

RAW, JPEG and TIFF

By [Bob Atkins](#)

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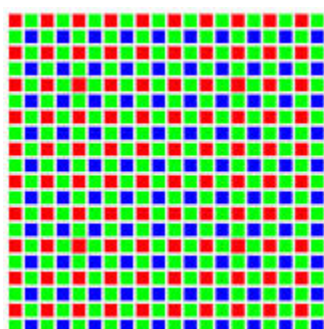
There seems to be a lot of confusion among some new digital camera owners about exactly what the difference is between RAW, JPEG and TIFF files. This article is intended to be a very basic guide to these file types and how they are related in a typical digital camera.

First some basics

The digital sensor in the majority of digital cameras is what is known as a BAYER PATTERN sensor.

This relates to the arrangement of red, green and blue sensitive areas.

A typical sensor looks like this:



Each pixel in the sensor responds to either red, green or blue light and there are 2 green sensitive pixels for each red and blue pixel. There are more green pixels because the eye is more sensitive to green, so the green channel is the most important. The sensor measures the intensity of light falling on it. The green pixels measure the green light, the red the red and the blue the blue. The readout from the sensor is of the

form color:intensity for each individual pixel, where color can be red, green or blue and intensity runs from 0 to 4095 (for a 12-bit sensor)

A conventional digital image has pixels which can be red, green, blue or any one of millions of other colors, so to generate such an image from the data output by the sensor, a significant amount of signal processing is required. This processing is called Bayer interpolation because it must interpolate (i.e. calculate) what the color of each pixel should be. The color and intensity of each pixel is calculated based on the relative strengths of the red, green and blue channel data from all the neighboring pixels. Each pixel in the converted image now has three parameters: red:intensity, blue:intensity and green:intensity. In the end the calculated image looks something like this:

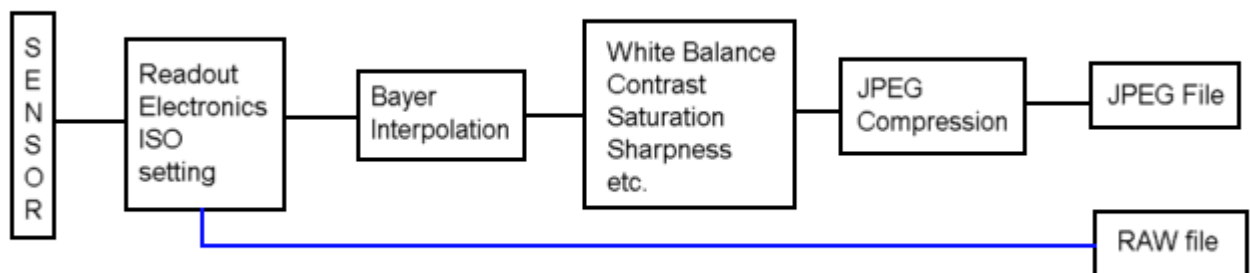


RAW data

RAW data (which Nikon call NEF data) is the output from each of the original red, green and blue sensitive pixels of the image sensor, after being read out of the array by the array electronics and passing through an analog to digital converter. The readout electronics collect and amplify the sensor data and it's at this point that "ISO" (relative sensor speed) is set. If readout is done with little amplification, that corresponds to a low ISO

(say ISO 100), while if the data is read out with a lot of amplification, that corresponds to a high ISO setting (say ISO 3200). As far as I know, RAW isn't an acronym, it doesn't stand for anything, it just means raw, unprocessed, data.

