

**PHOTO CD INFORMATION BULLETIN**

**Fully Utilizing Photo CD Images**  
Typical Monitor Luminance Values for PhotoYCC Luma Values  
**Article Number 6**

This article is the sixth in a series in which we discuss selected topics covering the imaging science of the KODAK Photo CD System. The goals of this series are to further your understanding of Photo CD technology and to provide information to help you maximize the quality of each Photo CD image.

**Introduction**

In the majority of imaging systems, one of the first priorities is to obtain the correct tone scale reproduction. Each of the following factors can affect the quality of a Photo CD image displayed on your monitor.

- Conversion from PhotoYCC to RGB.
- Conversion by the driver board from the above RGB to analog voltages, including hardware and software controls.
- Monitor calibration, which specifies how the analog voltages are converted to monitor luminance.
- Monitor color temperature and color balance.

You can use this paper along with the associated Photo CD IMAGE PAC File to evaluate your complete display path and ensure that the overall tone scale of your display system can produce a pleasing image.

The issue of monitor color temperature and color balance is beyond the scope of this article.

**Reference Photo CD IMAGE PAC File**

The monitor luminance values in the table on page 3 were derived from a reference Photo CD IMAGE PAC File. You can download this reference IMAGE PAC File, which is BASE resolution and below only, via the World Wide Web (see below) or anonymous ftp. The file is contained in self-extracting archives for MACINTOSH computers and for IBM or IBM-compatible computers.

Access the file via your Web browser by typing the following URL:

for MACINTOSH computers, type:

`ftp://ftp.kodak.com/pub/photo-cd/  
general/referenceImage.sea.hqx`

for IBM or IBM-compatible computers, type:

`ftp://ftp.kodak.com/pub/photo-cd/  
general/referenceImage.exe`

The reference IMAGE PAC File contains 64 large area regions ranging from a Y value of 3 to a Y value of 255. For all regions, the C1 and C2 values are fixed at 156 and 137, respectively. The latter constraint ensures that each region represents a neutral object as recorded by an ideal reference capture device, based on the definition of PhotoYCC. (See KODAK Publication PCD-9 KIC, "Kodak Photo CD Products--A Planning Guide for Developers," and KODAK Publication PCD-045 "PhotoYCC Color Encoding and Compression Schemes.")

This reference image was created through purely digital means and did not involve scanning film on a Photo CD imaging workstation. The patches represent ideal neutral patches in PhotoYCC. *The purpose of the reference image is to help optimize your monitor and method of Photo CD image acquisition for optimal display of real Photo CD images.*

In some cases, you may not obtain neutral values equal to those in the digital reference image from real film that is scanned onto Photo CD discs. Though it is possible to use the balancing tools on the Photo CD imaging workstation to make a particular gray patch match these ideal values, this procedure may not produce a preferred reproduction.

For many films, the preferred color balance may be off-neutral in order to produce more pleasing flesh tones or other colors. In these cases, you may want to preserve this feature of the film, especially reversal

film. Additionally, when the Scene Balance Algorithm is used, variations in color balance may occur from image to image due to varying scene content.

In summary, the digital reference image is designed to help you adjust the resultant luminance levels of a monitor and not necessarily its color balance or its color reproduction.

### Displaying the Reference Image

The reference IMAGE PAC File should be read by the display system, converted to RGB, and shown on the associated TV or monitor. In this context, the display system includes the conversion from PhotoYCC to RGB, the driver board's conversion to analog voltage, and the monitor's conversion of these voltages to luminance. Be sure to warm up the TV or monitor for at least 30 minutes before viewing the image or taking any measurement data.

### Subjective Viewing of the Reference Image

For best viewing results, room lighting should be dim with no light shining directly on the screen. (See KODAK Publication PCD-077 "Maintaining Color Consistency When Creating KODAK Photo CD Portfolio Discs.")

Observe the reference image after it is displayed through your method of conversion from PhotoYCC. (If you are viewing through the KODAK Photo CD Acquire Module for ADOBE PHOTOSHOP Software or KODAK Photo CD Access Plus Software, choose the Portfolio look-up table [LUT] for this test.)

Most of the 64 patches of the reference image should be distinctly visible. The highlights should be compressed, with just a slight gradation visible in the uppermost row of patches. The shadows should also be compressed, but each patch in the bottom row should be distinct, with no appearance of clipping.

If any of these conditions are not met, then you may have a problem with either your monitor setup (see Publication PCD-077, "Maintaining Color Consistency When Creating KODAK Photo CD Portfolio Discs") or your method of acquiring Photo CD images. Adjust your monitor according to the manufacturer's recommendations.

