



Instrument Geometries and Color Measurements Part III: Comparison of 45°/0° and Diffuse/8° Measurements

Absolute Measurements

45°/0° (or 0°/45°) and sphere instruments generally do not give identical absolute results for reflectance measurements. This makes sense when we remember that 45°/0° and 0°/45° instruments measure diffuse reflectance of samples, providing results that agree with visual assessments made with similar illumination and viewing conditions. The usual mode for sphere instruments is reflectance-specular included (diffuse plus specular reflectance). The measurements obtained for a single green tile using an UltraScan XE sphere instrument in RSIN and RSEX modes were compared to those obtained from a LabScan XE 0°/45° as shown in the table below. Two readings were made for each instrument mode and averaged.

Sphere RSIN ID	L (D65/ 10°)	a (D65/ 10°)	b (D65/ 10°)	Sphere RSEX ID	L (D65/ 10°)	a (D65/ 10°)	b (D65/ 10°)	0°/45° ID	L (D65/ 10°)	a (D65/ 10°)	b (D65/ 10°)
Read 1	49.30	-16.33	7.82	Read 1	43.77	-18.24	8.92	Read 1	44.99	-18.79	9.60
Read 2	49.31	-16.34	7.83	Read 2	43.77	-18.23	8.92	Read 2	44.97	-18.77	9.60
Avg	49.31	-16.34	7.83	Avg	43.77	-18.24	8.92	Avg	44.98	-18.78	9.60
Difference between sphere RSIN values and 0°/45° values									4.33	2.44	-1.77

As you can see, the numbers are in the same ballpark, but are not close enough to meet the specifications of most companies. It is always advisable to compare absolute measurements only from instruments of the *same geometry*. Preferably, these instruments would also be of the same brand and model so that inner dimensions and other instrument specifications would not cause the readings to differ. If this is not possible, however, difference measurements can be compared more reliably than absolute measurements.

Difference Measurements

When used to measure color differences between items that are **equal in gloss and surface texture**, the two types of instruments will give very similar or equal results. An illustration is provided in the table

below. Two green paint chips of equal gloss and texture were measured on an UltraScan XE (in RSIN mode) and a LabScan XE 0°/45°. The first chip (Chip 1) was measured as a standard (twice), and the second chip (Chip 2) was measured as a sample. The difference data is provided below.

Sphere ID	ΔL^* (D65/10°)	Δa^* (D65/10°)	Δb^* (D65/10°)	45°/0° ID	ΔL^* (D65/10°)	Δa^* (D65/10°)	Δb^* (D65/10°)
Reading 1	-0.77	0.19	-0.23	Reading 1	-0.98	0.15	-0.17
Reading 2	-0.78	0.19	-0.22	Reading 2	-0.96	0.19	-0.24
Average	-0.78	0.19	-0.23	Average	-0.97	0.17	-0.21
Difference between sphere values and 45°/0° values					0.21	0.02	0.02

For samples where **surface texture or gloss differs**, the agreement in difference measurements is not as good. To illustrate this, two pieces of white paper, one glossy and the other flat, were analyzed on a ColorQuest XE (sphere) and a ColorQuest 45/0. The glossy paper was measured twice on each instrument as a standard, and the flat paper was also measured twice. There was a 90° rotation of each paper between the two measurements and the papers were backed with a white tile to ensure opacity. The difference data is shown below.

Sphere ID	ΔL (D65/10°)	Δa (D65/10°)	Δb (D65/10°)	45°/0° ID	ΔL (D65/10°)	Δa (D65/10°)	Δb (D65/10°)
Reading 1	-0.75	-0.32	-1.71	Reading 1	-0.28	-0.55	-1.68
Reading 2	-0.74	-0.32	-1.80	Reading 2	-0.30	-0.53	-1.66
Average	-0.75	-0.32	-1.76	Average	-0.29	-0.54	-1.67
Difference between sphere values and 45°/0° values					-0.46	-0.22	-0.09

When comparing measurements made on instruments of different geometries, it is best to compare difference values rather than expect absolute values to correspond.

References

Billmeyer, Fred W., Jr. and Saltzman, Max, *Principles of Color Technology*, New York: John Wiley & Sons, Inc., 1981.

Hunter, Richard S. and Harold, Richard W., *The Measurement of Appearance*, New York: John Wiley & Sons, Inc., 1987.

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