Film vs. Digital Characteristic Curves

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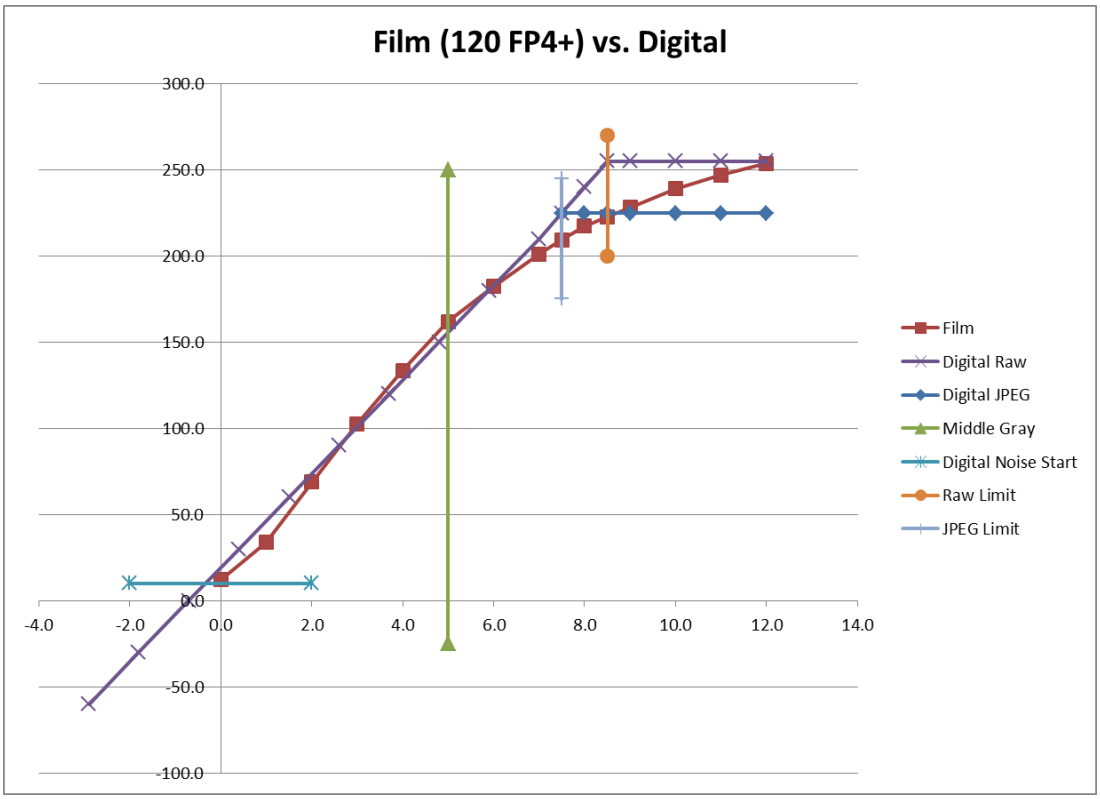
There have been a lot of comparisons of the digital to the analog approach. They can be contentious and fraught with emotional arguments. An objective comparison of the characteristic curves does not prove that either is superior. They are just different.

Here is a view of a real film characteristic curve compared to a typical digital capture.



The data for the film curve is based on the previous article, A Practical Guide to Film Characteristic Curves.

The digital capture is initially recorded as levels in a raw file as an arithmetic progression. For a 14-bit raw file this might be:

Zone*	-3	-2	-1	0	1	2	3	4	5	6	7	8	9
Bottom	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
Middle	6	11	23	45	90	181	362	723	1447	2893	5787	11574	N/A
Top	7	15	31	63	127	255	511	1023	2047	4095	8191	16383	N/A

* Zone refers to exposure zones, not Zone System zones. Exposure zone 5 is middle gray.

That is the way that a sensor might measure and record the image in the raw file. We cannot see the image the way that the raw file records it. The arithmetic progression needs to be converted to a logarithmic progression because that is how our eyes see tonality. This is done for us naturally by film even though its characteristic curve is not perfectly straight. The camera or computer does this to

generate a JPEG or TIFF from the raw data. There are also ways you can alter the digital characteristic curve during this step.

The first thing you may notice is that the information in the raw file appears as a perfectly straight line. This is true for most sensors (not for some Canon sensors).

There is no exposure zone 9 for digital, at least for the Nikon and Sony digital cameras I have examined using RawDigger. If a scene contains anything that measures four or more stops brighter than middle gray, the highlights are "blown out".

Film, on the other hand, does not approach exposure zone 9 in a linear fashion. The contrast is becoming progressively lower and it can actually record well above exposure zone 12. Some films can be extended slightly beyond with modified development but others have such inherently high contrast that they simply blow out just like digital.

With a JPEG image, even exposure zone 8 may be discarded unless there is some processing done in the camera or later on the computer to recover the highlights. A scene containing some portions in exposure zone 8 will probably display highlight warnings or "blinkies" on the camera's LCD.

When you scan film you can adjust the characteristic curve either during scanning or afterwards in post processing. If you print in a wet darkroom you can modify all or part of the image in many ways including your choice of paper.

Scenes with a moderate dynamic range (about five stops) will be recorded on film or digital sensors with about the same degree of linearity. It's only when you push the limits that you will begin to see the differences.

Whereas film cannot record anything below film base plus fog, around exposure zone 0 in this case, digital can continue to collect data. But for even the best sensors noise begins to become a problem at around exposure zone 0. In addition, the number of raw steps within a zone for a 14-bit digital raw file keeps getting smaller. Changing to a 16-bit raw file would provide four times as many steps but it would also increase the file size.

Based solely on the characteristic curves and noise threshold, digital dynamic range is limited to about 8 stops, exposure zone 0 through 8. Beyond that it is necessary to resort to HDR (high dynamic range) techniques. Film can easily be used from 0 through 12 and beyond.

But neither medium can reach the level that out eyes can see, about 18-20 stops.