

Color threshold formula LABJNDS 1985 (JND=just noticeable difference)

$$\Delta E_{JND}^* = Y_0 [(\Delta Y)^2 + (a_0 \Delta a'' \cdot Y)^2 + (b_0 \Delta b'' \cdot Y)^2]^{1/2} / (s + q \cdot Y)^t$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0,4 z/y \quad b_n = -0,4 z_n/y_n$$

$$a'' = a_n + (a - a_n) / (1 + 0,5 |a - a_n|) \quad n = D65 \text{ or } A \text{ (surround)}$$

$$b'' = b_n + (b - b_n) / (1 + 0,5 |b - b_n|)$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a'' = a_1'' - a_2'' \quad \Delta b'' = b_1'' - b_2''$$

$$s = 0,0170 \quad q = 0,0058 \quad t = 1,0$$

$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5$ surround D65

$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0$ surround A

Just noticeable difference (JND) in four colour directions

$$\Delta Y = \text{const} (s + q \cdot Y)^t / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta a'' \cdot Y = \text{const} (s + q \cdot Y)^t / (Y_0 \cdot a_0) \quad \text{in chromaticity direction } RG$$

$$\Delta b'' \cdot Y = \text{const} (s + q \cdot Y)^t / (Y_0 \cdot b_0) \quad \text{in chromaticity direction } YB$$

$$\Delta c_{ab}'' \cdot Y = \text{const} (s + q \cdot Y)^t / (Y_0 \cdot [a_0^2 + b_0^2]^{1/2}) \quad \text{in any chromaticity direction } c_{ab}$$

1-000030-L0

UE130-3N

Color threshold formula LABJNDS 1996 for NW achromatic colours

$$\Delta E_{JND,NW}^* = Y_0 [(\Delta Y_W)^2 + (\Delta c_{ab,W} \cdot Y_W)^2]^{1/2} / (s + q \cdot Y_W)^s$$

$$= Y_0 [(\Delta Y_N)^2 + (\Delta c_{ab,N} \cdot Y_N)^2]^{1/2} / (s + q \cdot Y_N)^s$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0,4 z/y \quad b_n = -0,4 z_n/y_n$$

$$c_{ab} = [a_0^2(a - a_n)^2 + b_0^2(b - b_n)^2]^{1/2} \quad n = D65 \text{ or } A \text{ (surround)}$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a = a_1 - a_2 \quad \Delta b = b_1 - b_2$$

$$p_{c,NW} = c_{ab,NW} / c_{ab,o} = 0 \quad s = 0,0170 \quad q = 0,0058 \quad t = 1,0$$

$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5$ surround D65

$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0$ surround A

Just noticeable difference of complementary (c) NW colours with:

$$(a_W - a_n)Y_W = (a_N - a_n)Y_N; \quad (b_W - b_n)Y_W = (b_N - b_n)Y_N; \quad c_{ab,W}Y_W = c_{ab,N}Y_N$$

$$\Delta Y_W = \text{const} (s + q \cdot Y_W)^s / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta c_{ab,W} \cdot Y_W = \text{const} (s + q \cdot Y_W)^s / Y_0 \quad \text{in any chromaticity direction } c_{ab}$$

$$\Delta c_{ab,N} \cdot Y_N = \text{const} (s + q \cdot Y_N)^s / Y_0 \quad \text{and for the NW purity } p_{c,NW} = 0$$

1-000030-L0

UE130-7N

TUB-test chart UE13; Colour thresholds spaces
LABJNDS 1985, and 3 modifications 2014

Color threshold formula LABJNDS 1996 for Ostwald (o & oc) colours

$$\Delta E_{JND,o}^* = Y_0 [(\Delta Y_o)^2 + (\Delta c_{ab,o} \cdot Y_o)^2]^{1/2} / (s + q \cdot Y_o)^s$$

$$= Y_0 [(\Delta Y_{oc})^2 + (\Delta c_{ab,oc} \cdot Y_{oc})^2]^{1/2} / (s + q \cdot Y_{oc})^s$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0,4 z/y \quad b_n = -0,4 z_n/y_n$$

$$c_{ab} = [a_0^2(a - a_n)^2 + b_0^2(b - b_n)^2]^{1/2} \quad n = D65 \text{ or } A \text{ (surround)}$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a = a_1 - a_2 \quad \Delta b = b_1 - b_2$$

$$p_{c,o} = c_{ab,o} / c_{ab,o} = p_{c,oc} = c_{ab,oc} / c_{ab,oc} = 1; \quad s = 0,0170 \quad q = 0,0058 \quad t = 1,0$$

$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5$ surround D65

$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0$ surround A

Just noticeable difference of complementary (c) Ostwald (o & oc) colours:

$$(a_o - a_n)Y_o = (a_{oc} - a_n)Y_{oc}; \quad (b_o - b_n)Y_o = (b_{oc} - b_n)Y_{oc}; \quad c_{ab,o}Y_o = c_{ab,oc}Y_{oc}$$

$$\Delta Y_o = \text{const} (s + q \cdot Y_o)^s / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta c_{ab,o} \cdot Y_o = \text{const} (s + q \cdot Y_o)^s / Y_0 \quad \text{in any chromaticity direction } c_{ab}$$

$$\Delta c_{ab,oc} \cdot Y_{oc} = \text{const} (s + q \cdot Y_{oc})^s / Y_0 \quad \text{and for Ostwald purity } p_{c,o} = p_{c,oc} = 1$$

1-000030-L0

UE131-3N

Color threshold formula YCHJNDS 1996 for all colours o&oc, N&W

$$\Delta E_{JND}^* = Y_0 [(\Delta Y_{eff})^2 + (\Delta c_{ab} \cdot Y_{eff})^2]^{1/2} / (s + q \cdot Y_{eff})^t$$

$$Y_{eff} = Y \cdot [1 - p_{c,o} \cdot (1 - Y_o / Y_n)]; \quad Y_o = \text{tristimulus value Ostwald colour}$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0,4 z/y \quad b_n = -0,4 z_n/y_n \quad Y_n = 100$$

$$c_{ab} = [a_0^2(a - a_n)^2 + b_0^2(b - b_n)^2]^{1/2} \quad n = D65 \text{ or } A \text{ (surround)}$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a = a_1 - a_2 \quad \Delta b = b_1 - b_2$$

$$p_{c,o} = c_{ab} / c_{ab,o}; \quad p_{c,oc} = c_{ab} / c_{ab,oc} \quad s = 0,0170 \quad q = 0,0058 \quad t = 1,0$$

$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5$ surround D65

$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0$ surround A

Just noticeable difference of all complementary (c) colours o&oc, N&W

$$(a_o - a_n)Y_o = (a_{oc} - a_n)Y_{oc}; \quad (b_o - b_n)Y_o = (b_{oc} - b_n)Y_{oc}; \quad c_{ab,o}Y_o = c_{ab,oc}Y_{oc}$$

$$\Delta Y_{eff} = \text{const} (s + q \cdot Y_{eff})^t / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta c_{ab} \cdot Y_{eff} = \text{const} (s + q \cdot Y_{eff})^t / Y_0 \quad \text{in any chromaticity direction } c_{ab}$$

$$\Delta c_{ab,c} \cdot Y_{c,eff} = \text{const} (s + q \cdot Y_{c,eff})^t / Y_0 \quad \text{and for any purity } 0 \leq p_c \text{ or } p_{c,c} \leq 1$$

1-000030-L0

UE131-7N

input: w/rgb/cmyk -> w/rgb/cmyk-
output: no change