



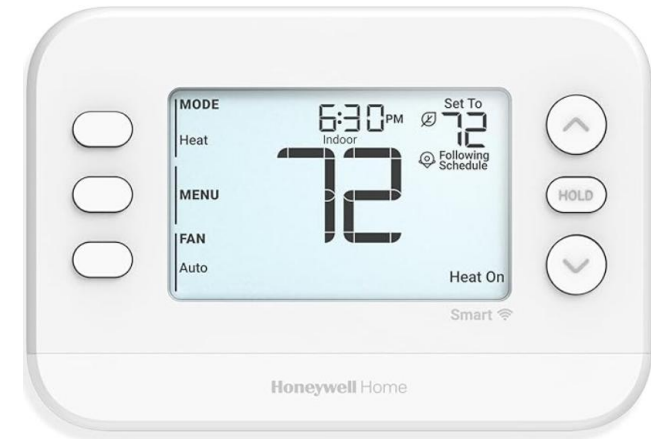
What is **cie** D65?

- The closer the illumination matches true daylight, the more reliably instrumental measurements align with visual evaluation.
- However, not all light sources that claim “D65” are equal.



The Plain-English Analogy

- D65 is like saying 'room temperature, but 68°F and 78°F are both called room temperature—and they feel very different.
- Two light sources can both be called D65, but one actually looks like daylight—and the other just claims to.



What **cie** Defines

Defined in CIE Publication 51 (and the updated ISO/CIE 23603)

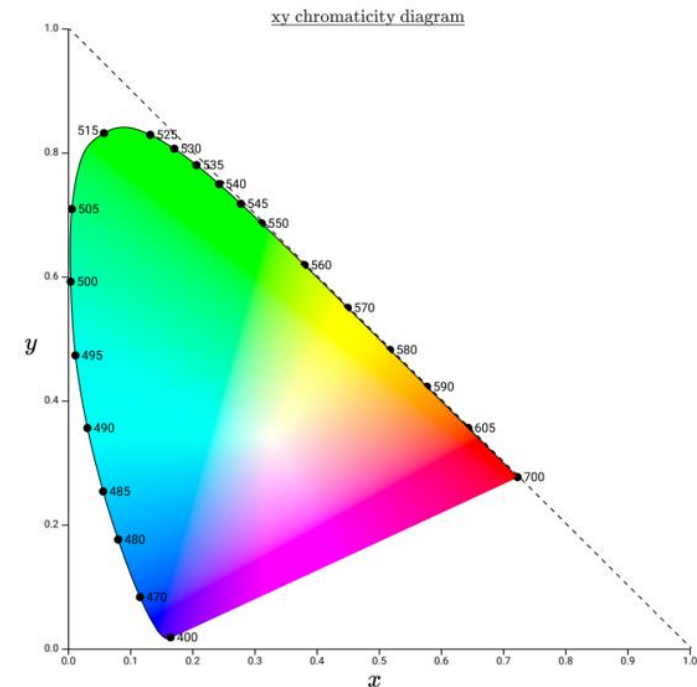
- The theoretical D65 spectral power distribution (SPD)
 - A tabulated reference spectrum
 - Represents average daylight at ~6500 K
 - Published as numerical values at specific wavelength intervals
- Colorimetric requirements
 - Tristimulus values (X, Y, Z)
 - Chromaticity coordinates (x, y)
 - Correlated Color Temperature (CCT)
- Methods to evaluate how closely a source matches D65
 - Spectral comparison
 - Chromaticity tolerances
 - Colorimetric error metrics



How D65 Quality Is Defined & Measured

1. Chromaticity Tolerance

- Measured by:
 - Distance from D65 chromaticity point in the CIE 1931 (x,y) diagram
 - Often constrained by small Δx , Δy limits
- Limitation:
 - Chromaticity alone does **not** guarantee correct material response



