

| Coding Theory |        | See notes over to the right |           |            |           |           |           |           |          |  |  |  |
|---------------|--------|-----------------------------|-----------|------------|-----------|-----------|-----------|-----------|----------|--|--|--|
| CIE Y         | CIE L* | CIE L* 8bits                | Gamma 1.0 | Gamma 1.25 | Gamma 1.8 | Gamma 2.2 | Gamma 2.5 | Gamma 3.0 | 8bit Log |  |  |  |
| 100.0000      | 100.00 | 255.00                      | 255.00    | 255.00     | 255.00    | 255.00    | 255.00    | 255.00    | 255.00   |  |  |  |
| 97.5000       | 99.03  | 252.51                      | 248.63    | 249.89     | 251.44    | 252.08    | 252.43    | 252.86    | 253.84   |  |  |  |
| 95.0000       | 98.03  | 249.99                      | 242.25    | 244.75     | 247.84    | 249.12    | 249.82    | 250.68    | 252.64   |  |  |  |
| 92.5000       | 97.02  | 247.41                      | 235.88    | 239.58     | 244.19    | 246.12    | 247.17    | 248.46    | 251.41   |  |  |  |
| 90.0000       | 96.00  | 244.79                      | 229.50    | 234.39     | 240.50    | 243.08    | 244.48    | 246.20    | 250.15   |  |  |  |
| 87.5000       | 94.95  | 242.12                      | 223.13    | 229.16     | 236.77    | 239.98    | 241.74    | 243.90    | 248.86   |  |  |  |
| 85.0000       | 93.88  | 239.40                      | 216.75    | 223.91     | 232.99    | 236.84    | 238.95    | 241.55    | 247.53   |  |  |  |
| 82.5000       | 92.80  | 236.63                      | 210.38    | 218.63     | 229.15    | 233.65    | 236.11    | 239.16    | 246.15   |  |  |  |
| 80.0000       | 91.68  | 233.80                      | 204.00    | 213.31     | 225.27    | 230.40    | 233.23    | 236.72    | 244.74   |  |  |  |
| 77.5000       | 90.55  | 230.91                      | 197.63    | 207.96     | 221.33    | 227.10    | 230.28    | 234.23    | 243.28   |  |  |  |
| 75.0000       | 89.39  | 227.95                      | 191.25    | 202.58     | 217.34    | 223.74    | 227.28    | 231.68    | 241.77   |  |  |  |
| 72.5000       | 88.21  | 224.93                      | 184.88    | 197.16     | 213.28    | 220.32    | 224.22    | 229.08    | 240.21   |  |  |  |
| 70.0000       | 87.00  | 221.84                      | 178.50    | 191.70     | 209.16    | 216.84    | 221.10    | 226.42    | 238.60   |  |  |  |
| 67.5000       | 85.76  | 218.68                      | 172.13    | 186.20     | 204.98    | 213.28    | 217.90    | 223.69    | 236.93   |  |  |  |
| 65.0000       | 84.48  | 215.43                      | 165.75    | 180.66     | 200.73    | 209.65    | 214.64    | 220.89    | 235.19   |  |  |  |
| 62.5000       | 83.18  | 212.11                      | 159.38    | 175.08     | 196.40    | 205.95    | 211.30    | 218.02    | 233.39   |  |  |  |
| 60.0000       | 81.84  | 208.69                      | 153.00    | 169.46     | 192.00    | 202.16    | 207.87    | 215.08    | 231.51   |  |  |  |
| 57.5000       | 80.46  | 205.17                      | 146.63    | 163.79     | 187.51    | 198.29    | 204.37    | 212.05    | 229.55   |  |  |  |
| 55.0000       | 79.04  | 201.56                      | 140.25    | 158.06     | 182.94    | 194.32    | 200.76    | 208.93    | 227.51   |  |  |  |
| 52.5000       | 77.58  | 197.83                      | 133.88    | 152.29     | 178.27    | 190.26    | 197.06    | 205.71    | 225.37   |  |  |  |
| 50.0000       | 76.07  | 193.98                      | 127.50    | 146.46     | 173.50    | 186.08    | 193.25    | 202.39    | 223.13   |  |  |  |
| 47.5000       | 74.51  | 190.00                      | 121.13    | 140.57     | 168.63    | 181.80    | 189.33    | 198.96    | 220.77   |  |  |  |
| 45.0000       | 72.89  | 185.87                      | 114.75    | 134.62     | 163.64    | 177.38    | 185.28    | 195.41    | 218.28   |  |  |  |
| 42.5000       | 71.21  | 181.60                      | 108.38    | 128.60     | 158.52    | 172.83    | 181.09    | 191.72    | 215.65   |  |  |  |
| 40.0000       | 69.47  | 177.15                      | 102.00    | 122.51     | 153.27    | 168.14    | 176.75    | 187.89    | 212.86   |  |  |  |
| 37.5000       | 67.65  | 172.51                      | 95.63     | 116.35     | 147.87    | 163.27    | 172.25    | 183.89    | 209.90   |  |  |  |
| 35.0000       | 65.75  | 167.66                      | 89.25     | 110.10     | 142.31    | 158.23    | 167.56    | 179.71    | 206.72   |  |  |  |
| 32.5000       | 63.75  | 162.57                      | 82.88     | 103.76     | 136.57    | 152.99    | 162.66    | 175.32    | 203.32   |  |  |  |
