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How to... Work with ISO



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Sense & Sensitivity

Doug Harman looks in detail at sensitivity, ISO control and getting the most from your camera's settings while avoiding its possible pitfalls



There's no doubting modern digital cameras are technical marvels replete with some very clever equipment, marrying sophisticated

and traditional tools with modern technology. But, even with all that cleverness there is still an area considered an Achilles heel. This revolves around sensitivity, ISO control and problems with image noise.

ISO (International Standards Organisation) control, the name given to a camera's sensitivity adjustment, was originally used as a rating denoting camera film's sensitivity to light. A film with an ISO of 100 would be less sensitive to light than film with an ISO rating of 400, and so on.

■ **[Above] Although some new DSLRs don't offer ISO 100 (Olympus E-3 among them), you can achieve great detail shooting at this setting, as demonstrated here**
Shot details: Nikon D70, 48mm and f8, ISO 100, 1/800sec

That ISO sensitivity scale (incidentally previously called the ASA, the American Standards Association rating, until the ISO scheme was adopted) has been transferred to digital cameras – the higher the ISO number used, the more sensitive to light your camera's sensor becomes.

In simple terms, the ISO setting allows you to adjust the camera's sensitivity to light, so using the example above, the lower the light levels you wish to shoot in, the higher the ISO would be used. In this way, you can continue to shoot without using flash, for example.

As we'll see, ISO control is an indispensable tool for allowing your creativity to shine through, even in more challenging lighting conditions, and we'll look at ways to successfully mitigate issues surrounding noise. ►►

masterclass sensitivity and ISO



■ [Above left] These triathlon athletes were moving quickly but muted, overcast daylight and a long lens with fairly limiting aperture meant in order to freeze the action, a higher ISO had to be brought into play

Shot details: Nikon D70, 70-300mm Nikkor zoom, 135mm, f16, ISO 800, 1/125sec

► Typical subjects where you'll need to boost your camera's sensitivity include low-light shots, indoors and out, shooting fleeting action (particularly where you want to freeze the action but the range of shutter speeds open to you won't allow you to) or when snapping at longer focal lengths of a zoom lens, where your available apertures are restricted.

Another good example is when you need to get an ambient light exposure without using a tripod or other camera support and you don't want to use flash. Boosting the ISO allows you to claw back control over both shutter speeds and apertures.

As you increase the camera's sensitivity, at any given aperture it will bring higher or lower shutter speeds into play depending on what you want or intend for the shot at hand.

For instance, shooting in low light without a support could mean problems with camera shake, while bumping up the ISO will allow you to get a shutter speed that will allow you to freeze the shot properly.

Increasing the ISO will also give you improved control over your apertures an important factor if, say, depth of field control is important. You need to use a smaller aperture than those available at a given (lower) ISO and shutter speed combination.

You also have scenarios where use of flash is not allowed, such as within museums for example, or use of the flash will ruin the quality of ambient lighting. Adjusting the ISO upwards can bring into play the creative flexibility needed to still capture the image you want; keep it sharp and properly exposed.

Alternatively the opposite might be true, where there's too much light and you need to create a shot including an element of blur to convey the speed of a fast-moving subject. Here, reducing the ISO will allow you to reduce the shutter speeds and control apertures in a way that allows you to get a controlled amount of blur.

The same applies when panning with a subject to introduce background blur, for example. Here, adjusting to a lower ISO will ensure you can use a shutter speed that will keep the subject suitably sharp but with a controlled amount of blur to the background. Incidentally, this technique can also be very useful when a background might be distracting; panning with the subject as it passes can eliminate the problem quickly and easily.

