



COLOR MEASUREMENT

1. Scope and Field of Application

1.1 Scope

This objective method covers an instrumental comparison of a sample's color against a reference by defining measurement conditions and measurement procedures for the measurement of effect colors.

The aim is to instrumentally determine those color differences between sample and reference, which are caused by materials, processing, or which arise after testing of, e.g. aging.

The measurement results are similar to those of the visual perception, but visual assessment according to Ford Laboratory Test Method BI 109-01 will always override numerical measurement data and is compulsory for any type of appearance approval.

1.2 Field of Application

The application differentiates solid (uni) and effect colors and is recommended, but not limited to the following materials:

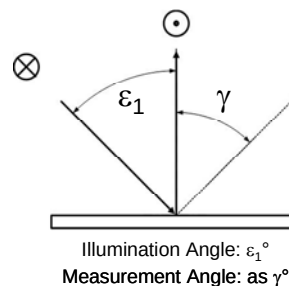
Substrate	Solid Colors (uni)	Effect Colors
Plastic	<ul style="list-style-type: none">- solids with or without texture- painted, excluding effect colors- foils, sheets & slush skins- foam films & foams	<ul style="list-style-type: none">- electroplated, galvanized- painted in effect colors- colored foils and films
Metal	<ul style="list-style-type: none">- painted, excluding effect colors	painted in effect colors
Fabric, excluding multi-colored fabrics	<ul style="list-style-type: none">- not pile-direction sensitive without structure- not pile-direction sensitive with structure- pile-direction sensitive without structure	
Leather	<ul style="list-style-type: none">- Natural- Artificial	

2. Definitions

Terms and definitions in terminology ASTM E284 are applicable to this method. Definitions of terms specific to this method are:

2.1 Angles

45°/0° circumferential – Circumferential illumination under 45° angles to the normal of the surface and measurement in direction of the normal (0°) is recommended for any textured surface.



ε_1° as γ° – ε_1 denotes the angle of directional illumination from the normal of the surface, while γ denotes the measurement angle from the corresponding gloss ($\gamma > 0$: towards illumination; $\gamma < 0$: away from illumination).

Date	Action	Revisions	Rev. 2
2011 10 19	Revision	Interior/exterior alignment & equipment update	
2009 11 20	Released	In reference to national/international standards	



2.2 Color

Solid (uni) color – The appearance is very similar to ideal diffuse reflectors and therefore almost angle-independent, which allows for characterization with one measurement angle, i.e. 45°/0° circumferential. Solid (uni) colored exterior paints only can also be measured with the 45° as 45° geometry.

Effect color – The perceived color is strongly depending on the angles of observation and illumination (goniochromatism). Besides the diffuse reflecting color pigments the surface layers also contain directional reflecting effect particles (metallic, pearlescent, interference, etc.), that require multi-angle measurements, i.e. $\varepsilon_1 = 45^\circ$ with $\gamma = -15^\circ, 15^\circ, 25^\circ, 45^\circ, 75^\circ$ and 110° .

2.3 Instrument

Master instrument – The Master Instrument is an instrument to establish the basic references among various levels of standards and among other equipments. This instrument is the normal arbiter in any situation not adequately resolved at a lower level and is retained by the organization that issues the masters.

Secondary instrument – A Secondary Instrument is any other instrument used for color evaluation of the product by reference to the masters.

2.4 Masters

Target – A physical Design idea representation (intended to be developed).

Internal Approval – A physical representation approved to the target released to go to testing.

Final Approval – A physical representation approved to the internal approval released to master.

Master – A physical representation meant to define Design Intent, which is distributed.

Regional Standard – A physical representation of a regional level capability to the master; for distribution within the specific region only (must be coded different to master).

Reference Approval – A visual approval to either a master or regional standard to validate Design Intent and verify feasibility of specific materials.

2.5 Pile-Direction Sensitive

A fabric that appears different after brushing over the surface with the hand.

2.6 Reference

A master or any other physical sample that the measurement of samples is correlated to. If only compared within a sample lot, the one sample is chosen to be reference that is visually closest to the idea/vision of the evaluator.

2.7 Structure

Structures are imprints or regular sewing lines that generate locally different pile heights and therefore lead to visually perceivable contrast differences.



3. Requirements

3.1 General

The evaluator shall be trained on the instrument to be used by either the manufacturer of the equipment, certified dealers or by Ford personnel.

3.2 Equipment & Maintenance

3.2.1 Equipment Requirements

Measurements shall be made with spectrophotometers meeting the requirements of ASTM E805 (45°/0° circumferential) as well as ASTM E2194-09 & ASTM E2539-08 (multi-angle with 45° illumination).

The spectral resolution of the color measuring instrument shall be 10 nm maximum, uniformly distributed over the spectral measuring range from at least 400 - 700 nm. The repeatability of measurements shall be less than 0.05 ΔE^* CIELAB units for the white CERAM Color Standards Series II (CCSSII, formerly BCRA Series II) tile. The inter instrument agreement shall be less than 0.2 ΔE^* CIELAB units for the average of the CCSSII tiles

Daylight illumination (CIE Illuminant D₆₅), Incandescent illumination (CIE Illuminant A) and Fluorescent 'three-band' illumination (CIE Illuminant F11) shall be computable as well as the respective metamerism indices (according to ISO/CIE 23603).

3.2.2 Instruments proposed

Aligned with the differentiation of solid (uni) and effect colors, color spectrophotometers meeting the requirements of this method and therefore recommended are:

Instrument	Solid (uni) Colors	Effect Colors
Master	Konica Minolta CM-2500c CT	Byk mac
Secondary	Byk Gardner spectro guide	X-Rite MA98, 96, 94

3.2.3 Maintenance and Calibration

Maintenance and calibration is of prime importance in providing constant and reliable measurements. The instrument has to be maintained and calibrated in accordance with the instructions of the manufacturer of the equipment.

The instrument shall NOT be calibrated NOR charged within a series of measurements.

The instrument shall be calibrated at least every 8th hour and preferably just prior to the sample measurement, using the white and black calibration tiles furnished by the instrument manufacturer.

At regular intervals or with the 8th hour calibration measurement equipment monitoring needs to be performed and put down in a report. A green or cyan test tile is recommended for this purpose, which is usually provided by the manufacturer of the equipment (alternatively, CCSSII tiles may be used). If the instrument exceeds a tolerance of 0.2 ΔE^* for the required temperature the manufacturer of the equipment or a certified dealer needs to be contacted for assistance and support.

