

Contrast step C_{Yi} ($i=1$ to 8), CIE tristimulus value Y_N , grey steps according to ISO 9241-306¹⁾

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 illuminance E_{P+R} [lux] ³⁾	measured projector (P) display illuminance E_P [lux] ³⁾	room light (R) display illuminance E_R [lux] ³⁾	grey steps without output linearisation $\Delta L^*=1$ amount a_n^2	grey steps with output linearisation $\Delta L^*=1$ amount a_n^2
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

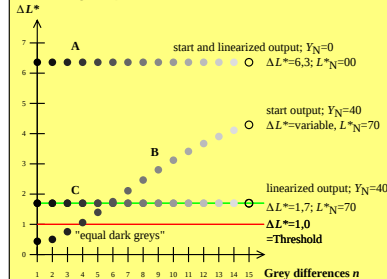
- 1) The example is intended for data projectors (P). The standard contrast step (bold) $C_{Y5} = 36:1$ is hard to reach.
2) For the amount of discriminable colour steps use the equations: $c_n = a_n^2$ or $c_1 = a_1^2$, for example $c_8 = 4096$ for $a_8 = 16$.
3) For the contrast C_{Yi} 2:1 the viewing 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.
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.

Contrast step C_{Yi} ($i=1$ to 8) and absolute and relative Gamma according to ISO 9241-306¹⁾

Contrast step C_{Yi} and Y_N -ratio ($i=1 \dots 8$)	CIE tristimulus value; range $Y_{N1} \dots Y_{N2}$	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
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	88,9 : 40,0	30,0 ... <60,0	$G_{P7} = 1,14$	$g_{P7} = 0,475$	display and surface

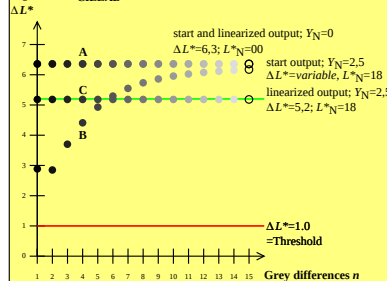
- 1) The example is intended for data projectors (P) with $G_{P0}=2,4$. compare IEC 61966-2-1: $G_{P0}=2,4$.
2) The computer operating system Apple has used the value 1,8 until 2010. The change to 2,4 (= Windows) is in the wrong direction.
3) For the contrast C_{Yi} 2:1 the viewing luminances of both the black in the projection and the white standard offset paper are equal (1).
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.
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.

Lightness L^* CIE LAB



AES41-3N

Lightness L^* CIE LAB



AES41-7N

TUB-test chart AES4; L^* difference of 16 grey steps
Change of spacing by two reflections: $L^*=2,5\%$ and 40% , sRGB display

input: $rgb/cmy0/000k/n$