

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

Contrast step C_{Y_i} and Y-ratio ($i=1 \dots 8$)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	CIE tristimulus values; Range $Y_{N1} \dots Y_{N2}$	absolute Gamma G_{P_k} ($k=0$ to 7) for display (P) with $G_{P_0}=2,4^{2)}$ $G_{P_k}=2,4-0,18k$	relative Gamma g_{P_k} ($k=0$ to 7) for display (P) with $G_{P_0}=2,4^{2)}$ $g_{P_k}=G_{P_k}/2,4$	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
C_{Y_8} 288:1	88,9 : 0,31	0,00 ... <0,46	$G_{P_0} = 2,40$	$g_{P_0} = 1,000$	display, only 062 lux
C_{Y_7} 144:1	88,9 : 0,62	0,46 ... <0,93	$G_{P_1} = 2,22$	$g_{P_1} = 0,925$	display, only 125 lux
C_{Y_6} 72:1	88,9 : 1,25	0,93 ... <1,87	$G_{P_2} = 2,04$	$g_{P_2} = 0,850$	display, only 250 lux
C_{Y_5} 36:1	88,9 : 2,50	1,87 ... <3,75	$G_{P_3} = 1,86$	$g_{P_3} = 0,775$	display & surface
C_{Y_4} 18:1	88,9 : 5,00	3,75 ... <7,50	$G_{P_4} = 1,68$	$g_{P_4} = 0,700$	display & surface
C_{Y_3} 9:1	88,9 : 10,0	7,50 ... <15,0	$G_{P_5} = 1,50$	$g_{P_5} = 0,625$	display & surface
C_{Y_2} 4,5:1	88,9 : 20,0	15,0 ... <30,0	$G_{P_6} = 1,32$	$g_{P_6} = 0,550$	display & surface
C_{Y_1} 2,25:1 ³⁾	88,9 : 40,0	30,0 ... <60,0	$G_{P_7} = 1,14$	$g_{P_7} = 0,475$	display & surface

- 1) The example is intended for data projectors (P) with $G_{P_0}=2,4$. Compare IEC 61966-2-1: $G_{P_0}=2,4$.
- 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_{Y_1} 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 steps C_{Yi} ($i=1$ to 8), and absolute and relative Gamma according to ISO 9241-306¹⁾

Contrast step C_{Yi} and Y-ratio ($i=1 \dots 8$)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	CIE tristimulus values; Range $Y_{N1} \dots Y_{N2}$	absolute Gamma G_{Pk} ($k=-3$ to 4) for display (P) with $G_{P0}=1,86^{2)}$ $G_{Pk}=1,86-0,18k$	relative Gamma g_{Pk} ($k=-3$ to 4) for display (P) with $G_{P0}=1,86^{2)}$ $g_{Pk}=G_{Pk}/1,86$	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	$G_{P,-3} = 2,40$	$g_{P,-3} = 1,29$	display, only 062 lux
C_{Y7} 144:1	88,9 : 0,62	0,46 ... <0,93	$G_{P,-2} = 2,22$	$g_{P,-2} = 1,20$	display, only 125 lux
C_{Y6} 72:1	88,9 : 1,25	0,93 ... <1,87	$G_{P,-1} = 2,04$	$g_{P,-1} = 1,10$	display, only 250 lux
C_{Y5} 36:1	88,9 : 2,50	1,87 ... <3,75	$G_{P0} = 1,86$	$g_{P0} = 1,00$	display & surface
C_{Y4} 18:1	88,9 : 5,00	3,75 ... <7,50	$G_{P1} = 1,68$	$g_{P1} = 0,90$	display & surface
C_{Y3} 9:1	88,9 : 10,0	7,50 ... <15,0	$G_{P2} = 1,50$	$g_{P2} = 0,81$	display & surface
C_{Y2} 4,5:1	88,9 : 20,0	15,0 ... <30,0	$G_{P3} = 1,32$	$g_{P3} = 0,71$	display & surface
C_{Y1} 2,25:1 ³⁾	88,9 : 40,0	30,0 ... <60,0	$G_{P4} = 1,14$	$g_{P4} = 0,61$	display & surface

- 1) The example is intended for data projectors (P) with $G_{P0}=1,86$. Compare NTSC television: $G_{P0}=1,8$.
- 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_{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 steps C_{Y_i} ($i=1$ to 8), CIE tristimulus values Y_W and Y_N according to ISO 9241-306¹⁾