It's worth bearing in mind that the higher the ISO, the more your images might be affected by image noise. Image noise can be thought of as analogous to film grain

ISO and noise comparison A series of images shot on a typical zoom compact digital camera, to show



■ This shot displays vibrant colour, with plenty of detail and no noise



■ Good colours and detail noise slightly raised, but not enough to be noticeable



■ Similar to the ISO 200 image, but noise in shadows becoming evident



ISO and flash

Because increasing ISO makes your camera more sensitive to light, you can increase the flash's effective illumination range by increasing ISO. This helps get more from the often limited flash range of built-in or pop-up style flash units on digital compacts and DSLRs.

The following table gives a good rule of thumb for various ISO settings. Your camera's manual will show the flash range, set usually in meters and based on the camera at ISO 100 and at a given focal length. This 'base' is indicated in the table as

CCD sensitivity (ISO setting)	Conversion Factor
ISO 25	x0.5
ISO 50	x0.71
ISO 100	x1
ISO 200	x1.4
ISO 400	x2
ISO 800	x2.8
ISO 1600	x4

a factor of x1. Therefore, if your flash can properly illuminate a subject three meters away at ISO 100, by increasing the ISO to 1600 and multiplying the normal flash range (at the base sensitivity shown in the manual) in this case, it's three meters at ISO 100, and with the conversion factor of x4 you get the boosted range. So, in this example, the new extended flash range will be 12m.



and looks like lots of small red, blue and monochromatic speckles over the image, typically showing up more in dark or shadowy areas of a scene.

The noise exhibited in an image will increase as the sensitivity is increased (see below). Contrast can also increase as ISO increases and to a degree, colour can be affected too, typically becoming less saturated. It's important to bear these things in mind, particularly if you want a very smooth, noise-free shot, but it can also be exploited.

For example, the effect can be used to recreate the grainy effect that fast black-and-white films used to provide. If you're intending to shoot the images and switch them to black and white on PC later on (or even just shoot mono images in camera), high ISO noise can be used to great advantage.

Whatever you wish to do image-wise, the level of flexibility increasing ISO provides depends on the range of sensitivity settings available to your camera. If you want to use

■ **[Above left]** This shot, taken at ISO 50, shows the sheer level of detail achievable even with a digital compact, such as the Casio model used for this image
Shot details: Casio Exilim EX-Z1200, 37-111mm zoom, 37mm, f2.8, ISO 50, 1/200sec

■ **[Above right]** Here the main subject is kept sharp by firing a burst of slow-sync flash, recording the ambient lighting and retaining as much detail as possible. An ISO 200 and a shutter speed of 1/3sec did the trick, with the flash ensuring the jumping lad is pin-sharp
Shot details: Nikon D70, 18-70mm Nikkor zoom, 18mm, f3.5, ISO 100, 1/3sec

high ISOs but reduce the effects of noise, ensure you switch on your camera's image noise reduction systems (usually in menus), which can help mitigate the worst of it.

A drawback with noise reduction processing is that it can slow down the speed you buffer images to memory (important if you intend to shoot bursts of multiple images). It can also, depending on the camera, reduce detail as it tries to smooth out the worst aspects of the noise.

An alternative to this is to post-process noise away using noise-removal software on PC. Some of the widely available noise reduction packages available include Neat Image, Noiseware Pro or Noise Ninja (as reviewed in *Digital Photographer* issue 64, page 106). Such software is not expensive and can remove the worst of image noise without adversely affecting the detail in a shot, not to mention other aspects such as colour and contrast. Some image editing software will also have tools to deal with lesser noise.

High-end cameras – DSLRs in particular and generally more expensive machines – have better performance and tools to control camera sensitivity and image noise. The latest digital cameras are better than earlier models of any ilk at controlling or dealing with it.

Controlling the camera's sensitivity involves adjusting the camera's ISO to bring into play a higher range of shutter speeds, for example. The higher the ISO number selected, the more sensitive your camera's sensor is made to the light striking it. However, in the digital domain, increasing the ISO actually means you turn up the sensor's gain, which is akin to increasing its volume; it amplifies the signal (the light) and so any noise hidden within it.

