CIELAB 1976 $L^*a^*b^*$ color space definition and reversal

$L^* = 116\,(Y/Y_n)^{1/3} - 16$

$a^* = 500\,[\,(X/X_n)^{1/3} - (Y/Y_n)^{1/3}\,]$

$b^* = 200\,[\,(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}\,]$

$X = X_n\,[\,(L^* + 16)\,/\,116 + a^*/500\,]^3$

$Y = Y_n\,[\,(L^* + 16)\,/\,116\,]^3$

$Z = Z_n\,[\,(L^* + 16)\,/\,116 - b^*/200\,]^3$

CES20–1N

Q-function changes; transition from light- to color metrics

scaling function of **light metrics:**

$\boldsymbol{Q\,[k(x - u] = Q[k(\log L - \log L_u)]}$

$\log L$ -> $\log P$ **for color metrics:**

$Q[k(\log P - \log L_u)]$

$= Q[k(\log L - \log L_u + \log P - \log L)]$

with saturation $p = \log P - \log L$

for color metrics: $\boldsymbol{Q\,[k\,(x - u + p)]}$

CES20–2N

CIELAB 1976 $L^*a^*b^*$ color space and CIELAB$_u$ 2022 L^{*u} a^{*u} b^{*u} color space

$L^* = 116\,(Y/Y_n)^{1/3} - 16$ $\quad [Y/Y_n]^{1/3} > 24/116$

$a^* = 500\,[\,(X/X_n)^{1/3} - (Y/Y_n)^{1/3}\,]$ $\quad Y > 0{,}885$

$b^* = 200\,[\,(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}\,]$

$L^{*u} = 116\,c_u\,(Y/Y_u)^{1/3} - 16 = L^* - 0{,}49$ $\quad Y_u = 18$

$a^{*u} = 500\,c_u\,[\,(X/X_u)^{1/3} - (Y/Y_u)^{1/3}\,] = a^*$

$b^{*u} = 200\,c_u\,[\,(Y/Y_u)^{1/3} - (Z/Z_u)^{1/3}\,] = b^*$

$c_u = [Y_u/Y_n]^{1/3} = 0{,}18^{1/3} = 0{,}5647$, similar for X, Z

$u_u = 116 c_u = 65{,}51$, $a_u = 500 c_u = 282{,}35$, $u_b = 200 c_u = 112{,}94$

CES21–1N

CIELAB 1976 $L^*a^*b^*$ color space and CIELAB$_v$ 2022 L^{*v} a^{*v} b^{*v} color space

$L^* = 116\,(Y/Y_n)^{1/3} - 16$ $\quad [Y/Y_n]^{1/3} > 24/116$

$a^* = 500\,[\,(X/X_n)^{1/3} - (Y/Y_n)^{1/3}\,]$ $\quad Y > 0{,}885$

$b^* = 200\,[\,(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}\,]$

$L^{*v} = 116\,c_v\,(Y/Y_v)^{1/3} - 16 = L^*$ $\quad Y_v = 18{,}41$

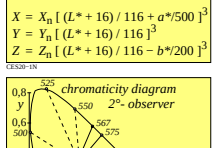
$a^{*v} = 500\,c_v\,[\,(X/X_v)^{1/3} - (Y/Y_v)^{1/3}\,] = a^*$

$b^{*v} = 200\,c_v\,[\,(Y/Y_v)^{1/3} - (Z/Z_v)^{1/3}\,] = b^*$

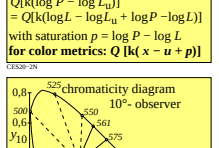
$c_v = [Y_v/Y_n]^{1/3} = 0{,}1841^{1/3} = 0{,}5689$, similar for X, Z

$v_v = 116 c_v = 66$, $v_u = 500 c_u = 284{,}56$, $v_b = 200 c_v = 113{,}78$

CES21–2N



CES20–3N



CES20–4N

CIELAB$_u$ 2022 L^{*u} a^{*u} b^{*u} color space definition and reversal ($X_u/X_n = Y_u/Y_n = Z_u/Z_n = 0{,}18$)

$L^{*u} = 116\,c_u\,(Y/Y_u)^{1/3} - 16 = L^*_{\mathrm{CIELAB}} - 0{,}49$

$a^{*u} = 500\,c_u\,[\,(X/X_u)^{1/3} - (Y/Y_u)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*u} = 200\,c_u\,[\,(Y/Y_u)^{1/3} - (Z/Z_u)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$X = X_u\,[\,(L^{*u} + 16)\,/\,(116\,c_u) + a^{*u}/(500\,c_u)\,]^3$