| 30.0000       | 61.65  | 157.22                      | 76.50     | 97.33      | 130.63    | 147.53    | 157.54    | 170.71    | 199.63   |  |  |  |
| 27.5000       | 59.43  | 151.56                      | 70.13     | 90.78      | 124.47    | 141.80    | 152.15    | 165.83    | 195.63   |  |  |  |
| 25.0000       | 57.08  | 145.54                      | 63.75     | 84.12      | 118.05    | 135.79    | 146.46    | 160.64    | 191.25   |  |  |  |
| 22.5000       | 54.55  | 139.11                      | 57.38     | 77.32      | 111.34    | 129.44    | 140.41    | 155.10    | 186.40   |  |  |  |
| 20.0000       | 51.84  | 132.18                      | 51.00     | 70.37      | 104.29    | 122.69    | 133.95    | 149.12    | 180.99   |  |  |  |
| 17.5000       | 48.88  | 124.65                      | 44.63     | 63.24      | 96.83     | 115.47    | 126.99    | 142.63    | 174.85   |  |  |  |
| 15.0000       | 45.63  | 116.37                      | 38.25     | 55.90      | 88.88     | 107.66    | 119.39    | 135.49    | 167.76   |  |  |  |
| 12.5000       | 42.00  | 107.10                      | 31.88     | 48.31      | 80.32     | 99.09     | 111.00    | 127.50    | 159.38   |  |  |  |
| 10.0000       | 37.84  | 96.50                       | 25.50     | 40.41      | 70.96     | 89.54     | 101.52    | 118.36    | 149.11   |  |  |  |
| 7.5000        | 32.92  | 83.94                       | 19.13     | 32.11      | 60.47     | 78.56     | 90.48     | 107.54    | 135.88   |  |  |  |
| 5.0000        | 26.73  | 68.17                       | 12.75     | 23.21      | 48.28     | 65.34     | 76.94     | 93.94     | 117.24   |  |  |  |
| 4.0000        | 23.67  | 60.36                       | 10.20     | 19.42      | 42.65     | 59.04     | 70.37     | 87.21     | 106.98   |  |  |  |
| 3.0000        | 20.04  | 51.11                       | 7.65      | 15.43      | 36.35     | 51.80     | 62.72     | 79.23     | 93.75    |  |  |  |
| 2.0000        | 15.49  | 39.49                       | 5.10      | 11.15      | 29.02     | 43.08     | 53.33     | 69.22     | 75.10    |  |  |  |
| 1.0000        | 8.99   | 22.93                       | 2.55      | 6.41       | 19.74     | 31.44     | 40.41     | 54.94     | 43.23    |  |  |  |
| 0.7500        | 6.77   | 17.28                       | 1.91      | 5.09       | 16.83     | 27.58     | 36.02     | 49.91     | 30.00    |  |  |  |
| 0.5000        | 4.52   | 11.52                       | 1.28      | 3.68       | 13.43     | 22.94     | 30.63     | 43.60     | 11.35    |  |  |  |
| 0.2500        | 2.26   | 5.76                        | 0.64      | 2.11       | 9.14      | 16.74     | 23.21     | 34.61     | -20.52   |  |  |  |
| 0.2000        | 1.81   | 4.61                        | 0.51      | 1.77       | 8.07      | 15.13     | 21.23     | 32.13     | -30.78   |  |  |  |
| 0.1000        | 0.90   | 2.30                        | 0.26      | 1.02       | 5.49      | 11.04     | 16.09     | 25.50     | -62.66   |  |  |  |
| 0.0500        | 0.45   | 1.15                        | 0.13      | 0.58       | 3.74      | 8.06      | 12.19     | 20.24     | -94.53   |  |  |  |
| 0.0400        | 0.36   | 0.92                        | 0.10      | 0.49       | 3.30      | 7.28      | 11.15     | 18.79     | -104.80  |  |  |  |
| 0.0300        | 0.27   | 0.69                        | 0.08      | 0.39       | 2.81      | 6.39      | 9.94      | 17.07     | -118.03  |  |  |  |
| 0.0200        | 0.18   | 0.46                        | 0.05      | 0.28       | 2.25      | 5.31      | 8.45      | 14.91     | -136.67  |  |  |  |
| 0.0100        | 0.09   | 0.23                        | 0.03      | 0.16       | 1.53      | 3.88      | 6.41      | 11.84     | -168.55  |  |  |  |
| 0.0050        | 0.05   | 0.12                        | 0.01      | 0.09       | 1.04      | 2.83      | 4.85      | 9.39      | -200.42  |  |  |  |
| 0.0040        | 0.04   | 0.09                        | 0.01      | 0.08       | 0.92      | 2.56      | 4.44      | 8.72      | -210.68  |  |  |  |
| 0.0030        | 0.03   | 0.07                        | 0.01      | 0.06       | 0.78      | 2.24      | 3.96      | 7.92      | -223.91  |  |  |  |
| 0.0020        | 0.02   | 0.05                        | 0.01      | 0.04       | 0.63      | 1.86      | 3.36      | 6.92      | -242.56  |  |  |  |
| 0.0010        | 0.01   | 0.02                        | 0.00      | 0.03       | 0.43      | 1.36      | 2.55      | 5.49      | -274.43  |  |  |  |
| 0.0000        | 0.00   | 0.00                        | 0.00      | 0.00       | 0.00      | 0.00      | 0.00      | 0.00      |          |  |  |  |

