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Flash Photography with Canon EOS Cameras - Part I.

Version 1.7. 23 February, 2007.

http://photonotes.org/articles/eos-flash/

The invention and subsequent automation and miniaturization of electronic flash revolutionized photography. If you're a photographer you're no longer tied to available light. A reliable and portable light source is immediately at your disposal if you choose.

But flash photography has always been a very difficult technique to master on any camera system. It's easy to take a snapshot of your friends in a restaurant and get that hideously blown-out rabbit-in-the-headlights look from built-in automatic flash. But using electronic flash well - achieving natural-looking images - is quite tricky.

This is in large part, of course, because the human eye can't fully discern the effects of a flash burst at the time an image is taken - the brief pulse of light is just too short for us to process. And you can't even see the flash if you're looking through the viewfinder of an SLR camera anyway, as the mirror will have been raised for the duration of the flash. It's also because small light sources mounted close to the lens produce a very unnatural form of light.

So you have to read manuals and experiment. But with film-based photography there's a long lag time in the feedback loop - you have to take your film in to be processed before you see what worked and what didn't. Taking notes can be cumbersome because of the highly automated nature of modern flash. Even professionals don't rely entirely on their experience and flash meters and do test shots with a Polaroid instant film back in studio flash situations. Digital photography has one of the benefits of shortening this feedback loop considerably, but that doesn't really help those of us who still use film.

So, here's some information that may help you understand some of the mysteries of flash photography with Canon EOS camera equipment. Much of the information presented herein is fairly general in nature and thus covers similar flash systems used by other manufacturers, but much is very specific to Canon EOS products.

Note that this document covers Canon EOS products, including digital EOS cameras. Canon's PowerShot series of digital cameras can use Speedlite EX-series flash units, but since they aren't EOS cameras there are significant differences in the way they work.

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Existing documentation.

Learning more about flash photography with EOS cameras is hard as there's relatively limited information available on the topic. Canon's manuals tend to be fairly short, and not much information has been published about the flash algorithms used by EOS cameras. There's a brochure on the topic - Canon's "Flash Work," but unlike the excellent and similarly titled book "Lens Work," the flash brochure does not go into much detail. Hove/Silver Pixel Press published a book on the Canon Speedlite 540EZ flash unit, which also briefly described other Canon flash units sold at the time, but the book is now apparently out of print.

Canon USA did publish two technical booklets on the subject in the early 1990s - the "Canon Speedlite Reference Guide" and the smaller "Canon EOS Speedlite System." However, these are now out of print and don't cover E-TTL technology. The Speedlite Reference Guide is a very useful resource for learning more about TTL and A-TTL flash, however. Many thanks to Brett Cheng for mailing me a copy!

When the Elan II (EOS 50) was released, Canon USA's Chuck Westfall provided some valuable information that Mark Overton wrote up in the form of an FAQ. This document is very useful, but somewhat terse - it doesn't cover a lot of the terminology and background. It also deals primarily with one camera/flash combination - the Elan II and the Speedlite 380EX. So I decided to write a somewhat more detailed account of how EOS flash works.

The document you are currently reading is, however, extremely long and detailed. So if you want a quick précis of EOS flash technology you should probably consult the Westfall/Overton FAQ on Bob Atkins' Web site.

Finally, please note that I have no particular insight into or access to the mysterious ways of Canon's flash engineers. I wrote this document partly because I thought it might be helpful to others and partly because explaining something is a great way to learn something yourself. But there may, of course, be technical errors in this document. If you spot any errors or ambiguous or vague sections, Please send feedback!

Top Ten Frequently Asked EOS Flash Questions.

Before we start, however, I'd like to provide quick answers to the top ten Frequently Asked EOS Flash Questions, since they come up an awful lot.

I'm also going to mention my Canon EOS Camera/Flash Compatibility Lookup page, which allows you to compare different camera and flash models to determine their compatibility and what functions are available to you.

1) My camera already has a built-in flash. Do I need an external one? If so, what kind?

This question crops up all the time on discussion forums, much to the irritation of oldtimers. And their irritation usually arises for two simple reasons. First, they're grumpy cantankerous curmudgeons and second, the question is sort of meaningless without

knowing what your photographic requirements and interests are.

It's very much like asking, "Which car should I buy?" The answer depends on your needs and budget. But here's a brief overview of what you should consider.

If you just want something to take snapshots with, a built-in popup flash is probably sufficient. It can't produce much light and so doesn't have a lot of range, but then friends in restaurants aren't going to be very far from you. It has a harsh quality, but for snapshots most people don't seem to mind much. And internal flash units are convenient - you can't lose them unless you lose the whole camera, and they don't add any additional weight or bulk.

