

Contrast step  $C_{Yi}$  (i=1 to 8), CIE tristimulus value  $Y_N$ , grey steps according to ISO 9241-306<sup>1)</sup>

| Contrast step<br>$C_{Yi}$ and Y<br>-ratio<br>(i=1 .. 8) | CIE tristi-<br>mulus value<br>$Y_N$ and CIE<br>lightness<br>$L^*_N$ of<br>black | total<br>viewing<br>display<br>illuminance<br>$E_{P+R}$<br>[lux] <sup>3)</sup> | measured<br>projector<br>(P) display<br>illuminance<br>$E_P$<br>[lux] <sup>3)</sup> | room light<br>(R) display<br>illuminance<br>$E_R$<br>[lux] <sup>3)</sup> | grey steps<br>without<br>output<br>linearisation<br>$\Delta L^*=1$<br>amount $a_n$ <sup>2)</sup> | grey steps<br>with<br>output<br>linearisation<br>$\Delta L^*=1$<br>amount $a_1$ <sup>2)</sup> |
|---|---|--|---|--|--|---|
| $C_{Y8}$ 288:1  | 0,31 / 1  | 80000+64000  | 143500  | 500  | 47 (max)   | 94 (max)  |
| $C_{Y7}$ 144:1  | 0,62 / 6  | 40000+32000  | 61500   | 500  | 44   | 88  |
| $C_{Y6}$ 72:1   | 1,25 / 11   | 20000+16000  | 35500   | 500  | 42   | 84  |
| $C_{Y5}$ 36:1   | 2,5 / 18  | 10000+8000   | 17500   | 500  | 38   | 77  |
| $C_{Y4}$ 18:1   | 5,0 / 27  | 5000+4000  | 8500  | 500  | 34   | 68  |
| $C_{Y3}$ 9:1  | 10 / 38   | 2500+2000  | 4000  | 500  | 28   | 57  |
| $C_{Y2}$ 4,5:1  | 20 / 52   | 1250+1000  | 1750  | 500  | 21   | 43  |
| $C_{Y1}$ 2,25:1   | 40 / 70   | 625+500  | 625   | 500  | 12   | 25  |

- 1) The example is intended for data projectors (P). The standard contrast step (bold)  $C_{Y5} = 36:1$  is hard to reach.  
2) For the amount of discriminable colour steps use the equations:  $c_n = a_n^3$  or  $c_l = a_l^3$ , for example  $c_n = 4096$  for  $a_n = 16$ .  
3) For the contrast  $C_Y=2:1$  the viewing luminances of both the black in the projection and the white standard offset paper are equal (!).  
Visual fatigue caused by the adaptation luminance ratio 36:1 of the black at the screen and the black at the paper shall be reduced.  
If for example a grey screen with the CIE tristimulus value  $Y_Z = 22,2$  ( $=0,25 \cdot 88,9$ ) is used the contrast step  $C_{Yi}$  remains constant.  
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

AE980-3N

Contrast step  $C_{Yi}$  (i=1 to 8) and absolute and relative Gamma according to ISO 9241-306<sup>1)</sup>

