

# TUB registration: 20230701-eej6/eej6l0np.pdf /ps

TUB material: code=rha4ta



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$$\log[L^*_{r,TUBJND}] \text{ relative lightness normalized to the background lightness } L^*_{u,TUBJND}$$

$$100L^*_{TUBJND} = (t/a) \ln(1+a \cdot Y)$$

$$L^*/L^*_u = \ln(1+a \cdot Y) / \ln(1+a \cdot Y_u)$$

$$L^*/L^*_u = \ln[1+b \cdot (Y/Y_u)] / \ln(1+b)$$

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$$\log[\Delta Y / \Delta Y_u] \Delta Y_{TUBJND} \text{ tristimulus-value difference normalized to } \Delta Y_{u,TUBJND}$$

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$$\text{Lightness } L^* \text{ and differences } \Delta Y \text{ or } dY \text{ in the colour space TUBJND}$$

The lightness  $L^*$  is defined by the equation:

$$L^*_{TUBJND} = (t/a) \ln[1+b \cdot (Y/Y_u)] = (t/a) \ln[1+b \cdot (Y_u/Y)]$$

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This equation is based on psychophysical BAM-research results

$$dY = (s + q \cdot Y) \cdot c, \text{ see Richter BAM-Forschungsbericht 115, 1985}$$

There are different versions of these equations, all with equal content

$$dY = (A_1 + A_2 \cdot Y) / A_0, \text{ see CIE 230; Eq. (A.7a)}$$

$$dY = (1+b \cdot Y) / t = (1+b \cdot (Y/Y_u)) / t$$

$$A_1 = -0,0170 A_2 = 0,0058 A_0 = c = 1,5 \quad (c = \text{scaling constant})$$

The lightness  $L^*$  is called the line element of  $dY$ , see the equation

$$L^*_{TUBJND}(Y) = \int \frac{t \cdot dY}{[1+a \cdot Y]} = (t/a) \ln[1+a \cdot Y]$$

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**Line-element examples for grey samples ( $0 \leq x = Y/Y_u \leq 5$ )**

$F(x)$  is called the line-element function of  $f(x)$ .  
The following relations are valid for  $x = Y/Y_u = Y_u/18$ :

$$\frac{dF(x)}{dx} = f(x) \quad [1]$$

$$F(x) = \int \frac{f'(x)}{f(x)} dx \quad [2]$$

Example for all normalized tristimulus values  $x = Y/Y_u$ , for example for  $Y_u = 3,6, Y_u = 18, Y_u = 90$ .

$$\frac{d(t \ln(1+b \cdot x))}{dx} = \frac{tb}{1+b \cdot x} \quad [3]$$

$$t \ln(1+b \cdot x) = \int \frac{tb}{1+b \cdot x} dx \quad [4]$$

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TUB-test chart eej6; TUBJND colour space and colour differences, see CIE 230:2019  
 $\log[\text{lightness } L^*, \text{ threshold } \Delta Y, \text{ sensitivity } \Delta Y/Y, \text{ contrast } Y/\Delta Y]$ , unnormalized and normalized for U