However, if you want to get into more advanced photography you'll probably want either to buy a good external flash unit or else eschew flash as often as possible and rely more on available light. As noted above, the light from an internal flash unit is very harsh, whereas external units let you soften the light by bouncing it off of walls or ceilings, or attaching light-softening diffusers. Most importantly, an external flash unit can be taken off the camera - either with an extension cord or wireless. This is important since on-camera flash provides unnatural head-on lighting.

At this point it's largely a matter of how much you want to spend and how much weight you want to carry around. Please consult the "which flash?" section of this document for more details.

Nonetheless, remember that flash is no panacea for photographic lighting problems. It's obviously a valuable tool, but often the best way to ruin a nice picture is to blast tons of light onto the scene with a flash unit. Available light photography forces you to slow down and consider the light around you, which ultimately can help you become a better photographer.

2) I have an old flash unit. Will it work on my new Canon digital EOS camera?

Maybe. That depends on what type of flash unit you have.

Canon digital cameras can only use Canon Speedlite flash models with names ending in EX. If your Canon flash unit has a model name which ends with E or EZ or anything else then it will not work with any Canon digital EOS camera.

As for flash units manufactured by other makers, check its specifications to see if it supports "E-TTL flash metering." If it does not, or only lists "Canon TTL flash metering" then it most likely will not work. For details see the section on flash metering with digital cameras.

3) I'm not happy with my flash photos. The lighting always looks harsh and unflattering.

Flash is like that. Basically, soft lighting is light which originates from a large area. Portable camera flashes, by contrast, have very small light-producing areas and, therefore, produce very hard-edged light with pronounced shadows. Flash units also tend to be mounted right next to the camera lens, producing an unnatural look. How often do you see the world illuminated by light emanating from your head? You probably don't - unless you're wearing a caving helmet or a head-mounted camping light. Light tends to come from overhead sources - the sun, ceiling lamps, etc.

The easiest way to soften the lighting in your flash photos is to bounce the light from the flash unit off a large white surface. Walls and ceilings work for this, as do portable folding reflectors. You can also buy diffusers that attach to your flash that help a little bit as well. For more information have a look at the section on quality of light.

4) Are my friends and family possessed by demonic powers? Their eyes are glowing an evil red!

This is the "redeye" effect; a common problem with the internal flash units built into cameras. It's caused by the white light from the flash unit reflecting off the red blood vessels lining the interior of the eye. The light shines back into the camera, resulting in the famous red glow.

The easiest way to minimize the risk of redeye is to use an external flash unit rather than a built-in flash. The problem is fully explained in the redeye section of this document, as is

the related problem of greeneye in cats and dogs.

If, however, your friends' and family's eyes glow an evil red in real life and not just in your flash photos of them then you should probably consider arranging an exorcism. Contact a tabloid first if you want to exploit the situation to your financial advantage.

5) I took two flash photos in rapid succession and the second one is totally dark. Why?

All flash units take a number of seconds to charge up between flash bursts. Some flash units have "rapid-fire" abilities which let them fire the flash even if the internal capacitor is not yet fully charged - but others don't.

So if your second photo is dark it probably means that your flash unit lacks rapid-fire capabilities. You have to wait for the unit to charge up fully (and the pilot light on the back of the unit goes on) before taking the second photo. However, if your flash does have rapid-fire capabilities then you probably took the second photo too quickly and the flash unit hadn't enough time to recharge to an adequate power level.

Note that different types of batteries charge up the flash at different speeds, so if this is a consistent problem you should look into your battery options.

6) I've put a diffuser or reflector on my flash. Do I have to compensate for this somehow?

Diffusers of any kind obviously reduce the amount of light that your flash unit produces. You'll find a similar effect if you bounce the light from your flash unit off a wall or into a photographic umbrella.

However, so long as you're using automated (TTL, A-TTL or E-TTL) metering then the camera will compensate automatically. There is no need to adjust anything.

You'll have decreased range, but you shouldn't have any exposure problems unless you're too far away from the subject and the decreased range now means you're out of range. Diffusers can easily cost you at least half your flash range, depending on the type.

7) I tried to take a flash photo and the camera wanted a really slow shutter speed. Why?

This occurred because you are trying to take a flash photo in low-light conditions and the camera is in Av (aperture priority) mode or the night PIC (icon) mode if your camera has it.

In Av, night and Tv (shutter speed priority) modes the camera meters for ambient (existing) light and fills in the foreground subject using the flash. It does *not* assume that the primary light source is the flash, and therefore the shutter speed it sets is the same as it would set if you weren't using flash at all.

In low light this results in slow shutter photography. If the shutter speed is very long you will, therefore, need a tripod to avoid motion blur during the exposure.