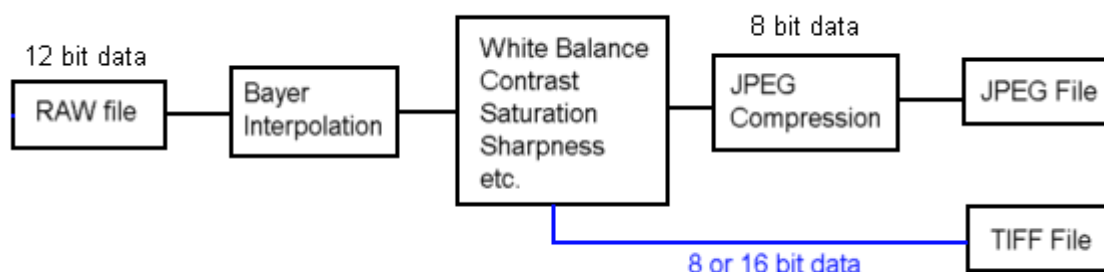
Now one of two things can be done with the RAW data. It can be stored on the memory card, or it can be further processed to yield a JPEG image. The diagram below shows the processes involved:



If the data is stored as a JPEG file, it goes through the Bayer interpolation, is modified by in camera set parameters such as white balance, saturation, sharpness, contrast etc, is subject to JPEG compression and then stored. The advantage of saving JPEG data is that the file size is smaller and the file can be directly read by many programs or even sent directly to a printer. The disadvantage is that there is a quality loss, the amount of loss depending on how much compression is used. The more compression, the smaller the file but the lower the image quality. Lightly compressed JPEG files can save a significant amount of space and lose very little quality. For more on JPEG compression see <http://www.photo.net/learn/jpeg/index.html>

RAW to JPEG or TIFF conversion

If you save the RAW data, you can then convert it to a viewable JPEG or TIFF file at a later time on a PC. The process is shown in the diagram below:



You'll see this is pretty similar to the first diagram, except now you're doing all the processing on a PC rather than in the camera. Since it's on a PC you can now pick whatever white balance, contrast, saturation, sharpness etc. you want. So here's the first advantage of saving RAW data. You can change

many of the shooting parameters AFTER exposure. You can't change the exposure (obviously) and you can't change the ISO, but you can change many other parameters.

A second advantage of shooting a RAW file is that you can also perform the conversion to an 8-bit or 16-bit TIFF file. TIFF files are larger than JPEG files, but they retain the full quality of the image. They can be compressed or uncompressed, but the compression scheme is lossless, meaning that although the file gets a little smaller, no information is lost. This is a tricky concept for some people, but here's a simple example of lossless compression. Take this string of digits:

147452965333333659762888888356789

Is there a way to store this that doesn't lose any digits, but takes less space? The answer is yes. One way would be as follows

1474529653[5]6597628[6]356789

Here the string 33333 has been replaced by 3[5] - meaning a string of 5 3s, and the string 888888 has been replaced by 8[6] - meaning a string of 6 8s. You've stored the same exact data, but the "compressed" version takes up less space. This is similar (but not identical) to the way lossless TIFF compression is done.

I said above that the data could be stored as an 8 or 16-bit TIFF file. RAW data from most high end digital camera contains 12 bit data, which means that there can be 4096 different intensity levels for each pixel. In an 8-bit file (such as a JPEG), each pixel can have one of 256 different intensity levels. Actually 256 levels is enough, and all printing is done at the 8 bit level, so you might ask what the point is of having 12 bit data. The answer is that it allows you to perform a greater range of manipulation to the image without degrading the quality. You can adjust curves and levels to a greater extent, then convert back to 8-bit data for printing. If you want to access all 12 bits of the original RAW file, you can convert to a 16-bit TIFF file. Why not a 12-bit TIFF file? Because there's no such thing! Actually what you do is put the 12 bit data in a 16 bit container. It's a bit like putting a quart of liquid in a gallon jug, you get to keep all the liquid but you have some free space. Putting the 12 bit data in a 8 bit file is like pouring that quart of liquid into a pint container. It won't all fit so you have to throw some away.

When to shoot RAW, when to shoot JPEG?

The main reason to shoot JPEG is that you get more shots on a memory card and it's faster, both in camera and afterwards. If you shoot RAW files you have to then convert them to TIFF or JPEG on a PC before you can view or print them. If you have hundreds of images, this can take some time. If you know you have the correct exposure and white balance as well as the optimum camera set parameters, then a high quality JPEG will give you a print just as good as one from a converted RAW file, so you may as well shoot JPEG.

