The Technology Inside the New *Kodak Professional* DCS 620x Digital Camera

High-Quality Images at Extremely High ISO Settings

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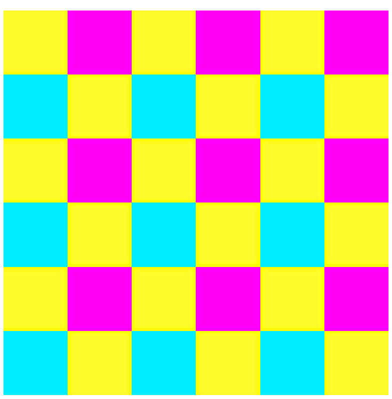
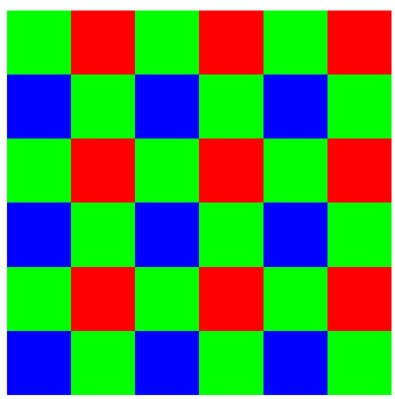
The new *Kodak Professional* DCS 620x digital camera, a variant of the DCS 620 (which remains available), is notable for its ISO range of from 400 to 6400 (calibrated from ISO 400-4000), and its impressive image quality. Key to these features are a new 2-megapixel indium tin oxide CCD (charge couple device), new color filter array (CFA) pattern, and new low-noise electronics. The camera is ideal for fast-action, low-light and changing lighting conditions.

Kodak's high-performance 2-megapixel CCD in the DCS 620x utilizes a Cyan-Magenta-Yellow (CMY) Bayer pattern color filter array. This new color pattern (shown below) looks very similar to the RGB Bayer pattern used in the DCS 620.



CMY Bayer Pattern (New DCS 620x)



RGB Bayer Pattern (DCS 620)

In fact, Dr. Bayer, a Kodak scientist who invented the Bayer pattern approximately 20 years ago, suggested in his original patent that either RGB or CMY colors could be employed. Until now, Kodak DCS cameras have employed the RGB pattern because of issues with color fidelity and CCD manufacturing. However, CMY deployment is now possible, thanks to groundbreaking advancements in CCD design with indium tin oxide (ITO) materials and newly developed CFA manufacturing techniques.

The major advantage of CMY CFA colors is sensitivity, or speed. In photographic terms, speed is equivalent to ISO. The CMY CFA has two attributes that increase effective speed:

- Less unwanted dye absorption
- Increased color signal and signal-to-noise ratio

The reduced dye absorption behavior of a CMY CFA is easy to explain. In the RGB CFA system, each color is "built" from a combination of two of three available dye layers – cyan (C), magenta (M) or yellow (Y). For example, the green layer is "built" by combining one layer of yellow and one layer of cyan.

Therefore, the RGBs are built with the following formulas:

Red = Y + M
Green = Y + C
Blue = M + C

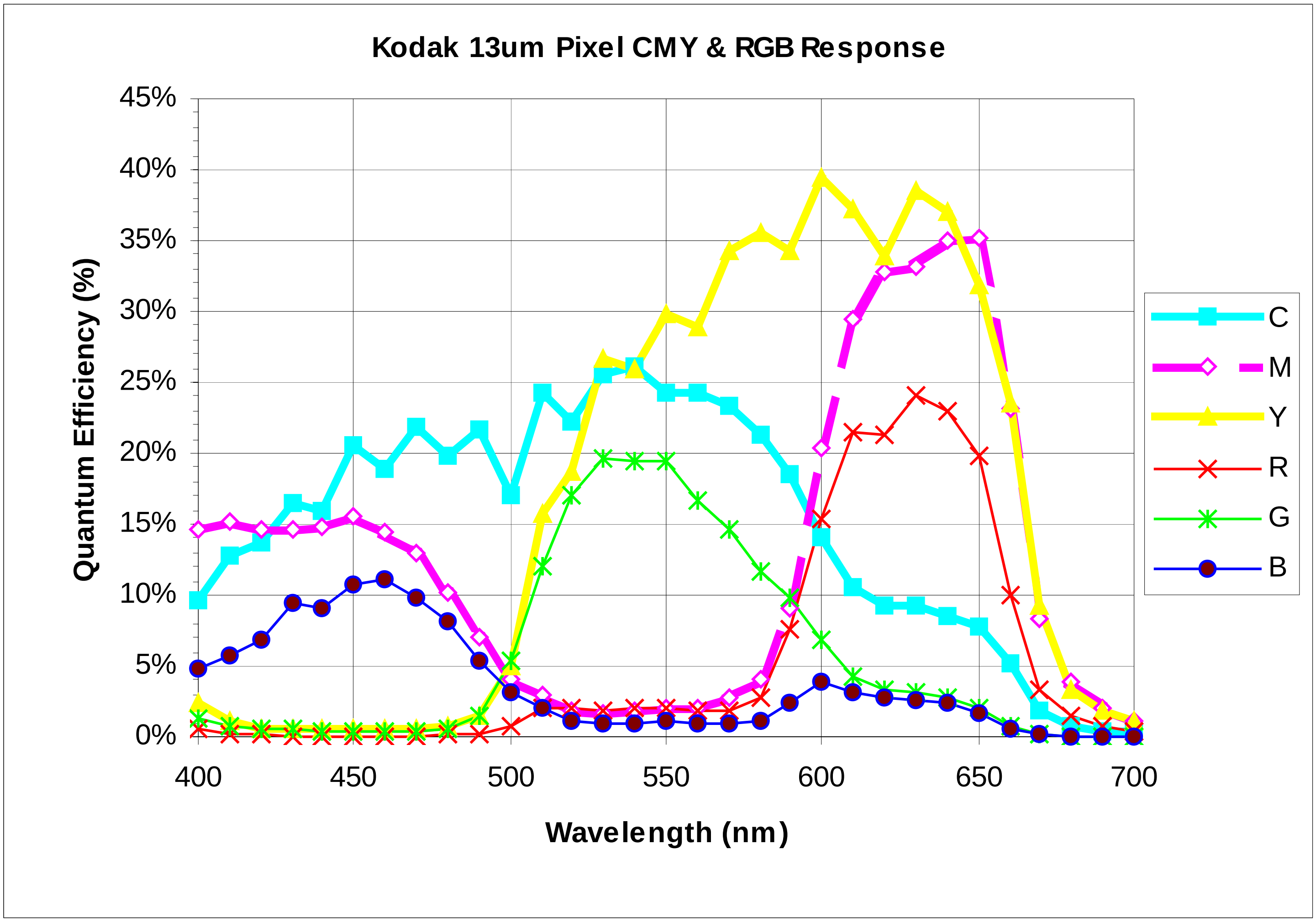
Even though a single color – say, Y – is supposed to pass yellow color and absorb all others; it has a tendency to absorb yellow as well. This is called unwanted absorption. Since both colors that make up any particular primary RGB color have unwanted absorption, this further reduces the amount of light that passes through to the CCD. In the CMY system, there is only one dye color for each primary color. So this system has less unwanted absorption, effectively passing more primary light to the CCD.

The discussion around increased signal is a bit more complicated. First, let's examine a few basics on how CCD's work.[1] The photoactive area of a CCD pixel is the region that converts light to electrical charge. This electrical charge is proportional to the amount of light striking the pixel. To create a CCD readout, the electrical charge is converted into a proportional voltage, and the A/D (analog to digital) converter subsequently samples this voltage.

When the camera shutter "takes" the picture, each CCD pixel is presented with an amount of light that originated in the scene being photographed. Also, each color in the scene is made up of different amounts of energy at particular wavelengths of light. All the wavelengths of light striking the pixel are "integrated" (averaged together) to form the signal at each pixel.

If a pixel has a color dye placed above it, as in the case of a color CCD, then that pixel will respond more to that particular color. Therefore, the green pixels in a RGB Bayer pattern CCD respond more to green scene content, but the total green signal is developed by integrating all the energies in the entire 400-700nm wavelength band.

In the case of green, that means more energy is allowed to pass through to the CCD in the green area of the spectrum and less in others. Refer to the CCD response vs. wavelength chart below.



This chart shows both an RGB and a CMY CCD response. The chart was made by combining data from the two different CCD systems. Note the green line, which is the green response of the RGB system. Compare it to the yellow line, which is the yellow response of the CMY system. You should notice two attributes.

First, the yellow curve is much larger in overall amplitude (approximately 37% yellow vs. 20% green). This occurs because of the reduction in unwanted absorption mentioned earlier. Second, you should notice that the area "under the curve" for the yellow is much larger than the green signal. Notice that yellow starts rising at about 500nm and stops responding at 700nm, but the green signal, while it also starts at 500nm, ends at around 600nm.

If you were to shine a light source that has constant energy at all wavelengths onto the CCD, the yellow signal would be about twice as large as the green signal. This occurs because the yellow signal integrates more light compared to the green signal. Since in either case the noise in the underlying CCD is constant, we also have larger signal-to-noise ratio (SNR) in the CMY system. This larger signal provides higher effective ISO, and the increased SNR provides for more ISO range.

The increased ISO range was used to maximum advantage in the DCS 620x system. Note that the DCS 620 has an ISO range of 8x – 200 to 1600 – while the DCS 620x has a range of 16x – 400 to 6400. The larger signal of the CMY system provides the increased base ISO of 400, and the greater SNR provides for the increased ISO range.

As mentioned earlier, the DCS 620x also incorporates new lower-noise analog electronics compared to the DCS 620. This further increases SNR, and enhances the ISO range of the CMY system. While this is very difficult to see at the base ISO of 400, the image quality improvement at ISO 6400 is quite noticeable.

It is precisely that image quality at very high ISO settings that will appeal to photographers who shoot digital images in changing and dim-lighting conditions. For them, the most important thing is to "get the shot," but not at the cost of poor image quality. With its unique combination of technology, the DCS 620x provides the perfect solution.

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