CIE 1931 xy Chromaticity Diagram



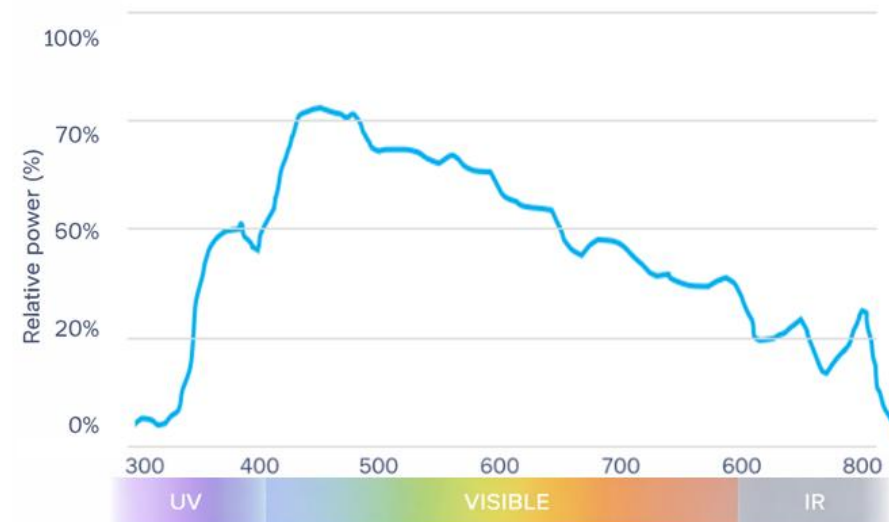
How D65 Quality Is Defined & Measured

2. Spectral Power Distribution (SPD) Match

- Measured by:
 - Comparing the instrument's measured SPD to the reference CIE D65 SPD
 - Evaluating wavelength-by-wavelength deviation
- Key Idea
 - Two sources can have the same CCT and chromaticity but very different SPDs.



CIE D65 Spectral Power Distribution (SPD)



How D65 Quality Is Defined & Measured

3. UV Content & Control

- Measured by:
 - Energy present below ~400 nm
 - Stability and repeatability of UV output
 - Ability to switch UV-in / UV-out
- Critical for:
 - Optical brighteners
 - Fluorescent pigments
 - "Cool roof" materials

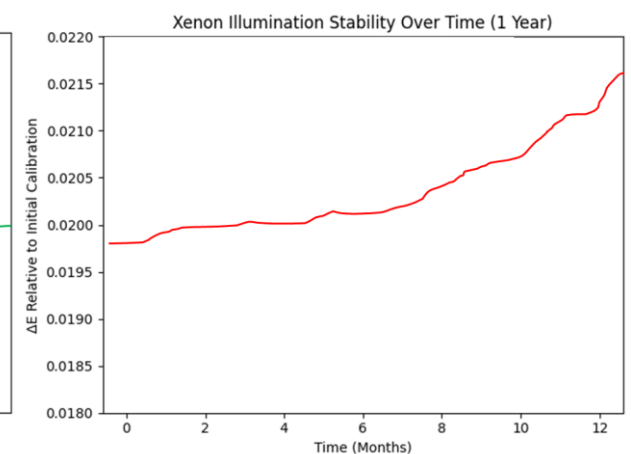
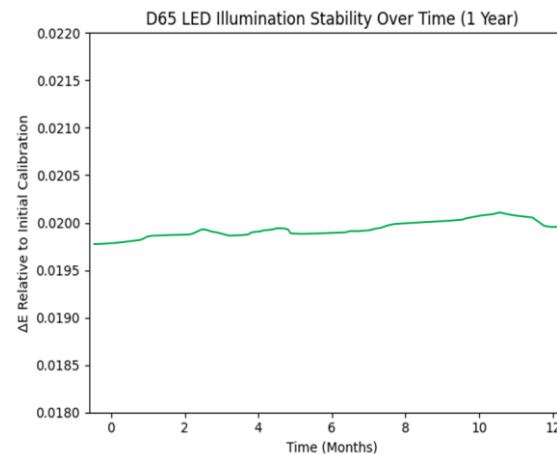
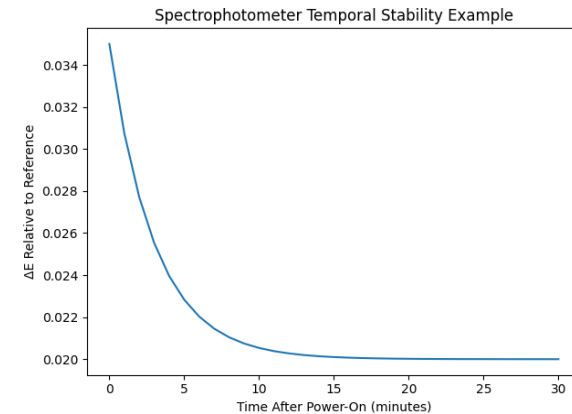


How D65 Quality Is Defined & Measured

4. Temporal Stability

A temporal stability graph for a spectrophotometer is a time-based plot that shows how stable the instrument's output remains after warm-up and over continued operation.