$Y = Y_u\,[\,(L^{*u} + 16)\,/\,(116\,c_u)\,]^3 \qquad Y_u = 18$

$Z = Z_u\,[\,(L^{*u} + 16)\,/\,(116\,c_u) - b^{*u}/(200\,c_u)\,]^3$

$c_u = [Y_u/Y_n]^{1/3} = 0{,}18^{1/3} = 0{,}5647$, similar for X, Z

$u_u = 116 c_u = 65{,}51$, $a_u = 500 c_u = 282{,}35$, $u_b = 200 c_u = 112{,}94$

CES21–3N

CIELAB$_v$ 2022 L^{*v} a^{*v} b^{*v} color space definition and reversal ($X_v/X_n = Y_v/Y_n = Z_v/Z_n = 0{,}1841$)

$L^{*v} = 116\,c_v\,(Y/Y_v)^{1/3} - 16 = L^*_{\mathrm{CIELAB}} - 0{,}49$

$a^{*v} = 500\,c_v\,[\,(X/X_v)^{1/3} - (Y/Y_v)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*v} = 200\,c_v\,[\,(Y/Y_v)^{1/3} - (Z/Z_v)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$X = X_v\,[\,(L^{*v} + 16)\,/\,(116\,c_v) + a^{*v}/(500\,c_v)\,]^3$

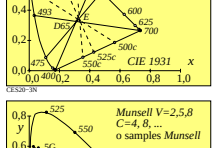
$Y = Y_v\,[\,(L^{*v} + 16)\,/\,(116\,c_v)\,]^3 \qquad Y_v = 18{,}41$

$Z = Z_v\,[\,(L^{*v} + 16)\,/\,(116\,c_v) - b^{*v}/(200\,c_v)\,]^3$

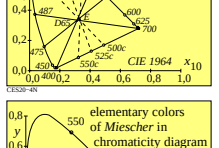
$c_v = [Y_v/Y_n]^{1/3} = 0{,}1841^{1/3} = 0{,}5689$, similar for X, Z

$v_v = 116 c_v = 66$, $v_u = 500 c_u = 284{,}56$, $v_b = 200 c_v = 113{,}78$

CES21–4N



CES20–5N



CES20–6N

CIELAB$_u$ 2022 L^{*u} a^{*u} b^{*u} color space definition and reversal ($X_u/X_n = Y_u/Y_n = Z_u/Z_n = 0{,}18$)

$L^{*u} = u_L\,(Y/Y_u)^{1/3} - 16 = L^*_{\mathrm{CIELAB}} - 0{,}49$

$a^{*u} = u_a\,[\,(X/X_u)^{1/3} - (Y/Y_u)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*u} = u_b\,[\,(Y/Y_u)^{1/3} - (Z/Z_u)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$X = X_u\,[\,(L^{*u} + 16)\,/\,u_L + a^{*u}\,/\,u_a\,]^3$

$Y = Y_u\,[\,(L^{*u} + 16)\,/\,u_L\,]^3 \qquad Y_u = 18$

$Z = Z_u\,[\,(L^{*u} + 16)\,/\,u_L - b^{*u}\,/\,u_b\,]^3$

$c_u = [Y_u/Y_n]^{1/3} = 0{,}18^{1/3} = 0{,}5647$, similar for X, Z

$u_u = 116 c_u = 65{,}51$, $u_a = 500 c_u = 282{,}35$, $u_b = 200 c_u = 112{,}94$

CES21–5N

CIELAB$_v$ 2022 L^{*v} a^{*v} b^{*v} color space definition and reversal ($X_v/X_n = Y_v/Y_n = Z_v/Z_n = 0{,}1841$)

$L^{*v} = v_L\,(Y/Y_v)^{1/3} - 16 = L^*_{\mathrm{CIELAB}} - 0{,}49$

$a^{*v} = v_a\,[\,(X/X_v)^{1/3} - (Y/Y_v)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*v} = v_b\,[\,(Y/Y_v)^{1/3} - (Z/Z_v)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$X = X_v\,[\,(L^{*v} + 16)\,/\,v_L + a^{*v}\,/\,v_a\,]^3$