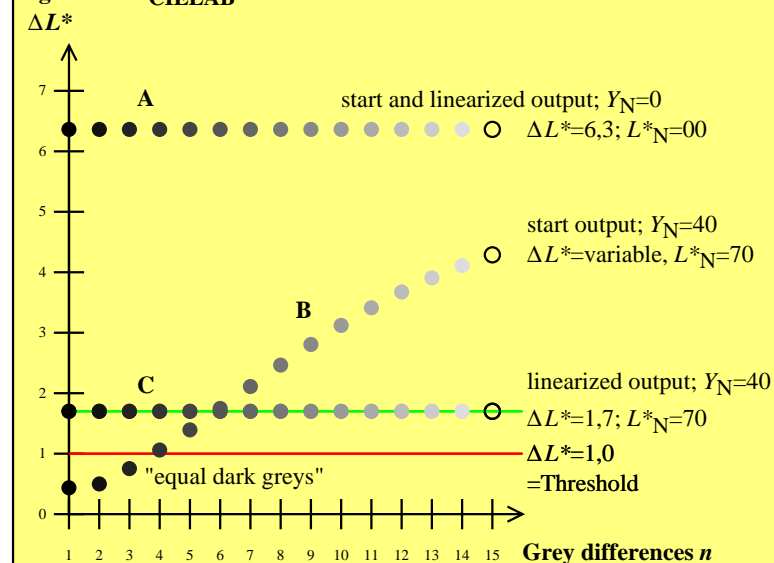
| Contrast step<br>$C_{Yi}$ and Y<br>-ratio<br>(i=1 .. 8) | CIE tristi-<br>mulus value;<br>ratio<br>$Y_W : Y_N$<br>White W<br>and Black N | CIE tristi-<br>mulus value;<br>range<br>$Y_{N1} \dots Y_{N2}$ | absolute<br>Gamma<br>$G_{Pk}$ (k=0 to 7)<br>for display (P)<br>with $G_{P0}=2,4$ <sup>2)</sup><br>$G_{Pk}=2,4 \cdot 0,18^k$ | relative<br>Gamma<br>$g_{Pk}$ (k=0 to 7)<br>for display (P)<br>with $G_{P0}=2,4$ <sup>2)</sup><br>$g_{Pk}=G_{Pk}/2,4$ | application and<br>colour mode<br>at work place;<br>illuminance<br>on display 500 lux<br>or 250/125/62 lux |
|---|---|---|---|---|--|
| $C_{Y8}$ 288:1  | 88,9 : 0,31   | 0,00 ... <0,46  | $G_{P0} = 2,40$   | $g_{P0} = 1,000$  | display, only 062 lux  |
| $C_{Y7}$ 144:1  | 88,9 : 0,62   | 0,46 ... <0,93  | $G_{P1} = 2,22$   | $g_{P1} = 0,925$  | display, only 125 lux  |
| $C_{Y6}$ 72:1   | 88,9 : 1,25   | 0,93 ... <1,87  | $G_{P2} = 2,04$   | $g_{P2} = 0,850$  | display, only 250 lux  |
| $C_{Y5}$ 36:1   | 88,9 : 2,50   | 1,87 ... <3,75  | $G_{P3} = 1,86$   | $g_{P3} = 0,775$  | display and surface  |
| $C_{Y4}$ 18:1   | 88,9 : 5,00   | 3,75 ... <7,50  | $G_{P4} = 1,68$   | $g_{P4} = 0,700$  | display and surface  |
| $C_{Y3}$ 9:1  | 88,9 : 10,0   | 7,50 ... <15,0  | $G_{P5} = 1,50$   | $g_{P5} = 0,625$  | display and surface  |
| $C_{Y2}$ 4,5:1  | 88,9 : 20,0   | 15,0 ... <30,0  | $G_{P6} = 1,32$   | $g_{P6} = 0,550$  | display and surface  |
| $C_{Y1}$ 2,25:1 <sup>3)</sup>                           | 88,9 : 40,0   | 30,0 ... <60,0  | $G_{P7} = 1,14$   | $g_{P7} = 0,475$  | display and surface  |

- 1) The example is intended for data projectors (P) with  $G_{P0}=2,4$ , compare IEC 61966-2-1:  $G_{P0}=2,4$ .  
2) The computer operating system Apple has used the value 1,8 until 2010. The change to 2,4 (= Windows) is in the wrong direction.  
3) For the contrast  $C_Y=2:1$  the viewing luminances of both the black in the projection and the white standard offset paper are equal (!).  
Visual fatigue caused by the adaptation luminance ratio 36:1 of the black at the screen and the black at the paper shall be reduced.  
If for example a grey screen with the CIE tristimulus value  $Y_Z = 22,2$  ( $=0,25 \cdot 88,9$ ) is used the contrast step  $C_{Yi}$  remains constant.  
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

AE980-7N

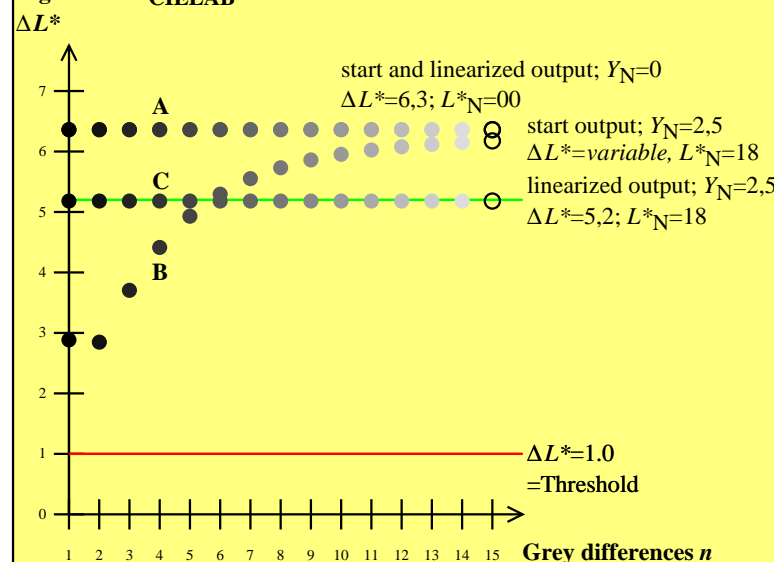
Test chart AE98;  $\Delta L^*$  of grey steps without and with linearisation  
Luminance reflection  $L^*_r=2,5\%$  and 40%, sRGB display

Lightness  $L^*$  CIELAB



AE981-3N

Lightness  $L^*$  CIELAB



AE981-7N

input: rgb/cmy0/000n/w set...  
output: ->rgbdd setrgbcolor