

The Zone System and the Digital Image

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Exposure Zones

Exposure zones are one stop increments on either side of what the camera sees as middle gray. For a scene with a wide dynamic range that can easily extend above zone 10 or below zone 0.

The point of the Zone System is that you might want to align only one of the exposure zones to a specific print zone. How you develop the film will determine where the other exposure zones fall. You can then move portions of the image relative to each other up or down during printing by dodging and burning, etc.

With digital images the situation is similar. You can align the brightness of a portion of the scene and all other parts of the scene will move up or down together. You can still edit the result to move portions of the image up or down as you could to when printing. If you are converting your image directly from raw data you can do more with highlights and shadows than if you are already committed to the camera's JPEG.

The raw file values are an arithmetic progression that gets turned into a logarithmic progression during raw conversion. They may be:

Table 1

EC ¹	14-bit raw value range	Exposure Zone
-3	128-255	2
-2	256-511	3
-1	512-1023	4
0 ²	1024-2047	5 ³
+1	2048-4095	6
+2	4096-8191	7
+3	8192-16383	8

1. Exposure compensation applies to exposure zones.0
2. Exposure zone 5 ranges about +/-1/2 stop above and below middle gray
3. "5" is designated as exposure zone 5 to align with print Zone V

A JPEG can normally range about +/- 2½ from middle gray – five exposure zones – 3 through 7. This is enough for the vast majority of scenes. Nikon, Canon, Sony and Fujifilm place middle gray within exposure zone 5, between 1024 and 2047.

Although a 14-bit raw file can record data for exposure zone 8, this is normally beyond the range used for the camera's JPEG.

Print Zones (JPEG Zones)

The zones described by Adams and Archer for the Zone System specifically refer to print zones.

Zone	Description
0	Pure black
I	Near black, with slight tonality but no texture
II	Textured black; the darkest part of the image in which slight detail is recorded
III	Average dark materials and low values showing adequate texture
IV	Average dark foliage, dark stone, or landscape shadows
V	Middle gray: clear north sky; dark skin, average weathered wood
VI	Average Caucasian skin; light stone; shadows on snow in sunlit landscapes
VII	Very light skin; shadows in snow with acute side lighting
VIII	Lightest tone with texture: textured snow
IX	Slight tone without texture; glaring snow
X	Pure white: light sources and specular reflections

From the [Wikipedia article on the Zone System](#)

Values in an 8-bit JPEG range from 0 (pure black) to 255 (pure white). The placement of middle gray within that range is arbitrary but 127 is about in the middle. The nine zones are distributed evenly with about 28 or 29 values per zone. Once this is done, print zones and JPEG zones are synonymous.

The Zone System specifically relates to black and white, not color. Colors become gradually less visible as you move away from Zone V in either direction.

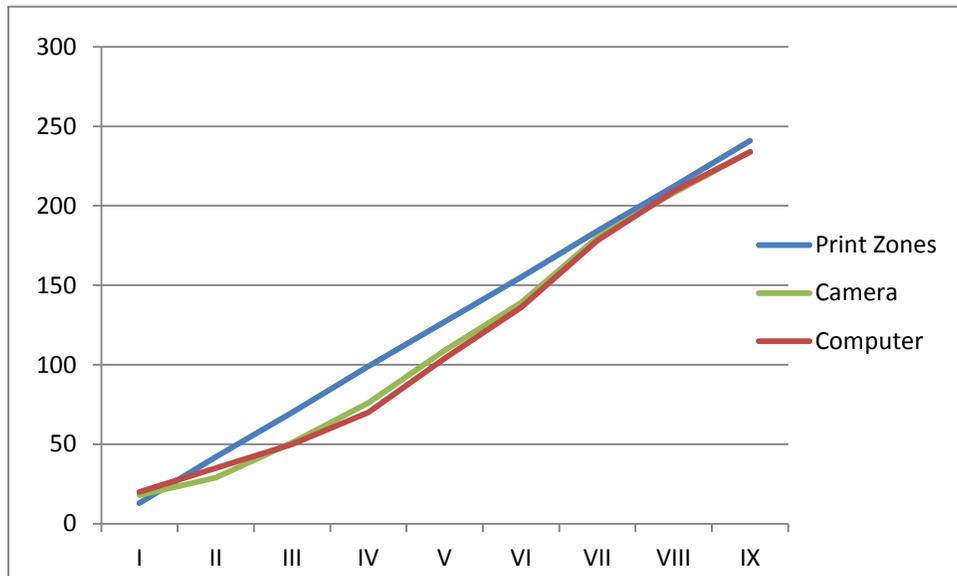
Mapping Exposure Zones to Print Zones

A scene with about six stops of dynamic range can be captured as a JPEG using little or no adjustment to the camera's default settings.

