

Contrast steps  $C_{Y_i}$  (i=1 to 8), CIE tristimulus values  $Y_W$  and  $Y_N$  according to ISO 9241-306<sup>1)</sup>

Contrast step $C_{Y_i}$ and Y-ratio (i=1 .. 8)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	absolute Gamma $G_{P_k}$ (k=0 to 7) for display (E) with $G_{P_0}=2,4^{2)}$ $G_{P_k}=2,4-0,18k$	Display (E) illuminance; Ratio <sup>4)</sup> [lux] $E_{WE} : E_{NE}$	Display (E) luminance; Ratio $L_{WE} : L_{NE}$ [cd/m <sup>2</sup> ]	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
$C_{Y_8}$ <b>288:1</b>	88,9 : 0,31	$G_{P_0} = 2,40$	445 : 1,55	142 : 0,50	display, only 062 lux
$C_{Y_7}$ <b>144:1</b>	88,9 : 0,62	$G_{P_1} = 2,22$	445 : 3,1	142 : 1,00	display, only 125 lux
$C_{Y_6}$ <b>72:1</b>	88,9 : 1,25	$G_{P_2} = 2,04$	445 : 6,2	142 : 2,00	display, only 250 lux
$C_{Y_5}$ <b>36:1<sup>3)</sup></b>	<b>88,9 : 2,50</b>	$G_{P_3} = 1,86$	<b>445 : 12,4</b>	<b>142 : 4,00</b>	<b>display &amp; surface</b>
$C_{Y_4}$ <b>18:1</b>	88,9 : 5,00	$G_{P_4} = 1,68$	445 : 24,8	142 : 8,00	display & surface
$C_{Y_3}$ <b>9:1</b>	88,9 : 10,0	$G_{P_5} = 1,50$	445 : 49,6	142 : 16,0	display & surface
$C_{Y_2}$ <b>4,5:1</b>	88,9 : 20,0	$G_{P_6} = 1,32$	445 : 99,2	142 : 32,0	display & surface
$C_{Y_1}$ <b>2,25:1</b>	88,9 : 40,0	$G_{P_7} = 1,14$	445 : 198	142 : 64,0	display & surface

- 1) The example is intended for emissive displays (E). The standard contrast step (bold)  $C_{Y_5}$  with  $L_{NE} = 4 \text{ cd/m}^2$  may be reached.
- 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  $C_{Y_5}=36:1$  the viewing luminances of both the black paper and the black on the screen are equal. Also the viewing luminances of all colours at the screen and the paper are equal, for example for a 16 step grey scale. For all black surfaces it is valid  $Y_N \geq 2,5$ . Therefore high contrast steps are only possible at the displays by reduced reflection.
- 4) Measurement of 445 (=  $500 \cdot 0,889$ ) lux corresponds to the viewing luminance  $L_V = 142 \text{ cd/m}^2$  for an emissive display (E).

PE060-3N

Contrast steps  $C_{Y_i}$  (i=1 to 8), CIE tristimulus values  $Y_W$  and  $Y_N$  according to ISO 9241-306<sup>1)</sup>

Contrast step $C_{Y_i}$ and Y-ratio (i=1 .. 8)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	absolute Gamma $G_{P_k}$ (k=0 to 7) for display (E) with $G_{P_0}=2,4^{2)}$ $G_{P_k}=2,4-0,18k$	Paper (S) illuminance; Ratio [cd/m <sup>2</sup> ] $L_{WS} : L_{NS}$	Display (E) luminance; Ratio [cd/m <sup>2</sup> ] $L_{WE} : L_{NE}$	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
$C_{Y_8}$ <b>288:1</b>	88,9 : 0,31	$G_{P_0} = 2,40$	142 : 0,50	142 : 0,50	display, only 062 lux
$C_{Y_7}$ <b>144:1</b>	88,9 : 0,62	$G_{P_1} = 2,22$	142 : 1,00	142 : 1,00	display, only 125 lux
$C_{Y_6}$ <b>72:1</b>	88,9 : 1,25	$G_{P_2} = 2,04$	142 : 2,00	142 : 2,00	display, only 250 lux
$C_{Y_5}$ <b>36:1<sup>3)</sup></b>	<b>88,9 : 2,50</b>	$G_{P_3} = 1,86$	<b>142 : 4,00</b>	<b>142 : 4,00</b>	<b>display &amp; surface</b>
$C_{Y_4}$ <b>18:1</b>	88,9 : 5,00	$G_{P_4} = 1,68$	142 : 8,00	142 : 8,00	display & surface
$C_{Y_3}$ <b>9:1</b>	88,9 : 10,0	$G_{P_5} = 1,50$	142 : 16,0	142 : 16,0	display & surface
$C_{Y_2}$ <b>4,5:1</b>	88,9 : 20,0	$G_{P_6} = 1,32$	142 : 32,0	142 : 32,0	display & surface
$C_{Y_1}$ <b>2,25:1</b>	88,9 : 40,0	$G_{P_7} = 1,14$	142 : 64,0	142 : 64,0	display & surface

- 1) The example is intended for emissive displays (E). The standard contrast step (bold)  $C_{Y_5}$  with  $L_{NE} = 4 \text{ cd/m}^2$  may be reached.
- 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  $C_{Y_5}=36:1$  the viewing luminances of both the black paper and the black on the screen are equal. Also the viewing luminances of all colours at the screen and the paper are equal, for example for a 16 step grey scale. A visual fatigue based on an adaptation change between paper and display is excluded. For all black surfaces it is valid  $Y_N \geq 2,5$ . Therefore high contrast steps are only possible at the displays by reduced reflection.