Alternatively you can switch to full auto (green rectangle) or Program (P) mode, which automatically expose for the flash-illuminated subject and not the background. These modes try to ensure that the shutter speed is high enough to let you handhold the camera without a tripod. The drawback of P and basic modes is that photos taken in dimly lit areas usually end up with black or poorly lit backgrounds.

8) I tried taking a flash photo and the camera wouldn't let me set a very high shutter speed. Why wouldn't it?

Each camera model has a top shutter speed that can be used with flash. This is known as its flash sync or X-sync speed, and varies from 1/90 sec on low-end cameras to 1/250 on pro cameras. (1/500 sec on the digital 1D)

If you have a newer camera and an EX series flash you can use FP mode to circumvent this limit - see the FP section for more details.

9) I took a flash photo and the background is pitch black or very dark. Why?

This is the flip side of question 7. In P (program) mode and all flash-using PIC (icon) modes except for night mode (if your camera has it) the camera uses the flash as the primary light source for the foreground subject.

If the ambient light levels are low, therefore, the background will turn out very dark. This is because the flash is not illuminating the background and the shutter speed is too short to expose adequately for background areas.

Remember that the light from any battery-powered flash is somewhat limited. You can't expect a small flash unit to light up the Grand Canyon or Eiffel Tower. You can only reasonably expect it to light up people standing in the foreground or close backgrounds such as room interiors.

To avoid this problem of black backgrounds you will need to take a photo in Av, Tv or M modes, as mentioned in question 7. If the ambient lighting is very low you may need a tripod to avoid motion blur for the time required to expose the background adequately. Using fast film (eg: ISO 800) and wide lens apertures (the smaller the f stop you can get on your lens) will help bring up the background as well.

10) Why does my camera meter in P and Av modes very differently when I have a flash turned on?

That's how EOS cameras are designed to work. P, Av, Tv and M modes all meter for flash in different ways. See the section on "EOS flash confusion" for details. Here's the short version, which repeats some of the points made in previous FAQ questions.

Keep in mind that the camera meters for ambient (existing) light conditions and flash illumination independently.

P (program) mode keeps the shutter speed between 1/60 sec and the maximum flash sync speed your camera can handle. It does this so that you shouldn't need a tripod, even if light levels are low. It then tries to illuminate the foreground using flash.

Av (aperture priority) and Tv (shutter speed priority) modes set the shutter speed or aperture to expose for the existing light conditions correctly. They then fill in the foreground using flash. If light levels are low you will need a tripod to avoid blur.

M (manual exposure) mode lets you set both aperture and shutter speed to be whatever you want. The camera then automatically controls the illumination of the foreground subject using flash.

Flash metering systems used by Canon EOS.

Electronic flash has come a long way since Harold "Doc" Edgerton, an American researcher and inventor, made modern electronic flash photography a reality in 1931. But simple or complex, the basic principle of electronic flash remains the same - you charge up a capacitor (or "condenser") with electricity and then release the stored energy in a brilliant split-second burst of light from a flash bulb - a glass tube filled with inert gases.

The light output changes instantly in response to the presence or absence of power being delivered to the tube, so the primary form of control you have over the light output is duration of the electrical pulse, which is switched off by a component called a "thyristor." Old-fashioned manual flashes require you to calculate the distance to the subject and then set the flash duration time yourself; a cumbersome and error-prone process. Modern flash units automate this process completely through the use of computer-controlled electronics.

Controlling flash exposure.

In regular photography you have two basic ways by which to control the amount of ambient (available) light entering the camera and exposing the film. You can adjust the shutter speed, which affects the duration of the exposure since ambient light is essentially constant in this context. And you can adjust the lens aperture - the physical diaphragm on most lenses which governs the quantity of light that enters the lens. (you can also use different lenses, add filters to the lens and so on, but we're talking about the fundamental issues here)

However, flash photography is quite different since it involves split-second bursts of light. A key point to remember in flash photography is that *the shutter speed of the camera normally does not have any bearing on flash exposure* - an exception being FP mode, mentioned later. Light from a continuous source is affected by shutter speeds, but flash bursts are so brief - in the milliseconds - that a mechanical shutter mechanism has no way of limiting the amount of light from a flash unit that hits the film. Shutter speed only affects the amount of ambient light.

You therefore have four basic ways to control how much light from a flash unit exposes the film.

- First, you can adjust the lens aperture. However, lens apertures also affect the amount of ambient light striking the film as well, so it would obviously be hugely inconvenient if that were the only option at our disposal.

- Second, you can adjust the distance from the flash unit to the subject. Light falloff follows known physical laws and so can reliably be calculated, but of course it'd be very inconvenient if you had to move the flash unit around all the time just to adjust flash exposures. That sort of thing is fine in a studio setting, but not for casual or photojournalist photography. Additionally, altering flash unit/subject distances affects the relative size of the flash light source, which results in different qualities of light (hard vs soft).