Contrast step C_{Y_i} and Y -ratio ($i=1 \dots 8$)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	CIE tristimulus values; Range $Y_{N1} \dots Y_{N2}$	Paper (S) luminance ²⁾ ; Ratio $[cd/m^2]$ $L_{WS} : L_{NS}$	Display (P) luminance ²⁾ ; Ratio $[cd/m^2]$ $L_{WP} : L_{NP}$	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
C_{Y_8} 288:1	88,9 : 0,31	0,00 ... <0,46	142 : 142/288	142*36 : 018	display, only 062 lux
C_{Y_7} 144:1	88,9 : 0,62	0,46 ... <0,93	142 : 142/144	142*36 : 035	display, only 125 lux
C_{Y_6} 72:1	88,9 : 1,25	0,93 ... <1,87	142 : 142/72	142*36 : 071	display, only 250 lux
C_{Y_5} 36:1	88,9 : 2,50	1,87 ... <3,75	142 : 142/36	142*36 : 142	display & surface
C_{Y_4} 18:1	88,9 : 5,00	3,75 ... <7,50	142 : 142/18	142*18 : 142	display & surface
C_{Y_3} 9:1	88,9 : 10,0	7,50 ... <15,0	142 : 142/09	142*09 : 142	display & surface
C_{Y_2} 4,5:1	88,9 : 20,0	15,0 ... <30,0	142 : 142/4,5	142*4,5 : 142	display & surface
C_{Y_1} 2,25:1³⁾	88,9 : 40,0	30,0 ... <60,0	142 : 142/2,25	142*2,25 : 142	display & surface

1) The example is intended for data projectors (P). The standard contrast step (bold) with $L_{WP}=142*36 \text{ cd/m}^2$ is hard to reach.

2) 500 lux corresponds to the viewing luminance $L_v=142 \text{ cd/m}^2$ for a standard white paper with the tristimulus value $Y_W=88,9$.

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 $Y_Z = 22,2 (=0,25*88,9)$ is used the contrast step C_{Y_1} 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 steps C_{Y_i} ($i=1$ to 8), CIE tristimulus values Y_W and Y_N according to ISO 9241-306¹⁾

Contrast step C_{Y_i} and Y -ratio ($i=1 \dots 8$)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	CIE tristimulus values; Range $Y_{N1} \dots Y_{N2}$	Paper (S) luminance ²⁾ ; Ratio $[cd/m^2]$ $L_{WS} : L_{NS}$	Display (P) luminance ²⁾ ; Ratio $[cd/m^2]$ $L_{WP} : L_{NP}$	application and colour mode at work place; illuminance on display 125 lux or 62/31/15 lux
C_{Y_8} 288:1	88,9 : 0,31	0,00 ... <0,46	142 : 142/288	36*36 : 4,5	display, only 15 lux
C_{Y_7} 144:1	88,9 : 0,62	0,46 ... <0,93	142 : 142/144	36*36 : 09	display, only 31 lux
C_{Y_6} 72:1	88,9 : 1,25	0,93 ... <1,87	142 : 142/72	36*36 : 18	display, only 62 lux
C_{Y_5} 36:1	88,9 : 2,50	1,87 ... <3,75	142 : 142/36	36*36 : 36	display & surface
C_{Y_4} 18:1	88,9 : 5,00	3,75 ... <7,50	142 : 142/18	36*18 : 36	display & surface
C_{Y_3} 9:1	88,9 : 10,0	7,50 ... <15,0	142 : 142/09	36*09 : 36	display & surface
C_{Y_2} 4,5:1	88,9 : 20,0	15,0 ... <30,0	142 : 142/4,5	36*4,5 : 36	display & surface
C_{Y_1} 2,25:1³⁾	88,9 : 40,0	30,0 ... <60,0	142 : 142/2,25	36*2,25 : 36	display & surface

- 1) The example is intended for data projectors (P). The standard contrast step (bold) with $L_{WP}=36*36 \text{ cd/m}^2$ is hard to reach.
- 2) 125 lux corresponds to the viewing luminance $L_v=36 \text{ cd/m}^2$ for a standard white paper with the tristimulus value $Y_W=88,9$.
- 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 $Y_Z = 22,2 (=0,25*88,9)$ is used the contrast step C_{Y_1} remains constant. Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.