- Measured by:
 - Repeat SPD measurements over time
 - Warm-up behavior
 - Aging effects
- Unstable sources may:
 - Meet D65 once
 - Drift out of tolerance later



How D65 Quality Is Defined & Measured

5. Metamerism Performance

- Measured by:
 - Evaluating how different material pairs behave under the source vs reference D65
 - Often aligned with **ISO 23603** (metamerism index)
- This is critical for:
 - Plastics
 - Coatings
 - Textiles
 - Building materials

CIE Metamerism Index

Conditions for Measurement

Instrumental: Any HunterLab spectrophotometer

Illuminants: Any

Standard Observer Function: 2 or 10 degree

Transmittance and/or Reflectance: Either.

Formulas

$$MI = \sqrt{(\Delta L_{n1} - \Delta L_{n2})^2 + (\Delta a_{n1} - \Delta a_{n2})^2 + (\Delta b_{n1} - \Delta b_{n2})^2}$$

where n1 is the first illuminant, n2 is the second illuminant, and $\Delta = \text{Value}_{\text{sample}} - \text{Value}_{\text{standard}}$.

AN 1010 Measuring Metamerism

support.hunterlab.com



Common D65 Illumination Quality Levels

Grade	Metamerism Index	Quality Description
A	<0.25	Excellent
B	0.25 to 0.50	Good
C	0.50 to 1.00	Fair
D	1.00 to 2.00	Poor
F	>2.00	Very Poor



Common D65 Illumination Quality Levels

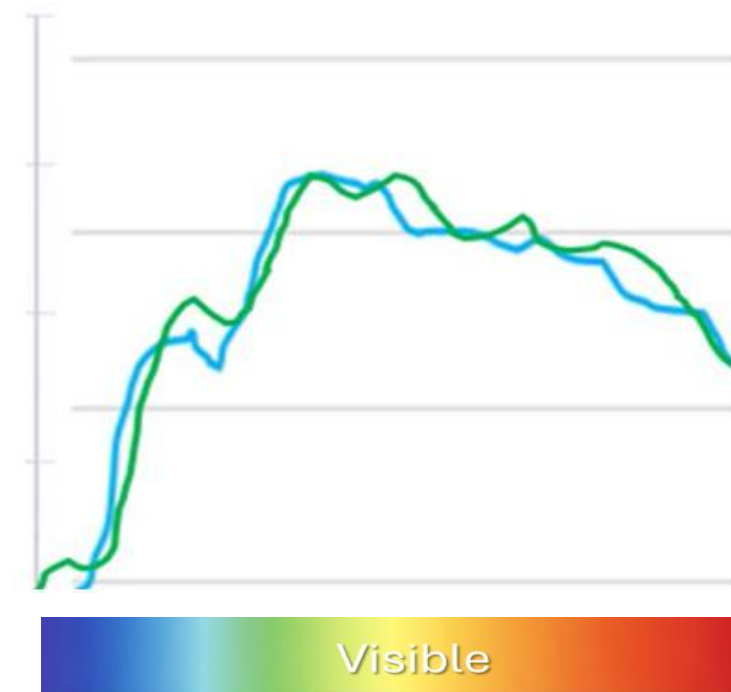
Grade A

True / Reference D65

(<0.25 - Excellent)

- Very close spectral match to the CIE D65 reference across the full visible range (and UV, if applicable)
- Tight tolerances on wavelength-by-wavelength deviation
- Stable, repeatable output over time
- Designed to meet **instrumental + visual correlation**

CIE D65
Spectral Power Distribution (Visible)