Increasing the ISO can also increase image noise, or the 'graininess' analogous to the static 'snow' seen on a poorly tuned TV. Image noise looks like blue, red and monochromatic speckles over an image but typically occurs within areas of darkness or shadows, plain areas of colour or low detail such as blue

how ISO can affect image quality – notice how shadows and the colour balance/vibrancy are the most affected areas



■ Colour beginning to drop off, as is contrast. Noise is evident over entire image but bad in shadows



■ Very obvious noise across entire image, particularly bad in shadows and colours leached from image



■ Noise is not much increased over ISO 1600, but colour has dropped off further and noticeably

masterclass sensitivity and ISO



■ This shot, taken at a party in low light indoors, is typical of the affect high ISO can have on detail. Even with a burst of flash, a combination of noise and noise suppression processing has removed a lot of detail
Shot details: Nikon D70, 28-800mm Sigma zoom, 70mm, f2.8, ISO 1000, 1/30sec

► skies, or lighter areas such as grey skies. With digital cameras, noise is the none-image forming 'static' that either comes from the environment, such as excessive heat, or from the camera's own electronic systems. The higher the signal (light) to noise (static) ratio, the better and the lower image noise will be. As ISO is increased, noise within the signal is also amplified, making any image noise problems more obvious and worse.

The ISO standard, 12232:2006, specifies definitions of the speed rating on digital

■ [Right] If you can't use a flash and need to get a shot indoors in low ambient lighting, you have no choice but to bump the ISO up. Here the camera's noise processing was switched on to help mitigate any noise issues
Shot details: Pentax Optio M30, 38-114mm Pentax zoom, 45mm, f3.5, ISO 800, 1/50sec

camera sensitivity, sensor noise, and the resulting digital image. They're related to traditional film speeds, based on how a standard 18 per cent reflective surface would appear in an image in a given lighting setup. This calculation is based on the properties of the sensor and the internal image processing carried out by the camera. The standard specifies the way speed ratings are reported by the camera, based on both noise-based speed and saturation-based speed. For more information Wikipedia has plenty on the subject, particularly for those of a more scientific bent. Point your web browser at http://en.wikipedia.org/wiki/Film_speed#ISO_film_speed_scales.

Another thing worth bearing in mind is that image noise becomes worse the smaller the sensor used and the more densely packed (the pixel pitch) the pixels. The smaller the sensor and the pixels, the less sensitive they are to light and the more the sensor's gain needs to be amplified to get a reasonable image. This explains why DSLRs, with their larger sensors and generally larger pixels, don't suffer as much as digital compacts from noise issues.

DSLRs tend to have better noise processing too, so helping to mitigate further problems associated with high ISO and noise.

In summary you can use ISO to improve flash performance, provide a greater range of fast shutter speeds for action shots and

Controlling ISO

ISO is typically controlled either via menus or a 'hard' button and dial combination, but depending on the camera you own, the camera may control the ISO automatically. If this is the case, it will automatically adjust dependent on the available light, so creative control of ISO is not possible.

If you have the ability to control ISO, you'll be given a set of options typically including a range of settings from ISO 100 up to ISO 6400. Pro or semi-pro level cameras will have a broader range of settings and fine-tuning options that allow better control of the ISO increments you can use.

The camera may allow you to tailor a maximum/minimum range of ISO settings, say from ISO 100 to ISO 400, the camera automatically choosing between these presets. Here it's possible to both control the affects of image noise by restricting the available top ISO setting and allow the camera to use ISO priority to determine exposure.



handhold low-light shots. Decrease ISO to get optimal quality for your shots, with minimal noise and more accurate colour and contrast.

Learn how your camera's ISO settings affect the images it makes, in order to quickly be able to creatively use or offset the effects in your images. Lastly, bear in mind that noise reduction processing can slow your camera's continuous drive mode performance, as the processing takes extra time before images are saved to the camera's memory card. DP

