

Digital Exposure Notes

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Although determining the “best” exposure with a digital camera is similar to determining exposure for slide film, there are some differences due to the different way that the digital camera responds to light.

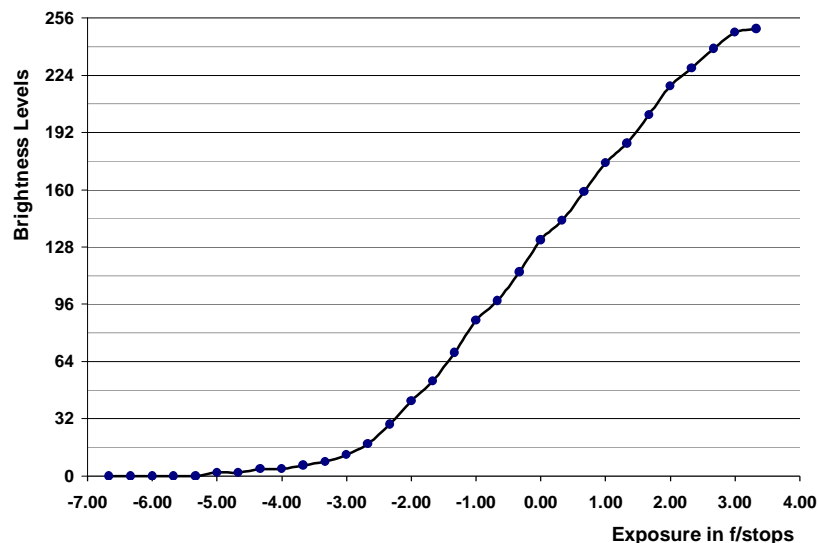
The following discussion, attributed to Bruce Lindbloom, is taken from the Luminous Landscape site (www.luminous-landscape.com/tutorials/expose-right.shtml):

For film based photography, the highlight end of the scale is compressed by the shoulder portion of the D/log E curve. So as brighter and brighter objects are photographed, the highlight detail gets gradually compressed more and more until eventually the film saturates. But up until that point, the highlight compression progresses in a gradual fashion.

Solid state sensors in digital cameras behave very differently. As light falls on a sensor, a charge either accumulates or dissipates (depending on the sensor technology). Its response is well behaved right up until the point of saturation, at which time it abruptly stops. There is no forgiveness by gradually backing off, as was the case with film.

To investigate the behavior mentioned by Lindbloom, I ran an experiment with my Canon 10D digital SLR. I photographed a Kodak gray card over 10 stops of exposure, from 6 2/3 stops under to 3 1/3 stops overexposure. The resulting image files were stored as JPEGs, so had the normal in-camera

processing including gamma correction. Converting the RGB files to Lab color in Photoshop®, I then created a grayscale image by extracting the L (luminosity) channel. After cropping out a 180-pixel square from the center of each frame, I used the Average blur filter to eliminate minor brightness fluctuations. Plotting the resulting values yielded the above calibration curve of relative exposure vs. resulting brightness level in the digital file. This curve is analogous to the D/log E (H&D) curve that characterizes film-based photography.



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This curve, shown above, is not quite as linear as implied by Lindbloom. It does show a well-behaved region from about 3 stops underexposure to 3 stops overexposure. Below -3 stops, there is a region of compression similar to the toe of a film curve. Above +3 stops the saturation is more abrupt. From this curve we can conclude that this camera has a useful dynamic range of approximately 6 stops, and that the saturation effect outside of this range is somewhat more abrupt for overexposure than for underexposure.

With slide film, we try to avoid overexposure and the resulting “blown” highlights. Shadow detail may be lost, but that is usually less objectionable. The goal with the digital camera is the same – avoid blown highlights. But, as with negative film, the final image is created in the (digital) darkroom. This means that exposure can be established to obtain the best print, rather than to obtain the best direct-from-camera slide. Digital guru Ian Lyons, quoted in the above-mentioned Luminous Landscape tutorial, says:

Get your histogram as close to the right side as possible but not so close as to cause the over exposure indicator to flash. The ideal exposure ensures that you have maximum number of levels describing your image without losing important detail in the highlights. The closer you get to this ideal then the more of those levels are being used to describe your shadows

This is analogous to the “expose for the highlights” maxim with slide film. Direct from the camera, the ideal digital image may appear overexposed. However, after post processing in Photoshop® or equivalent, the image will have full dynamic range. Those extra levels mentioned by Lyons insure that the shadows will maintain detail without posterization or excess noise. Engineers call this “maximizing the signal-to-noise ratio,” a fundamental principle in any electronic information transfer.

An example image should make this “move the histogram to the right” concept clearer. Because this low-contrast scene had less than the 6 stops of dynamic range that the camera could handle, it was exposed to push the histogram to the right and overexpose the midtones.



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The result is a flat and overexposed image, but its file contains all of the visual information with good signal-to-noise ratio. The image will be improved in the post-processing stage.

By post processing with Photoshop's curves adjustment, the histogram was expanded to pull the shadow areas to the left and re-establish full dynamic range (sometimes referred to as overall image contrast.) The shadow areas derived in this manner show less digital noise (the equivalent of film grain) than if the exposure were set for the shadows and overall contrast were established by stretching the histogram to the right.



For maximum effectiveness, images should be scanned or captured at 12 bits per pixel and stored in RAW format. When imported into Photoshop they will be stored at 16 bits per pixel and the arithmetic post-processing operations will be carried out with a resolution of 65536 levels, rather than the 256 levels of 8-bit images. When converted to 8-bit-per-pixel files for printing, there will be fewer gaps in the histogram that might cause posterization in the final print.

From this discussion and example, we can formulate a procedure for exposure with a digital camera:

- If the overall scene contrast is high, expose for the midtones to center the histogram and avoid clipping either the shadows or highlights.
- If the overall scene contrast is less than the dynamic range of the camera, expose to place the histogram to the right, then correct in post processing.
- If you must print directly from the unprocessed camera file, choose sRGB color space and expose for the midtones. If available, use the camera's contrast adjustment to modify the contrast of the resulting file.