Common D65 Illumination Quality Levels

Grade A

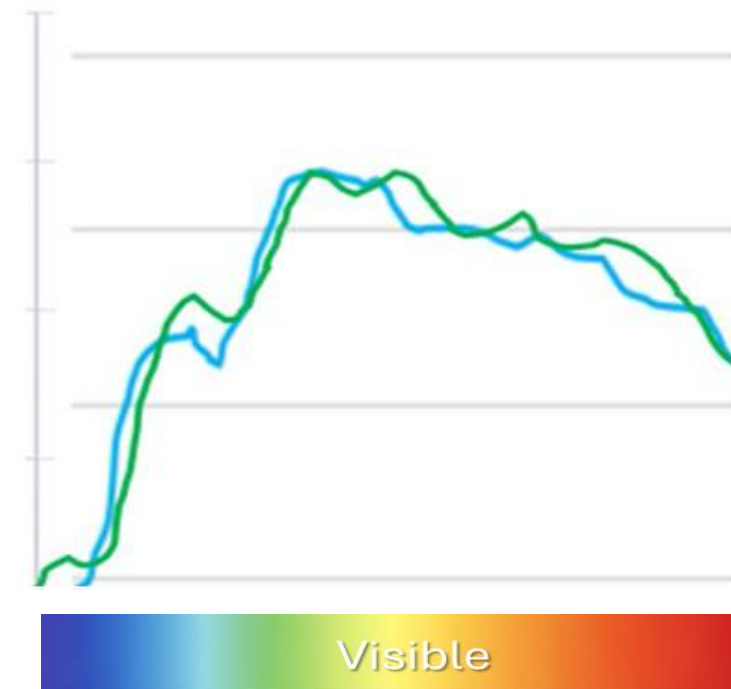
True / Reference D65

(<0.25 - Excellent)

Used in:

- Reference-grade spectrophotometers
- Critical color approval and specification work
- Applications where visual agreement matters (plastics, coatings, building materials)

CIE D65
Spectral Power Distribution (Visible)



Common D65 Illumination Quality Levels

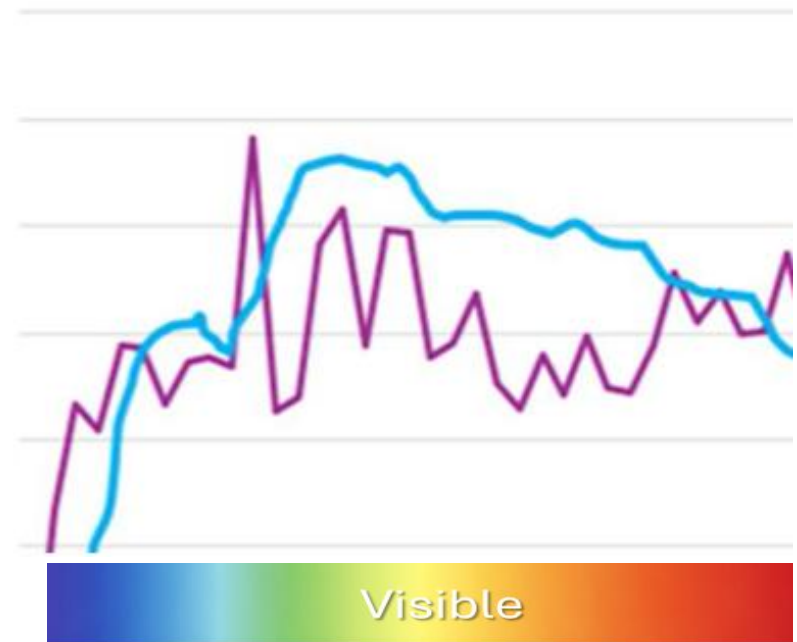
Grade B

Acceptable D65

(0.25 to 0.50 - Good)

- Reasonable daylight approximation
- Minor spectral deviations
- Suitable for routine quality control
- *Works for basic applications with broader tolerances.*

CIE D65
Spectral Power Distribution (Visible)