CIE L\* is approximately the way humans see gray values: it was created as a uniform lightness space

In other words, any step in one part of L\* looks visually the same as that step made in any other part

Or, a numerical difference between any two values in one part looks the same as that identical numerical difference in another

Or, the 50% point of the scale looks like it is precisely halfway between white and

(in fact, using that last definition, and then proceeding to find the point halfway between 50% and white, or 50% and black is one way to construct such a uniform scale --- which is how some of the original studies were done in the 1920s and 30s)

Gamma 2.5 provides the closest approximation of the L\* function

Gamma 1.0 has very little detail in the shadows

Gamma 1.25 is still pretty poor in the shadows

Gamma 1.8 is getting better - this gamma is used mostly by historical accident

Gamma 2.2 and 2.5 do a good job in the shadows

Gamma 3.0 goes too far (this is more obvious when evaluating images)

Logarithmic encoding just stinks in 8 bits

So, Gamma 2.5 provides the encoding that comes closest to being a uniform distribution of grays among the 256

But, in 'average' indoor viewing conditions, even gamma 2.5 looks like it goes too far, so most people use gamma 2.2

Gamma 1.8 is still used because Apple Computer chose it for their Macintoshes -- without additional processing it compensates for the typical 30% dot gain found on most printing presses and older laser printers