How do five exposure zones relate to nine print zones? We can keep exposure zone 5 in print Zone V and match up the darkest and brightest practical exposure zone with print Zones I and IX. Taking a total of nine images separated by exposure compensation steps of $2/3$ stop we get:

Nikon Df

EC	Print Zones	JPEG Value	Camera	Computer
	0	0		
-8/3	I	14	18	20
-6/3	II	42	29	35
-4/3	III	70	51	50
-2/3	IV	99	76	70
0	V	127	109	104
+2/3	VI	155	139	136
+4/3	VII	184	180	178
+6/3	VIII	212	208	209
+8/3	IX	241	234	234
	X	255		



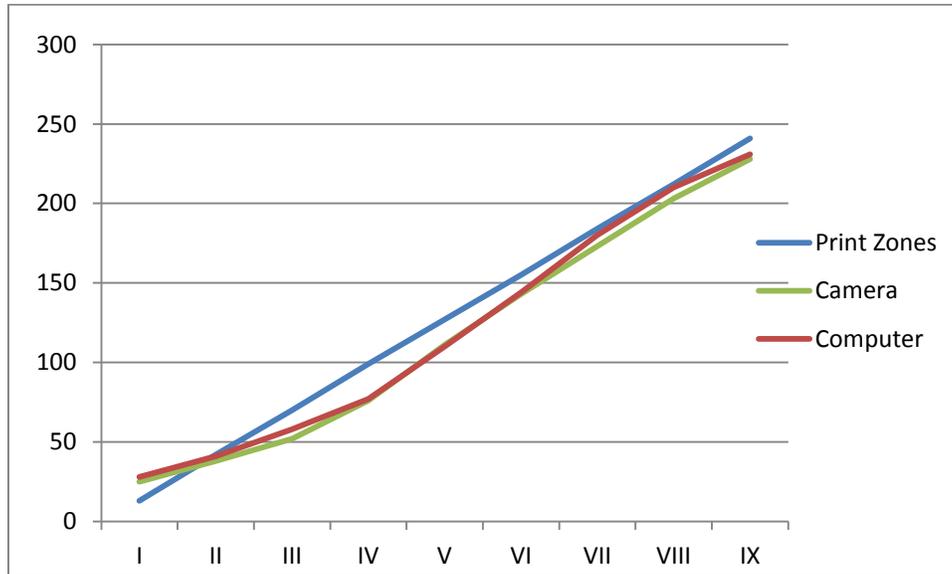
The JPEG Value column shows the middle value for the evenly spaced print zones, each 28 or 29 steps wide.

The Camera column shows the JPEG value at the center of a gray card image where the camera's spot meter was aimed using Aperture priority. The exposure compensation (EC) dial was used to vary the nine exposures.

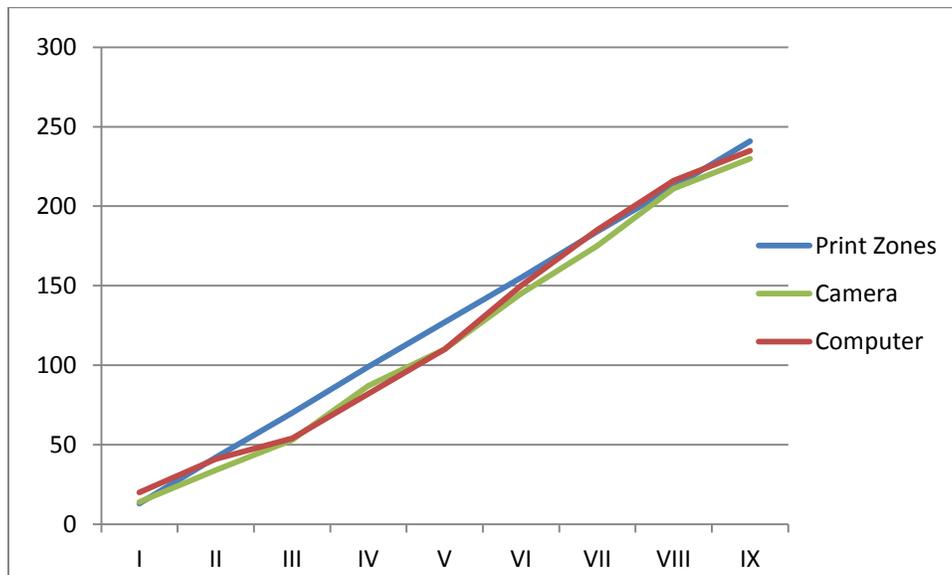
The Computer column shows the default JPEG values Capture One Pro produced from the raw images.

The experiment was repeated using a Sony A7 II and a Fujifilm X100T:

Sony A7 II



Fujifilm X100T



The raw file can, of course, record a scene with much more dynamic range than the default JPEG. The brightest stop (raw 8192-16383) contains highlight information that can be recovered.

