**Contrast steps $C_{Yi}$ (i=1 to 8), and absolute and relative Gamma according to ISO 9241−306[1)]**

| Contrast step $C_{Yi}$ and Y-ratio (i=1 .. 8) | CIE tristimulus values; Ratio $Y_W : Y_N$ of White $W$ and Black $N$ | CIE tristimulus values; Range $Y_{N1}$ ... $Y_{N2}$ | absolute Gamma $G_{Pk}$(k=0 to 7) for display (P) with $G_{P0}$=2,4[2)] $G_{Pk}$=2,4−0,18k | 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 & surface** |
| $C_{Y4}$ 18:1 | 88,9 : 5,00 | 3,75 ... <7,50 | $G_{P4}$ = 1,68 | $g_{P4}$ = 0,700 | display & surface |
| $C_{Y3}$ 9:1 | 88,9 : 10,0 | 7,50 ... <15,0 | $G_{P5}$ = 1,50 | $g_{P5}$ = 0,625 | display & surface |
| $C_{Y2}$ 4,5:1 | 88,9 : 20,0 | 15,0 ... <30,0 | $G_{P6}$ = 1,32 | $g_{P6}$ = 0,550 | display & surface |
| $C_{Y1}$ 2,25:1[3)] | 88,9 : 40,0 | 30,0 ... <60,0 | $G_{P7}$ = 1,14 | $g_{P7}$ = 0,475 | display & 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 $C_{Y1}$ =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 $Y_S$ = 22,2 (=0,25*88.9) is used the contrast step $C_{Y5}$ remains constant.
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

PE050−3N

**Contrast steps $C_{Yi}$ (i=1 to 8), and absolute and relative Gamma according to ISO 9241−306[1)]**

| Contrast step $C_{Yi}$ and Y-ratio (i=1 .. 8) | CIE tristimulus values; Ratio $Y_W : Y_N$ of White $W$ and Black $N$ | CIE tristimulus values; Range $Y_{N1}$ ... $Y_{N2}$ | 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 $C_{Y1}$ =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 $Y_S$ = 22,2 (=0,25*88.9) is used the contrast step $C_{Y5}$ remains constant.
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

PE050−7N

**Contrast steps $C_{Yi}$ (i=1 to 8), CIE tristimulus values $Y_W$ and $Y_N$ according to ISO 9241−306[1)]**

| Contrast step $C_{Yi}$ and Y-ratio (i=1 .. 8) | CIE tristimulus values; Ratio $Y_W : Y_N$ of White $W$ and Black $N$ | CIE tristimulus values; Range $Y_{N1}$ ... $Y_{N2}$ | Paper (S) luminance[2)]; Ratio [cd/m²] $L_{WS} : L_{NS}$ | Display (P) luminance[2)]; Ratio [cd/m²] $L_{WP} : L_{NP}$ | 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 | 142 : 142/288 | 142*36 : 018 | display, only 062 lux |
| $C_{Y7}$ 144:1 | 88,9 : 0,62 | 0,46 ... <0,93 | 142 : 142/144 | 142*36 : 035 | display, only 125 lux |
| $C_{Y6}$ 72:1 | 88,9 : 1,25 | 0,93 ... <1,87 | 142 : 142/72 | 142*36 : 071 | display, only 250 lux |
| $C_{Y5}$ 36:1 | **88,9 : 2,50** | **1,87 ... <3,75** | **142 : 142/36** | **142*36 : 142** | **display & surface** |
| $C_{Y4}$ 18:1 | 88,9 : 5,00 | 3,75 ... <7,50 | 142 : 142/18 | 142*18 : 142 | display & surface |
| $C_{Y3}$ 9:1 | 88,9 : 10,0 | 7,50 ... <15,0 | 142 : 142/09 | 142*09 : 142 | display & surface |
| $C_{Y2}$ 4,5:1 | 88,9 : 20,0 | 15,0 ... <30,0 | 142 : 142/4,5 | 142*4,5 : 142 | display & surface |
| $C_{Y1}$ 2,25:1[3)] | 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 cd/m² is hard to reach.**
2) 500 lux corresponds to the viewing luminance $L_S$=142 cd/m² for a standard white paper with the tristimulues value $Y_W$=88,9.
3) For the contrast $C_{Y1}$ =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 $Y_S$ = 22,2 (=0,25*88.9) is used the contrast step $C_{Y5}$ remains constant.
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

PE051−3N

**Contrast steps $C_{Yi}$ (i=1 to 8), CIE tristimulus values $Y_W$ and $Y_N$ according to ISO 9241−306[1)]**

| Contrast step $C_{Yi}$ and Y-ratio (i=1 .. 8) | CIE tristimulus values; Ratio $Y_W : Y_N$ of White $W$ and Black $N$ | CIE tristimulus values; Range $Y_{N1}$ ... $Y_{N2}$ | Paper (S) luminance[2)]; Ratio [cd/m²] $L_{WS} : L_{NS}$ | Display (P) luminance[2)]; Ratio [cd/m²] $L_{WP} : L_{NP}$ | application and colour mode at work place; illuminance on display 125 lux or 62/31/15 lux |
|---|---|---|---|---|---|
| $C_{Y8}$ 288:1 | 88,9 : 0,31 | 0,00 ... <0,46 | 142 : 142/288 | 36*36 : 4,5 | display, only 15 lux |
| $C_{Y7}$ 144:1 | 88,9 : 0,62 | 0,46 ... <0,93 | 142 : 142/144 | 36*36 : 09 | display, only 31 lux |
| $C_{Y6}$ 72:1 | 88,9 : 1,25 | 0,93 ... <1,87 | 142 : 142/72 | 36*36 : 18 | display, only 62 lux |
| $C_{Y5}$ 36:1 | **88,9 : 2,50** | **1,87 ... <3,75** | **142 : 142/36** | **36*36 : 36** | **display & surface** |
| $C_{Y4}$ 18:1 | 88,9 : 5,00 | 3,75 ... <7,50 | 142 : 142/18 | 36*18 : 36 | display & surface |
| $C_{Y3}$ 9:1 | 88,9 : 10,0 | 7,50 ... <15,0 | 142 : 142/09 | 36*09 : 36 | display & surface |
| $C_{Y2}$ 4,5:1 | 88,9 : 20,0 | 15,0 ... <30,0 | 142 : 142/4,5 | 36*4,5 : 36 | display & surface |
| $C_{Y1}$ 2,25:1[3)] | 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 cd/m² is hard to reach.**
2) 125 lux corresponds to the viewing luminance $L_S$=36 cd/m² for a standard white paper with the tristimulues value $Y_W$=88,9.
3) For the contrast $C_{Y1}$ =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 $Y_S$ = 22,2 (=0,25*88.9) is used the contrast step $C_{Y5}$ remains constant.
Then the luminance ratio of all colours at the screen and the paper has reduced to 9:1. This reduces visual fatigue.

PE051−7N

test chart PE05; Contrast steps of emittive displays
Eight contrast steps, and illuminances of displays for 500 lux

input: *w/rgb/cmyk −> rgb_*
output: no change