Contrast step C_{Yi}(i=1 to 8), **CIE tristimulus value Y_N, grey steps according to ISO 9241-306**[1)]

Contrast step C_{Yi} and *Y*-ratio (i=1 .. 8)	CIE tristimulus value Y_N and CIE lightness L^*_N of black	total viewing display 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_i[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: $c_n = a_n^{-3}$ or $c_i = a_i^{-3}$, for example c_n = 4096 for a_n = 16.
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_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.

PN040--3N

Contrast step C_{Yi}(i=1 to 8), **CIE tristimulus value Y_N, grey steps according to ISO 9241-306**[1)]

Contrast step C_{Yi} and *Y*-ratio (i=1 .. 8)	CIE tristimulus value Y_N and CIE lightness L^*_N of black	total viewing display illuminance E_{P+R} [lux][2)]	measured projector (P) display illuminance E_P [lux][2)]	room light (R) display illuminance E_R [lux][2)]	grey steps without output linearisation delta L^*=1 amount a_n[3)]	grey steps with output linearisation delta L^*=1 amount a_i[3)]
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

The following example assumes that a projector produces the contrast step C_{Y3} for the illuminances measured for 5 times the horizontal A4 direction (149 cm):

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

The illuminances E_P are by the factor 4 less for 10 times the *A4*-direction (298 cm):

C_{Yx1} **3:1**[4)]	30 / 61	1000+500	1000	500	17	34
C_{Yx2} **1,9:1**[5)]	45 / 74	438+500	438	500	10	21

1) The example is intended for data projectors (P). The standard contrast step (bold) C_{Y5} = 36:1 is not reached.
2) 500 lux corresponds to the viewing luminance L_v=142 cd/m² for a standard white paper with the tristimulus value Y_W=88,9.
3) For the amount of discriminable colour steps use the equations: $c_n = a_n^{-3}$ or $c_i = a_i^{-3}$, for example c_n = 4096 for a_n = 16.
4) The viewing contrast C_{Yx1} = 1500:500 = 3:1 is larger compared to the contrast C_{Y3} = 2,25:1. The contrast step is C_{Y3} = 2,25:1.
5) The viewing contrast C_{Yx2} = 938:500 = 1,9:1 is smaller compared to the contrast C_{Y1} = 2,25:1. A contrast step is not defined.

PN040--7N

Contrast step C_{Yi}(i=1 to 8), **CIE tristimulus value Y_N, grey steps according to ISO 9241-306**[1)]

Contrast step C_{Yi} and *Y*-ratio (i=1 .. 8)	CIE tristimulus value Y_N and CIE lightness L^*_N of black	total viewing display illuminance E_{P+R} [lux][2)]	measured projector (P) display illuminance E_P [lux][2)]	room light (R) display illuminance E_R [lux][2)]	grey steps without output linearisation delta L^*=1 amount a_n[3)]	grey steps with output linearisation delta L^*=1 amount a_i[3)]
C_{Y8} **288:1**	0,31 / 1	19200+16000	35075	125	47 (max)	94 (max)
C_{Y7} **144:1**	0,62 / 6	9600+8000	17475	125	44	88
C_{Y6} **72:1**	1,25 / 11	4800+4000	8675	125	42	84
C_{Y5} **36:1**	**2,5 / 18**	**2400+2000**	**4275**	**125**	**38**	**77**
C_{Y4} **18:1**	5,0 / 27	1200+1000	2075	125	34	68
C_{Y3} **9:1**	10 / 38	600+500	975	125	28	57
C_{Y2} **4,5:1**	20 / 52	300+250	425	125	21	43
C_{Y1} **2,25:1**	40 / 70	150+125	150	125	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: $c_n = a_n^{-3}$ or $c_i = a_i^{-3}$, for example c_n = 4096 for a_n = 16.
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_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.

PN041--3N

Contrast step C_{Yi}(i=1 to 8), **CIE tristimulus value Y_N, grey steps according to ISO 9241-306**[1)]

Contrast step C_{Yi} and *Y*-ratio (i=1 .. 8)	CIE tristimulus value Y_N and CIE lightness L^*_N of black	total viewing display illuminance E_{P+R} [lux][2)]	measured projector (P) display illuminance E_P [lux][2)]	room light (R) display illuminance E_R [lux][2)]	grey steps without output linearisation delta L^*=1 amount a_n[3)]	grey steps with output linearisation delta L^*=1 amount a_i[3)]
C_{Y3} **9:1**	10 / 38	2400+2000	4275	125	38	77
C_{Y2} **4,5:1**	20 / 52	1200+1000	2075	125	34	68
C_{Y1} **2,25:1**	40 / 70	600+500	975	125	28	57

The following example assumes that a projector produces the contrast step C_{Y3} for the illuminances measured for 5 times the horizontal A4 direction (149 cm):

C_{Y4} **36:1**	10 / 38	2400+2000	4275	125	38	77
C_{Y3} **9:1**	20 / 52	1200+1000	2075	125	34	68
C_{Y2} **4,5:1**	40 / 70	600+500	975	125	28	57

The illuminances E_P are by the factor 4 less for 10 times the *A4*-direction (298 cm):

C_{Yx1} **4:1**[4)]	30 / 61	1069+125	1069	125		34
C_{Yx2} **2:1**[5)]	45 / 74	518+125	518	125		21

1) The example is intended for data projectors (P). The standard contrast step (bold) C_{Y5} = 36:1 is not reached.
2) 125 lux corresponds to the viewing luminance L_v=35 cd/m² for a standard white paper with the tristimulus value Y_W=88,9.
3) For the amount of discriminable colour steps use the equations: $c_n = a_n^{-3}$ or $c_i = a_i^{-3}$, for example c_n = 4096 for a_n = 16.
4) The viewing contrast C_{Yx1} = 1194:125 = 8,5:1 is larger compared to the contrast C_{Y2} = 4,5:1. The contrast step is C_{Y2} = 4,5:1.
5) The viewing contrast C_{Yx2} = 643:125 = 5,1:1 is larger compared to the contrast C_{Y2} = 4,5:1. The contrast step is C_{Y2} =4,5:1.

PN041--7N

test chart PN04; Contrast steps of data projectors
Eight contrast steps, and illuminances of displays for 500 lux

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