You shoot RAW when you expect to have to do some post exposure processing. If you're not sure about exposure or white balance, or if you want to maintain the maximum possible allowable post exposure processing, then you'll want to shoot RAW files, convert to 16-bit TIFF, do all your processing, then convert to 8-bit files for printing. You lose nothing by shooting RAW except for time and the number of images you can fit on a memory card.

Note that some cameras can store a JPEG image along with the RAW file. This is the best of both worlds, you have a JPEG image which you can quickly extract from the file, but you also have the RAW data which you can later convert and process if there's a problem with the JPEG. The disadvantage is, of course, that this takes up even more storage space. Many cameras also store a small "thumbnail" along with the RAW file which can be read and displayed quickly without having to do a full RAW conversion just to see what's in the file.

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Phillip Northeast

The advantages of using RAW for the best quality images or save as JPEGs to store more shots on digital memory cards.

Photographers with high performance digital cameras can choose the file format the camera uses to store the images on the memory card, the common alternatives are RAW and JPEG.

RAW

RAW is not really a file format, instead it refers to the file format used by each camera manufacturer where there is minimal in-camera processing of the image data. The camera saves unaltered, or raw, image data plus camera settings for the image such as white balance, sharpness, contrast and saturation.

The camera manufacturer usually supplies the software tools required to process their own version of a RAW file with their cameras. There are software suppliers who offer alternatives that promise better, faster or more convenient computer processing of RAW files. Either they can be stand-alone programs or as plug in extras to programs such as Photoshop. There is a move by Adobe to create a standardized RAW format, or Digital Negative (DNG).

The larger RAW file size offers the potential for more detail in the final image. While some camera models may have issues with Automatic **White Balance** (AWB) performance, the ease of adjustment of color temperature while processing RAW images makes this the preferred option in difficult lighting situations.

For your best shots choose the RAW format and get more details, with minimal in camera processing. This allows greater scope for individual image adjustment on the computer, rather than accepting the preset in-camera adjustments. Also continuing advances in

software promises better RAW file processing in the future. Because RAW files are uncompressed and contain more information than JPEG files, they require more storage space and take longer to transfer and transmit.

JPEG

JPEG (or jpg) comes from the Joint Photographers Expert Group and is very common storage option for nearly all digital cameras. The camera's on-board computer takes the RAW data and applies preset image preferences, such as sharpness, saturation and contrast. Then the processed data is compressed and saved to the memory card as a JPEG file. The photographer can choose to use a range of JPEG sizes, the quality of the stored image getting worse the smaller the file. The advantage of smaller image size is that it allows more images on a memory card. The choice is how much quality is enough?

The smaller JPEG image files make better use of storage space and are quicker to send over the Internet. JPEG is the standard for the display of photographs on web pages, although these are usually smaller more compressed images. The best quality, or least compressed JPEGs are a very usable image. For example, they are used by professional photographers to produce publishable images for newspapers and many magazines. Top quality JPEGs from DSLR's are suitable for A4 size and larger prints.

Professionals choose the JPEG format when speed and storage capacity are an issue. It is possible to get three to four times as many high quality JPEG images onto a memory card than the uncompressed RAW format. This is an important consideration for a motor sports photographer, who may shoot thousands of images over a weekend race meeting. The smaller JPEG file size enables faster transfer and selecting of images to meet editorial deadlines for newspapers and Internet news sites. However, if you are shooting a spread for a glossy fashion magazine the choice is to use the RAW image data to ensure maximum quality

Some Forum Discussions:

As Big Bri has said (man of few words) It would not be true to say that all good images are taken in RAW.

As a basic understanding, And I do mean basic, The major difference is the structure of the data in a RAW file when compared to a Jpeg.

A RAW file in most cases has no in camera adjustments added to the data, A RAW file is just that RAW data straight from the Cameras CPU and as seen by the Sensor.

The RAW file allows more in the way of Post production alterations in your imaging software (ie Photoshop or whatever) In fact you are when dealing with

RAW files, Doing the Job that the Camera's CPU normally does to Jpegs.

However Your Computers CPU & Software are many times more powerful than the one in your camera, So it gives you much more control over the finished image.