$Y = Y_v\,[\,(L^{*v} + 16)\,/\,v_L\,]^3 \qquad Y_v = 18{,}41$

$Z = Z_v\,[\,(L^{*v} + 16)\,/\,v_L - b^{*v}\,/\,v_b\,]^3$

$c_v = [Y_v/Y_n]^{1/3} = 0{,}1841^{1/3} = 0{,}5689$, similar for X, Z

$v_v = 116 c_v = 66$, $v_u = 500 c_u = 284{,}56$, $v_b = 200 c_v = 113{,}78$

CES21–6N

CIELAB 1976 $L^*a^*b^*$ color space definition and derivation ($X_n/X_n = Y_n/Y_n = Z_n/Z_n = 0{,}18$)

$L^* = 116\,(Y/Y_n)^{1/3} - 16$ $\quad [Y/Y_n]^{1/3} > 24/116$

$a^* = 500\,[\,(X/X_n)^{1/3} - (Y/Y_n)^{1/3}\,]$ $\quad Y > 0{,}885$

$b^* = 200\,[\,(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}\,]$

$dL^*/dY = 116\,[(Y/Y_n)^{-2/3}(3Y_n)] \qquad Y_{100} = 100$

$da^*/dY = 500\,[(X/X_n)^{-2/3}(3X_n) - (Y/Y_n)^{-2/3}(3Y_n)]$

$db^*/dY = 200\,[(Y/Y_n)^{-2/3}(3X_n) - (Z/Z_n)^{-2/3}(3Z_n)]$

$c_n = [Y_n/Y_n]^{1/3} = 0{,}18^{1/3} = 0{,}5647$, similar for X, Z

$u_n = 116 c_n = 65{,}51$, $a_n = 500 c_n = 282{,}35$, $u_b = 200 c_n = 112{,}94$

CES20–7N

CIELAB$_u$ 2022 L^{*u} a^{*u} b^{*u} color space definition and derivation ($X_u/X_n = Y_u/Y_n = Z_u/Z_n = 0{,}18$)

$L^{*u} = 65{,}51\,(Y/Y_u)^{1/3} - 16 = L^*_{\mathrm{CIELAB}} - 0{,}49$

$a^{*u} = 282{,}35\,[\,(X/X_u)^{1/3} - (Y/Y_u)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*u} = 112{,}94\,[\,(Y/Y_u)^{1/3} - (Z/Z_u)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$dL^{*u}/dY = 65{,}51\,[(Y/Y_u)^{-2/3}(3Y_u)] \qquad Y_u = 18$

$da^{*u}/dY = 284{,}56\,[(X/X_u)^{-2/3}(3X_u) - (Y/Y_u)^{-2/3}(3Y_u)]$

$db^{*u}/dY = 113{,}78\,[(Y/Y_u)^{-2/3}(3X_u) - (Z/Z_u)^{-2/3}(3Z_u)]$

$c_u = [Y_u/Y_n]^{1/3} = 0{,}18^{1/3} = 0{,}5647$, similar for X, Z

$u_u = 116 c_u = 65{,}51$, $a_u = 500 c_u = 282{,}35$, $u_b = 200 c_u = 112{,}94$

CES20–8N

CIELAB$_v$ 2022 L^{*v} a^{*v} b^{*v} color space definition and reversal ($X_v/X_n = Y_v/Y_n = Z_v/Z_n = 0{,}1841$)

$L^{*v} = 66\,(Y/Y_v)^{1/3} - 16 = L^*_{\mathrm{CIELAB}}$

$a^{*v} = 284{,}56\,[\,(X/X_v)^{1/3} - (Y/Y_v)^{1/3}\,] = a^*_{\mathrm{CIELAB}}$

$b^{*v} = 113{,}78\,[\,(Y/Y_v)^{1/3} - (Z/Z_v)^{1/3}\,] = b^*_{\mathrm{CIELAB}}$

$X = X_v\,[\,(L^{*v} + 16)\,/\,66 + a^{*v}\,/\,284{,}56\,]^3$

$Y = Y_v\,[\,(L^{*v} + 16)\,/\,66\,]^3 \qquad Y_v = 18{,}41$

$Z = Z_v\,[\,(L^{*v} + 16)\,/\,66 - b^{*v}\,/\,113{,}78\,]^3$

$c_v = [Y_v/Y_n]^{1/3} = 0{,}1841^{1/3} = 0{,}5689$, similar for X, Z

$v_v = 116 c_v = 66$, $v_u = 500 c_u = 284{,}56$, $v_b = 200 c_v = 113{,}78$

CES21–7N

CES21–8N

TUB-test chart CES2; Special colorimetric properties for colour vision and image technology
Elementary colours, complementary wavelength, CIELAB equation and changes from Y_n to Y_u