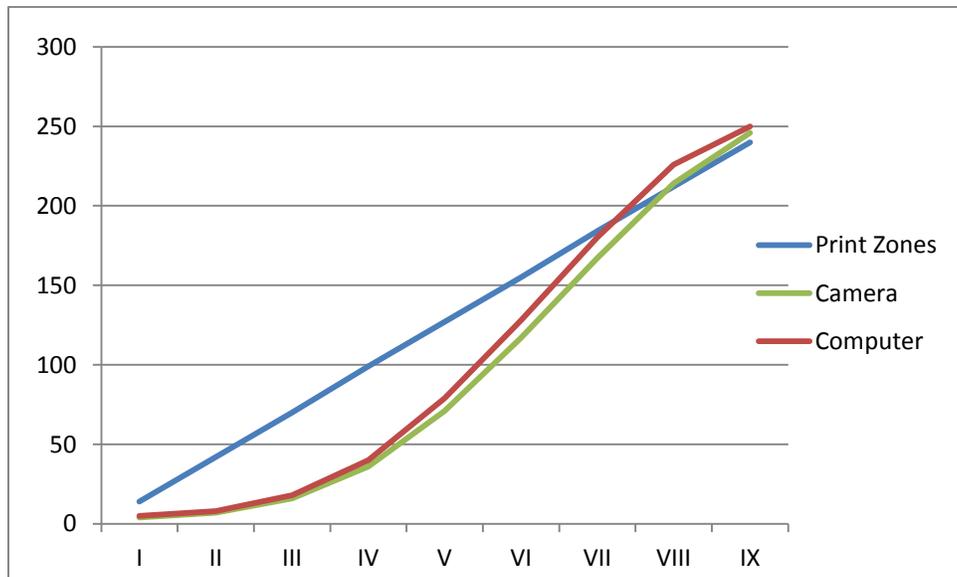
Two additional stops at the dark end (EC-4 64-127 raw, EC-5 32-63 raw) contain shadow information that can also be recovered without loss of tonality.

What happens if we use nine exposures each separated by a full stop?

Here are the results for a Nikon Df:

EC	Print Zones	JPEG Value	Camera	Computer	Adjustment
	0	0			
-5	I	14	4	5	1.83
-4	II	42	7	8	2.33
-3	III	70	16	18	2.27
-2	IV	99	36	40	1.90
-1	V	127	71	79	1.40
0	VI	155	117	128	0.84
+1	VII	184	167	180	0.40
+2	VIII	212	214	226	0.00
+3	IX	240	246	250	-0.25
	X	255			

The Adjustment column shows how much exposure adjustment is needed during raw conversion to reach the levels in the JPEG Value column.



The results for the other cameras were similar.

Some differences from the earlier results:

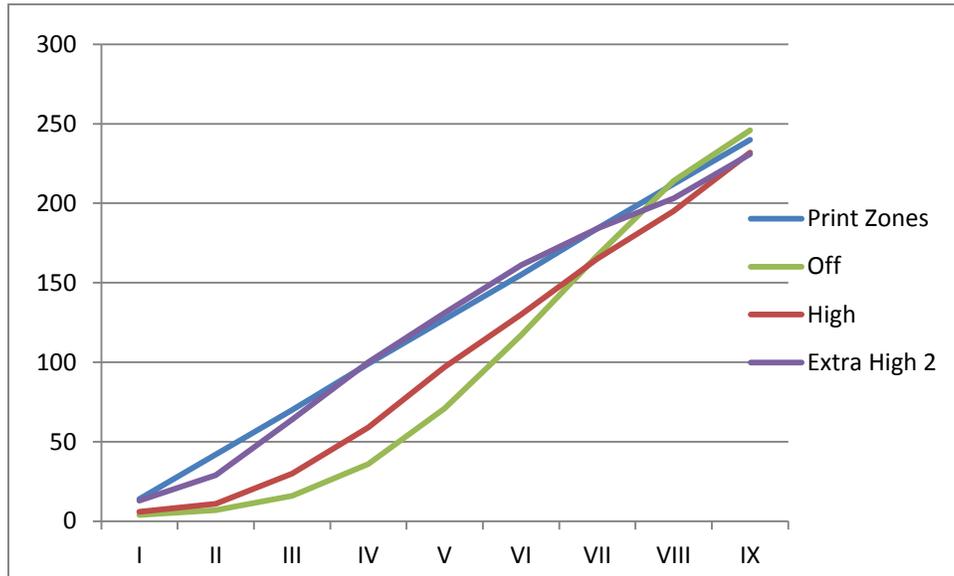
- The lower zones appear darker than expected.
- The “S” shape of the curve is pronounced and looks more like a film curve. There is low contrast at the dark end and high contrast in the middle. The high end still looks about the same.
- Banding might become visible in the JPEG below Zone IV.

The total practical dynamic range for a 14-bit raw file is about nine stops. Although you can use all nine stops you will need to do additional work to bring the zones and contrast back to normal.

In-camera Curve Adjustments

Highlights and shadows can be recovered during the raw conversion to provide a relatively straight relationship between exposure and print/JPEG density. But it can also be done in the camera.

Nikon does it with Active-D lighting (Canon Auto Lighting Optimizer and Sony Dynamic Range Optimization). Here are the results for a 9 stop dynamic range:



You still end up with an 8-bit file but the Extra High 2 curve is nearly straight without much deviation from the expected print value levels.

For a six stop dynamic range you don't need Extra High 2. You may not even want to bother with Active-D Lighting at all.

