

# Applications Note

*Insight on Color*

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## Tint Indices

### Background

By definition, the theoretical “perfect white” has reflectance values of 100% across the visible spectrum with corresponding colorimetric values of  $L^* = 100.00$ ,  $a^* = 0.00$ , and  $b^* = 0.00$ . If a white item is near, but not perfectly, white, it may be darker (have a lower  $L^*$  value), and possibly be slightly chromatic, either in the red-green dimension ( $a^*$ ) or in the yellow-blue dimension ( $b^*$ ).

The whiteness indices (described in the *Applications Note* entitled “Whiteness Index”) are biased in the blue-yellow dimension, such that higher whiteness index values are obtained if the white material is lighter or slightly bluer than the perfect white, and lower whiteness index values are obtained if the white material is darker or slightly yellower than the perfect white.

As a supplement, tint indices are biased in the red-green dimension and describe the amount of greenish or reddish tint in products that are close to perfect white. Negative tint values indicate a reddish cast (slightly positive  $a^*$ ), while positive tint values indicate a greenish cast (slightly negative  $a^*$ ). The tint indices are highly sensitive to color change, and make it easy to quantify very small lot-to-lot differences between white materials. There are three types of tint available using HunterLab instruments: CIE Tint, ASTM E313 Tint, and Ganz Tint. These indices are companion indices to the CIE Whiteness, ASTM E313 Whiteness, and Ganz Whiteness indices, respectively.

### Conditions for Measurement

**Instrumental:** ColorFlex, ColorQuest 45/0 LAV, ColorQuest II Sphere, ColorQuest XE, LabScan XE, MiniScan XE Plus, UltraScan XE, UltraScan PRO, and UltraScan VIS using **EasyMatch QC, Universal Software, and EasyMatch Coatings** (Tint GANZ available only for ColorQuest XE, LabScan XE, UltraScan XE, UltraScan PRO, and UltraScan VIS with the UV control option installed); SpectraProbe XE using **EasyMatch OL**; **ColorFlex and MiniScan XE** stand-alone instruments (ASTM E313 Tint only); **ColorTrend HT** (ASTM E313 Tint only)

### Illuminant/Observer Combinations (as available in HunterLab software and firmware):

ASTM E313 Tint: D65/10°, D65/2°, C/10°, C/2°, D50/10°, D50/2°

CIE Tint: D65/10°, D65/2°, C/2°

Ganz Tint: D65/10°

The combination that is common to all test organizations is D65/10° and this combination is recommended if there are no conflicting requirements.

**Transmittance and/or Reflectance:** Reflectance**Formulas**

The three tint indices are defined below.

**CIE Tint and ASTM E313 Tint** are calculated using the same equation, given below, but are available for different illuminant/observer combinations, as described above. Refer to CIE Publication 15:2004, *Colorimetry*, for more information on CIE Tint. Refer to ASTM E313, “Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates,” for more information on ASTM E313 Tint.

$$\text{Tint E313} = T_x (x_n - x) - 650 (y_n - y) = \text{Tint CIE}$$

where  $x$  and  $y$  are the chromaticity coordinates of the specimen and  $x_n$  and  $y_n$  are the chromaticity coordinates for the CIE standard illuminant used. These values are provided in the table below based on the illuminant and observer used. The  $T_x$  coefficient is also given in the table. The tint value is not calculated for any other illuminant/observer combinations.

Value	C/2°	D50/2°	D65/2°	C/10°	D50/10°	D65/10°
$T_x$	1000	1000	1000	900	900	900
$x_n$	0.3101	0.3457	0.3127	0.3104	0.3477	0.3138
$y_n$	0.3161	0.3585	0.3290	0.3191	0.3595	0.3310

$$\text{Tint GANZ} = mx + ny + k$$

where

$$m = \frac{-\cos(\alpha)}{BW} = -937.588$$

$$n = \frac{\sin(\alpha)}{BW} = 826.697$$

$$k = -m\bar{x} - n\bar{y} = 21.352$$

$x$  and  $y$  are the CIE chromaticity coordinates.

*Note: Only the ColorQuest XE, LabScan XE, UltraScan XE, UltraScan PRO, and UltraScan VIS instruments with the UV control option installed may correctly calculate Ganz Tint.*

**Typical Applications**

Products that can be considered white, such as paint, plastics, paper, and textiles.

A few caveats regarding measurement of tint:

- The application of the tint indices is restricted to samples that are called “white” commercially, that are similar to each other in color and fluorescence, and that are measured on the same instrument at the same time. Under these conditions, their use should give relative, but not absolute, evaluations of tint that are adequate for commercial use.

- The more positive the value of tint, the greater is the indicated greenish tint of the sample. The more negative the value of tint, the greater is its reddish tint. Lines of equal tint are approximately parallel to the line of dominant wavelength 466 nm. For perfect white, tint = 0.
- Equal differences in tint values do not always represent equal perceptual differences in tint.
- Tint index should only be used for samples having tint values between -3 and +3. Outside this range, the chromatic content is considered to be beyond where tint can be used effectively and  $L^*a^*b^*$  should be reported instead.

## References

AATCC Test Method 110, "Whiteness of Textiles," AATCC, Research Triangle Park, North Carolina, [www.aatcc.org](http://www.aatcc.org).

ASTM E313, "Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates," ASTM, West Conshohocken, Pennsylvania, [www.astm.org](http://www.astm.org).

CIE Publication 15:2004, *Colorimetry*, 3<sup>rd</sup> ed., CIE, Wien, Austria, [www.cie.co.at](http://www.cie.co.at).

Griesser, Rolf, "Assessment of Whiteness and Tint of Fluorescent Substrates with Good Interinstrument Correlation," *Color Research and Application*, **19**:6, 1994.

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