Common D65 Illumination Quality Levels

Grade B

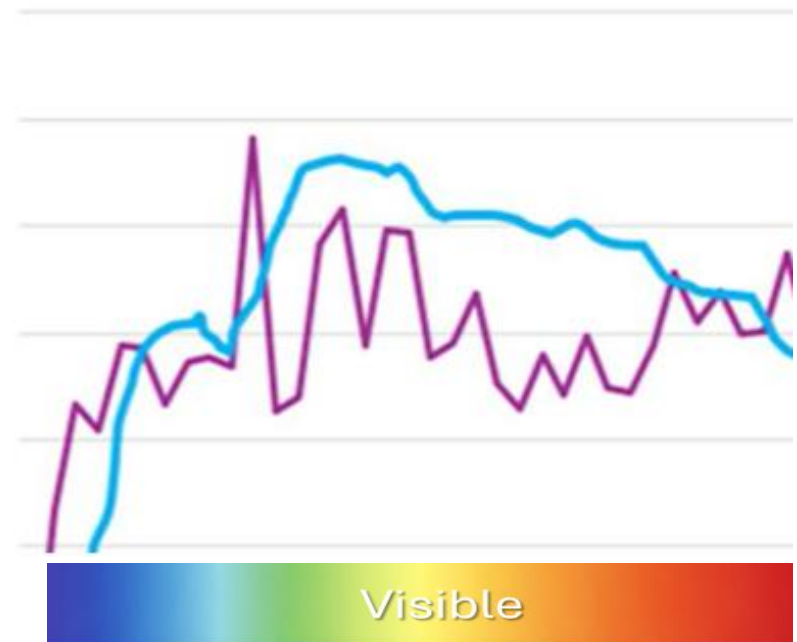
Acceptable D65

(0.25 to 0.50 - Good)

Used in:

- High quality non reference grade spectrophotometers
- Process monitoring where tolerances are broader
- Less sensitive materials

CIE D65
Spectral Power Distribution (Visible)



Common D65 Illumination Quality Levels

Grade C

Nominal D65

(0.50 to 1.00 - Fair)

- Labeled as D65, but loosely approximated
- Uneven spectral output
- Limited visual correlation
- *May look acceptable on paper, but not in real viewing.*



Common D65 Illumination Quality Levels

Grade C

Nominal D65

(0.50 to 1.00 - Fair)

Used in:

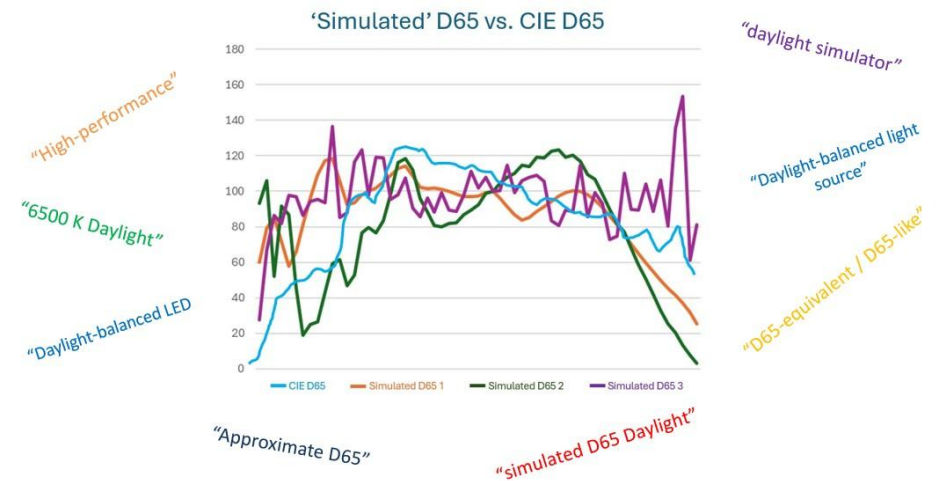
- Mid level spectrophotometers
- Situations where visual correlation is not critical



Not All D65 Illumination Is the Same

Many spectrophotometers claim D65, but their spectral accuracy varies widely

- Most only approximate daylight in name or color temperature
- Chromaticity alone does not guarantee correct daylight behavior
- Spectral shape determines how real materials respond
- Result
 - Instruments may agree numerically
 - Yet disagree visually—especially on sensitive materials



Common D65 Illumination Quality Levels

Material Sensitivity

- Some materials are highly sensitive to spectral shape, especially:
 - Bright whites
 - Optically brightened materials
 - Pigmented plastics
 - Coated metals
 - Roofing granules and building materials
- Lower-grade D65 sources can:
 - Misrepresent brightness
 - Shift hue
 - Mask fluorescence effects



Fluorescence, UV Control, and Weathering Correlation

- Controlled UV for fluorescent and UV-sensitive materials.
- Stronger correlation with QUV and outdoor weathering.
- More reliable measurement of UV-driven color change.

