

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 $C_{Yi}$ and $Y_N$ -ratio ( $i=1 \dots 8$ )	CIE tristimulus value $Y_N$ and CIE lightness $L^*_N$ of black	total viewing display illuminance $E_{P+R}$ [lux] <sup>3)</sup>	measured projector (P) display illuminance $E_P$ [lux] <sup>3)</sup>	room light (R) display illuminance $E_R$ [lux] <sup>3)</sup>	grey steps without output linearisation $\Delta L^*=1$ amount $a_n^{(2)}$	grey steps with output linearisation $\Delta L^*=1$ amount $a_n^{(2)}$
<b>C<sub>Y8</sub> 288:1</b>	0,31 / 1	80000+64000	143500	500	47 (max)	94 (max)
<b>C<sub>Y7</sub> 144:1</b>	0,62 / 6	40000+32000	61500	500	44	88
<b>C<sub>Y6</sub> 72:1</b>	1,25 / 11	20000+16000	35500	500	42	84
<b>C<sub>Y5</sub> 36:1</b>	<b>2,5 / 18</b>	<b>10000+8000</b>	<b>17500</b>	<b>500</b>	<b>38</b>	<b>77</b>
<b>C<sub>Y4</sub> 18:1</b>	5,0 / 27	5000+4000	8500	500	34	68
<b>C<sub>Y3</sub> 9:1</b>	10 / 38	2500+2000	4000	500	28	57
<b>C<sub>Y2</sub> 4,5:1</b>	20 / 52	1250+1000	1750	500	21	43
<b>C<sub>Y1</sub> 2,25:1</b>	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:  $c_n = a_n^2$  or  $c_1 = a_1^2$ , for example  $c_8 = 4096$  for  $a_8 = 16$ .  
 3) For the contrast  $C_{Yi}$ -2:1 the viewing luminances of both the black in the projection and the white standard offset paper are equal (1).  
 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  $Y_2 = 22,2$  ( $\approx 0,25 \cdot 88,9$ ) is used the contrast step  $C_{Y1}$  remains constant.  
 Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

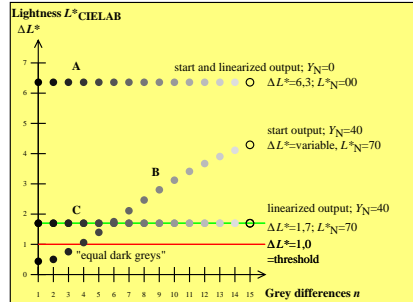
eeb10-3N

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

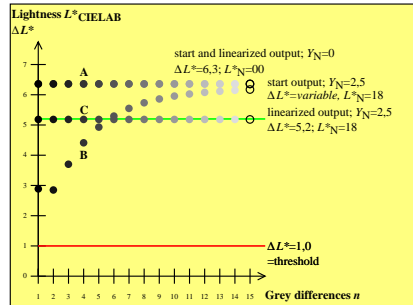
Contrast step $C_{Yi}$ and $Y_N$ -ratio ( $i=1 \dots 8$ )	CIE tristimulus value; ratio $Y_{W1} : Y_{N2}$ White W and Black N	CIE tristimulus value; range $Y_{N1} \dots Y_{N2}$	absolute Gamma $G_{Pk}(k=0$ to 7) for display (P) with $G_{P0}=2,4^{(2)}$ $G_{Pk}=2,4 \cdot 0,18k$	relative Gamma $g_{Pk}(k=0$ to 7) for display (P) with $G_{P0}=2,4^{(2)}$ $g_{Pk}=G_{Pk}/2,4$	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
<b>C<sub>Y8</sub> 288:1</b>	88,9 : 0,31	0,00 ... <0,46	$G_{P0} = 2,40$	$g_{P0} = 1,000$	display, only 062 lux
<b>C<sub>Y7</sub> 144:1</b>	88,9 : 0,62	0,46 ... <0,93	$G_{P1} = 2,22$	$g_{P1} = 0,925$	display, only 125 lux
<b>C<sub>Y6</sub> 72:1</b>	88,9 : 1,25	0,93 ... <1,87	$G_{P2} = 2,04$	$g_{P2} = 0,850$	display, only 250 lux
<b>C<sub>Y5</sub> 36:1</b>	<b>88,9 : 2,50</b>	<b>1,87 ... &lt;3,75</b>	<b><math>G_{P3} = 1,86</math></b>	<b><math>g_{P3} = 0,775</math></b>	<b>display and surface</b>
<b>C<sub>Y4</sub> 18:1</b>	88,9 : 5,00	3,75 ... <7,50	$G_{P4} = 1,68$	$g_{P4} = 0,700$	display and surface
<b>C<sub>Y3</sub> 9:1</b>	88,9 : 10,0	7,50 ... <15,0	$G_{P5} = 1,50$	$g_{P5} = 0,625$	display and surface
<b>C<sub>Y2</sub> 4,5:1</b>	88,9 : 20,0	15,0 ... <30,0	$G_{P6} = 1,32$	$g_{P6} = 0,550$	display and surface
<b>C<sub>Y1</sub> 2,25:1</b>	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  $C_{Yi}$ -2:1 the viewing luminances of both the black in the projection and the white standard offset paper are equal (1).  
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 If for example a grey screen with the CIE tristimulus value  $Y_2 = 22,2$  ( $\approx 0,25 \cdot 88,9$ ) is used the contrast step  $C_{Y1}$  remains constant.  
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eeb10-7N



eeb11-3N



eeb11-7N

TUB-test chart eeb1;  $\Delta L^*$  of grey steps without & with linearisation; 8 contrast steps ISO 9241-306  
 Luminance reflection  $L^*_T=2,5\%$  and 40%, sRGB display; Reflection of standard white 88,9%

see similar files of the whole series: <http://farbe.li.tu-berlin.de/eeb/1eeb1.htm>  
 technical information: <http://farbe.li.tu-berlin.de> or <http://color.li.tu-berlin.de>

TUB registration: 20230801-eeb110n1.txt /ps  
 application for evaluation and measurement of display or print output  
 TUB material: code=th4ta