For assistance with conversion from PhotoYCC, consult the Kodak technical publications (White

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Papers) listed in the "BIBLIOGRAPHY." These documents are available on the Kodak FaxBack system at 1-800-508-1531, or contact a Kodak customer support representative toll-free at 1-800-23-KODAK (1-800-235-6325) or at 1-716-726-7260 (a toll call).

### Measuring Monitor Luminance

Instruments such as the PHILLIPS Color Analyzer, Model PM5639, or the MINOLTA TV Analyzer CA100 can be used to measure monitor luminance. Follow the manufacturer's instructions for setting up and using the measurement device.

Room lighting should be dim or dark with no direct light shining on the screen. You will obtain best results by covering the screen and measurement device with an opaque, non-reflective black cloth to block all stray light. Ideally, each patch of the reference image should be surrounded by a black background and measured individually.

### Table of Monitor Luminance Values

The table on the next page provides the luminance value measured in footlamberts for each Y value in the reference IMAGE PAC File. This table ensures that information above 100% white is mapped within the limited dynamic range of typical monitors, thereby producing a pleasing image. (See KODAK Publication PCD-045, "PhotoYCC Color Encoding and Compression Schemes.")

### BIBLIOGRAPHY

Eastman Kodak Company, "Kodak Photo CD Products--A Planning Guide for Developers," KODAK Publication PCD-9 KIC, 1993.

Eastman Kodak Company, "PhotoYCC Color Encoding and Compression Schemes," KODAK Publication PCD-045 (White Paper), 1994.

Eastman Kodak Company, "Maintaining Color Consistency When Creating KODAK Photo CD Portfolio Discs," KODAK Publication PCD-077 (White Paper), 1994.

Eastman Kodak Company, "Using Information Beyond 100% White," KODAK Publication PCD-042 (White Paper), 1993.

**Table of Monitor Luminance Values That Map Information  
Beyond 100% White Into the Limited Range of Typical Monitors\***

| Y   | Luminance<br>(footlamberts) |
|-----|-----------------------------|
| 255 | 25.27                       |
| 251 | 25.06                       |
| 247 | 25.06                       |
| 243 | 24.86                       |
| 239 | 24.86                       |
| 235 | 24.65                       |
| 231 | 24.65                       |
| 227 | 24.45                       |
| 223 | 24.25                       |
| 219 | 24.04                       |
| 215 | 23.84                       |
| 211 | 23.64                       |
| 207 | 23.24                       |
| 203 | 22.85                       |
| 199 | 22.65                       |
| 195 | 22.26                       |
| 191 | 21.67                       |
| 187 | 21.28                       |
| 183 | 20.90                       |
| 179 | 20.14                       |
| 175 | 19.77                       |
| 171 | 19.04                       |
| 167 | 18.50                       |
| 163 | 17.61                       |
| 159 | 17.09                       |
| 155 | 16.40                       |
| 151 | 15.55                       |
| 147 | 14.89                       |
| 143 | 14.08                       |
| 139 | 13.45                       |
| 135 | 12.69                       |
| 131 | 11.96                       |

| Y   | Luminance<br>(footlamberts) |
|-----|-----------------------------|
| 127 | 11.27                       |
| 123 | 10.60                       |
| 119 | 9.95                        |
| 115 | 9.20                        |
| 111 | 8.58                        |
| 107 | 7.85                        |
| 103 | 7.27                        |
| 99  | 6.60                        |
| 95  | 5.98                        |
| 91  | 5.50                        |
| 87  | 4.96                        |
| 83  | 4.54                        |
| 79  | 3.97                        |
| 75  | 3.58                        |
| 71  | 3.14                        |
| 67  | 2.75                        |
| 63  | 2.45                        |
| 59  | 2.11                        |
| 55  | 1.84                        |
| 51  | 1.52                        |
| 47  | 1.22                        |
| 43  | 0.99                        |
| 39  | 0.83                        |
| 35  | 0.70                        |
| 31  | 0.54                        |
| 27  | 0.41                        |
| 23  | 0.29                        |
| 19  | 0.22                        |
| 15  | 0.15                        |
| 11  | 0.10                        |
| 7   | 0.06                        |
| 3   | 0.03                        |

\* The monitor should be set up such that black maps to 0.018 footlamberts and white maps to 25.3 footlamberts. If the monitor is not set up this way, adjust these values accordingly, using the manufacturer's recommendations.