Standards References:

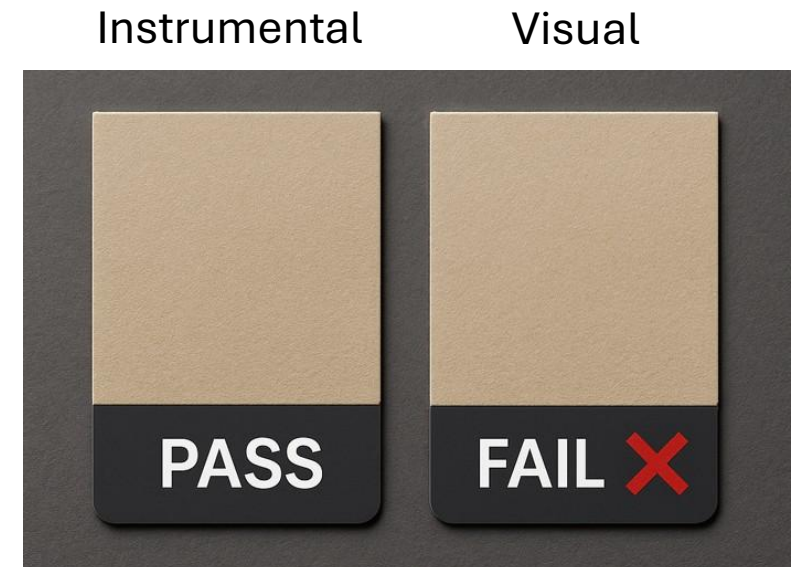
- **ASTM E308** – Standard Practice for Computing the Colors of Objects by Using the CIE System
- **ASTM E313** – Standard Practice for Calculating Yellowness and Whiteness Indices
- **CIE Publication 15** – Colorimetry (UV influence on color measurement and visual correlation)



Common D65 Illumination Quality Levels

Visual Agreement

- Customers don't approve products with numbers—they approve them **with their eyes**.
- If an instrument's D65 source is a poor match:
 - The instrument may say "PASS"
 - The customer may say "That doesn't look right"
- This leads to:
 - Disputes
 - Rework
 - Lost trust



Common D65 Illumination Quality Levels

Cross-Plant & Global Consistency

- A weak D65 implementation amplifies site-to-site differences
- Even identical instruments may disagree visually
- A high-grade D65 source becomes a common visual language across plants.



Business Impact

- Faster approvals
- Fewer rejected lots
- Less rework and scrap
- Fewer “it passed here but failed there” conversations
- Stronger customer confidence



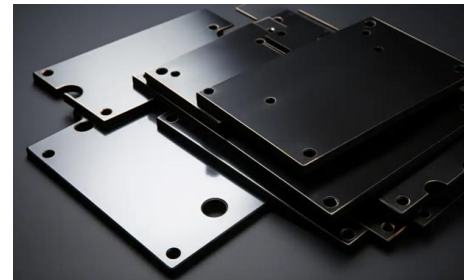


Agera L2 Dark Performance Mode

Enhanced performance for ultra-dark color evaluation

What is Dark Performance Mode?

- Ultra-dark (<15%R) materials reflect extremely little light
- Low signal levels make measurements highly noise-sensitive
- Stray light can significantly distort color results



Agera L2 Dark Performance Mode

Agera L2 solves this with Dark Performance Mode—a dedicated acquisition mode for samples below 15% reflectance.