PE060-7N

test chart PE06; Contrast steps of data projectors  
 Eight contrast steps, and illuminances of displays for 500 lux output: no change

Contrast steps  $C_{Y_i}$  (i=1 to 8), CIE tristimulus values  $Y_W$  and  $Y_N$  according to ISO 9241-306<sup>1)</sup>

Contrast step $C_{Y_i}$ and Y-ratio (i=1 .. 8)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	absolute Gamma $G_{P_k}$ (k=0 to 7) for display (P) with $G_{P_0}=2,4^{2)}$ $G_{P_k}=2,4-0,18k$	Paper (S) illuminance; Ratio [cd/m <sup>2</sup> ] $L_{WS} : L_{NS}$	Display (P) luminance; Ratio [cd/m <sup>2</sup> ] $L_{WP} : L_{NP}$	application and colour mode at work place; illuminance on display 500 lux or 250/125/62 lux
$C_{Y_8}$ <b>288:1</b>	88,9 : 0,31	$G_{P_0} = 2,40$	142 : 142/288	142*36 : 018	display, only 062 lux
$C_{Y_7}$ <b>144:1</b>	88,9 : 0,62	$G_{P_1} = 2,22$	142 : 142/144	142*36 : 035	display, only 125 lux
$C_{Y_6}$ <b>72:1</b>	88,9 : 1,25	$G_{P_2} = 2,04$	142 : 142/72	142*36 : 071	display, only 250 lux
$C_{Y_5}$ <b>36:1</b>	<b>88,9 : 2,50</b>	$G_{P_3} = 1,86$	<b>142 : 142/36</b>	<b>142*36 : 142</b>	<b>display &amp; surface</b>
$C_{Y_4}$ <b>18:1</b>	88,9 : 5,00	$G_{P_4} = 1,68$	142 : 142/18	142*18 : 142	display & surface
$C_{Y_3}$ <b>9:1</b>	88,9 : 10,0	$G_{P_5} = 1,50$	142 : 142/09	142*09 : 142	display & surface
$C_{Y_2}$ <b>4,5:1</b>	88,9 : 20,0	$G_{P_6} = 1,32$	142 : 142/4,5	142*4,5 : 142	display & surface
$C_{Y_1}$ <b>2,25:1<sup>3)</sup></b>	88,9 : 40,0	$G_{P_7} = 1,14$	142 : 142/2,25	142*2,25:142	display & surface

- 1) The example is given for data projectors (P). The standard contrast step (bold)  $C_{Y_5}$  with  $L_{WP}=142*36 \text{ cd/m}^2$  is hard to reach.
- 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  $C_{Y_5}=2:1$  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  $Y_Z = 22,2$  (=  $0,25*88,9$ ) 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.

PE061-3N

Contrast steps  $C_{Y_i}$  (i=1 to 8), CIE tristimulus values  $Y_W$  and  $Y_N$  according to ISO 9241-306<sup>1)</sup>

Contrast step $C_{Y_i}$ and Y-ratio (i=1 .. 8)	CIE tristimulus values; Ratio $Y_W : Y_N$ of White W and Black N	absolute Gamma $G_{P_k}$ (k=0 to 7) for display (P) with $G_{P_0}=2,4^{2)}$ $G_{P_k}=2,4-0,18k$	Display (P) illuminance; Ratio [lux] $E_{WP} : E_{NP}$	Display (P) luminance; Ratio [cd/m <sup>2</sup> ] $L_{WP} : L_{NP}$	application and colour mode at work place; illuminance on display 125 lux or 62/31/15 lux
$C_{Y_8}$ <b>288:1</b>	88,9 : 0,31	$G_{P_0} = 2,40$	125*36 : 015	36*36 : 4,5	display, only 15 lux
$C_{Y_7}$ <b>144:1</b>	88,9 : 0,62	$G_{P_1} = 2,22$	125*36 : 031	36*36 : 09	display, only 31 lux
$C_{Y_6}$ <b>72:1</b>	88,9 : 1,25	$G_{P_2} = 2,04$	125*36 : 062	36*36 : 18	display, only 62 lux
$C_{Y_5}$ <b>36:1</b>	<b>88,9 : 2,50</b>	$G_{P_3} = 1,86$	<b>125*36 : 125</b>	<b>36*36 : 36</b>	<b>display &amp; surface</b>
$C_{Y_4}$ <b>18:1</b>	88,9 : 5,00	$G_{P_4} = 1,68$	125*18 : 125	36*18 : 36	display & surface
$C_{Y_3}$ <b>9:1</b>	88,9 : 10,0	$G_{P_5} = 1,50$	125*09 : 125	36*09 : 36	display & surface
$C_{Y_2}$ <b>4,5:1</b>	88,9 : 20,0	$G_{P_6} = 1,32$	125*4,5 : 125	36*4,5 : 36	display & surface
$C_{Y_1}$ <b>2,25:1<sup>3)</sup></b>	88,9 : 40,0	$G_{P_7} = 1,14$	125*2,25:125	36*2,25 : 36	display & surface

- 1) The example is given for data projectors (P). The standard contrast step (bold)  $C_{Y_5}$  with  $L_{WP}=36*36 \text{ cd/m}^2$  is hard to reach.
- 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  $C_{Y_5}=2:1$  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  $Y_Z = 22,2$  (=  $0,25*88,9$ ) 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.

PE061-7N

input: w/rgb/cmyk -> rgb-

see similar files: http://130.149.60.45/~farbmetrik/PE06/PE06.HTM  
 technical information: http://www.ps.bam.de or http://130.149.60.45/~farbmetrik

TUB registration: 20130201-PE06/PE06LONA.TXT /.PS  
 application for measurement of display output  
 TUB material: code=rh4ta