AS for Jpegs, These are normally almost ready to print straight from camera, Baring a minor adjustment here or there, BUT that's it, You have nothing like the options open to you, That a RAW file offers.

MOST if not all Camera manuals, PUT it simply like this, RAW for images that will be extensively manipulated in post production.

And Jpegs for images that might have a minor tweak, Then straight to print.

Big Bri, Is quite right in that there is truck loads of stuff re the Jpeg V RAW subject, I have made this as simple and brief as possible.

If you need further on the subject, Do take a look at the search for more in depth explanations.

Duncan Evans

Posted: 4 Jul 2007 - 11:14

Duncan_E

I just want to add this detail about RAW images. There's this misconception that it's straight off the CCD, as it was shot, with no manipulation. This isn't quite the case, the RAW image is entirely processed by the firmware to create colour and to optimise the detail. It doesn't have the additional manipulation of in-camera sharpening, colour and contrast adjustment that that forms the second stage of image production, but it is entirely processed in the first place.

Memory is cheap (buying on the internet anyway). Every exposure error you make when shooting jpegs is cast in stone, so that if you blow highlights or block up shadows - there's little you'll be able to do about it afterwards. With RAW, the extra latitude often makes the difference between being able to revive a picture and having to reject it.

Therefore, if you're going on an expensive or far-reaching trip where the pictures won't be easily repeatable - I'd advise shooting RAW. If you don't feel you have enough experience to get the best from a RAW file, you can always go back to pictures at a later date and rework them when you're more accustomed to various techniques.

If, on the other hand, you want your picture-taking to be as simple as possible and don't want to get too involved with editing images - shoot jpegs. It hinges really on your outlook and what you want to get from your photography. Bear in mind that the camera doesn't always see things the way you want to remember them - sometimes it's the 'tweaking' which makes the difference, and RAW files are very pliable in that respect.

Depending upon your camera, you may also be able to shoot RAW files and jpegs simultaneously, which for example can be useful for creating quick slide shows from your holiday pictures without having to convert your RAW files first (which will typically be bigger, slower to open, and less universally recognised).
Quote

Re: RAW

RAW contains 12 or 16 bits of information per pixel and a JPEG contains 8 bits so the RAW image has more information to work on. If you shoot JPEG then the camera is processing the image how it has been set up to do so, sharpening, saturation, etc, but if you shoot RAW then you make those decisions when you process the image. In JPEG the image is compressed each time you save it so some information is lost. This does not happen if you shoot RAW and save it in a lossless format such as TIFF. You can shoot RAW on your camera, I don't know the specifics but you will need to go into the menu and set it up. Ian

RAW is like an image shot on film before it is processed. If you process a film and then print it, you will never print all the detail that is on the negative because the paper is a secondary image and cannot handle all the detail of the original. RAW is the original and has the maximum detail possible from your chip. It has to be processed but you can alter the exposure, colour, contrast etc BEFORE it is processed. You then save it as a Tiff or JPeg (The processed image!)

I use the Fuji S2 and have done exhaustive testing with both the Fuji EX raw convertor (version 2.0) and Adobe Camera Raw convertor (version 2.2x25) and can say there is a very distinct quality difference between a jpg and raw conversion - especially with EX. There is more detail, less fringing (chromatic aberrations), no jpg artifacts, and less halo effect - especially if sharpened before printing. Lastly, you will end up with a fuller color gamut from which to work with. Granted that if all you want is a 4"x6" or 6"x9" print you will never SEE the difference. However, if you should later decide to make a large print, say a 16x24, you will be very disappointed! There is a considerable difference in quality. That's why I shoot 100% raw. Besides that, in spite of 50 years experience, I still blow exposure from time to time. Raw keeps me from having to bracket. Sometimes that 1/3 stop one way or the other can make a considerable difference. Lastly, using raw enables me to expand my dynamic range. If I discover later that the range of the scene is excessive, I simply make two raw conversions, one to save the highlights and a second to preserve shadow detail. (You will need a working knowledge of Photoshop layers)