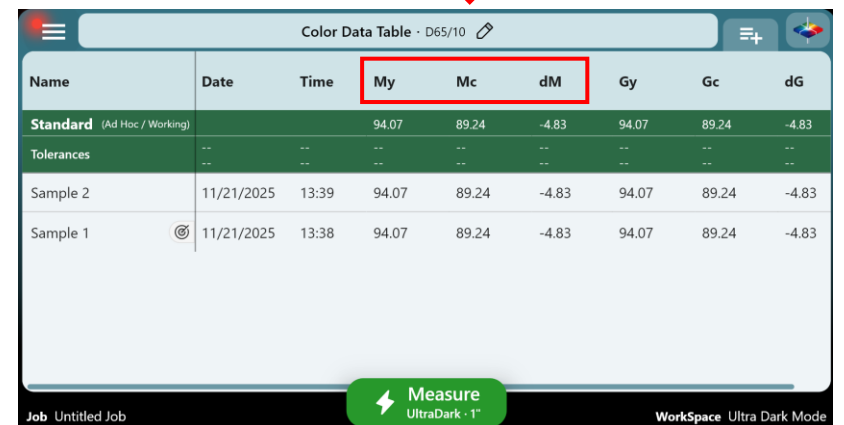


ISO Conformance for Extremely Dark Samples

ISO Blackness

- ISO 18314-3 provides formulas for evaluating the depth and undertone of very dark samples:
- My (black value)
- Mc (color depending black value)
- dM (absolute contribution of hue)

These indices are widely used in plastics, inks, and pigments when subtle undertone differences matter.



Name	Date	Time	My	Mc	dM	Gy	Gc	dG
Standard (Ad Hoc / Working)			94.07	89.24	-4.83	94.07	89.24	-4.83
Tolerances	--	--	--	--	--	--	--	--
Sample 2	11/21/2025	13:39	94.07	89.24	-4.83	94.07	89.24	-4.83
Sample 1	11/21/2025	13:38	94.07	89.24	-4.83	94.07	89.24	-4.83



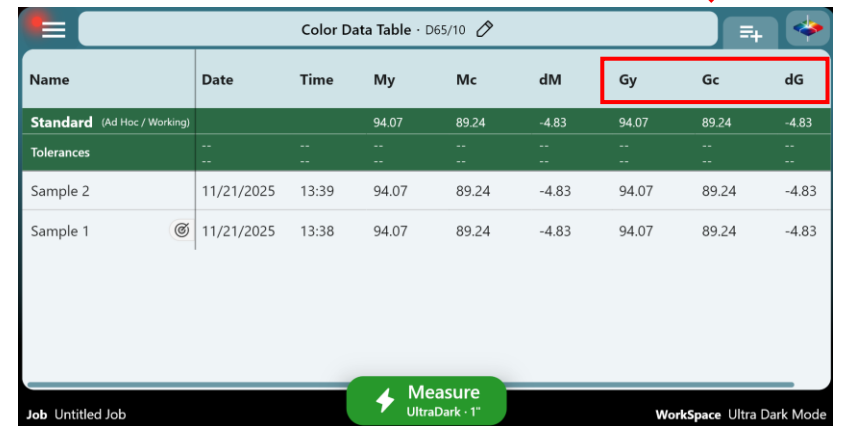
ISO Conformance for Extremely Dark Samples

ISO Greyness

ISO 18314-3 is a specialized index applied to black materials that do not behave like carbon-black-based jet blacks.

- Gy (hue independent greyness value)
- Gc (hue independent greyness value)
- dG (absolute contribution of hue)

Purpose of these indices is to quantify whether a material is close to a true neutral grey or whether it contains detectable chroma (e.g., a graphite grey that appears slightly green, blue, or red).



Name	Date	Time	My	Mc	dM	Gy	Gc	dG
Standard (Ad Hoc / Working)			94.07	89.24	-4.83	94.07	89.24	-4.83
Tolerances	--	--	--	--	--	--	--	--
Sample 2	11/21/2025	13:39	94.07	89.24	-4.83	94.07	89.24	-4.83
Sample 1	11/21/2025	13:38	94.07	89.24	-4.83	94.07	89.24	-4.83



Why ISO Indices Matter for Ultra-Dark Measurement

ISO blackness and greyness indices become meaningful only when an instrument can reliably measure very low reflectance values.

Without sufficient signal-to-noise performance, these calculations become unstable.



Reference-Grade Instrument vs Typical QC Instrument

Reference Grade Criteria	Agera L2	Typical QC Instruments
Measurement Geometry	✓	✓
Statistical Stability	✓	✓
Traceability & Reproducibility	✓	✓
CIE Calibrated D65 'A' Illumination	✓	Not typically
Optimized Signal Handling	✓	Not typically
Low-Reflectance Performance	✓	Not typically
Fluorescence Control	✓	Not typically
Role in Industry	Reference, correlation, and standardization	Pass/fail or trend monitoring



Schedule a free color consultation
with our experts



www.hunterlab.com