- Third, you can put various diffusers or light baffles between the flash unit and the subject, which would be a nuisance to carry around and deal with.

- Fourth, you can adjust the duration of the flash pulse as mentioned above, which thereby affects the intensity of the light produced. And this is the primary method of control we use for electronic flash.

So that's what flash metering is really all about, in a nutshell. You need to adjust the duration of the flash pulse so you can expose the film correctly and achieve your photographic goal. Determining what this flash duration should be is not an easy thing to do, however, and so camera makers over the years have come up with various automated systems to do it.

Flash metering principles.

Flash metering has very different requirements from normal ambient light metering for the reasons outlined above. Ambient light metering is performed well in advance of the shutter opening. EOS cameras, for example, activate the internal light meter when you press the shutter release button down halfway. But the subject-illuminating flash pulse, however, occurs *after* you press the shutter release all the way. That means that the flash pulse appears after the mirror has flipped up (blocking the ambient light meter) and the shutter has opened.

There are thus two basic ways you can meter for flash automatically. First, you can measure the flash pulse as it is being emitted or second, you can send out a low-power test pulse (preflash) of known brightness first and base your light calculations on that data before the shutter opens.

These two flash metering methods are used by Canon's automated flash metering systems. TTL and A-TTL flash use the former and E-TTL the latter. Flash units capable of E-TTL also support FP mode flash. Here's an explanation of these technologies.

TTL (through the lens) flash metering.

As noted above, the earliest electronic flashes required the photographer to perform distance calculations by hand. Later, the first generation of automatic electronic flash units relied upon external sensors to determine the flash exposure setting. These sensors, mounted on the front of the flash unit, simply recorded the flash bulb's light, reflected back from subject, and cut off the power when enough light for a satisfactory exposure was determined. The venerable Vivitar 285 still sold today works this way, in fact.

Of course, such external sensors were easily fooled. The sensor might, for example, cover more or less area than the lens currently in use. So Olympus pioneered through-the-lens flash metering in the mid 1970s with the OM2. Canon introduced their version of TTL flash metering with the T90 a decade later, then incorporated the feature as standard with the EOS line of film cameras. It's for this reason that the Canon T90 is the only non-EOS camera capable of using Canon's TTL flash metering system.

TTL flash metering works by measuring the pulse of flash-generated light bouncing back off the subject and entering the lens. It actually measures this light reflecting off the surface of the film itself, in realtime, by using an off the film (OTF) sensor. The light from the flash bulb is quenched when the sensor determines enough light has been produced to achieve a satisfactory flash exposure to get a mid-toned subject. Since digital cameras do not have film, digital EOS cameras do not support TTL.

For those interested, the OTF sensor is buried deep in the camera body, and is visible if you put the camera in bulb mode (ie: flip up the mirror and open the shutter) and open the camera back. It's a small lens pointing back at a 45° angle towards where the film surface would be, and is located at the bottom of the camera in the ridged black area right in front of the shutter curtain. The rectangular or cross-shaped hole or holes immediately in front of it are the autofocus sensors.

The TTL sequence of operation is as follows:

- When the shutter release is depressed halfway the current ambient light levels are metered by the camera as usual. Shutter speed and aperture are set by the camera or user depending on the current mode - P, Av, Tv or M. In P mode the camera sets the shutter speed to a value between 1/60 and X-sync. In the other modes it meters normally. (except on certain cameras which have a custom function that can lock the camera to X-sync in Av mode)

- When the shutter release is pressed all the way the camera flips up the mirror and opens the shutter, exposing the film.

- The flash unit sends power to the flash tube, illuminating the scene. The start time of the flash triggering depends on whether first or second curtain sync has been set.

- Duration of the flash pulse is determined by the OTF sensor, which meters for an average scene. If the photo is being taken under bright lighting conditions (10 EV or brighter), auto fill reduction is applied. (unless it has been disabled by a custom function, as is possible on some bodies) This can reduce the flash output by anywhere from 0.5 to 1.5 stops.

- As soon as the flash unit determines that the foreground subject has been adequately lit - by this realtime measurement of reflected flash light - it cuts off the power to the flash tube and the light from the flash unit is immediately quenched.

- The shutter stays open for the full duration of the shutter speed time.

- The shutter closes and the mirror flips back down. If the flash unit has a flash exposure confirmation light and if the flash metering was deemed adequate then the light glows.

  One note - since the sensor records light reflecting off the surface of the film itself it will of course react differently to film with very different reflective properties. According to B&H's Henry Posner on the EOS list, all cameras with TTL flash are calibrated to work with the emulsion characteristics of typical colour print film and there may, therefore, be very subtle differences in flash metering when you use slide film. Since slide film has very narrow exposure tolerances (latitude) this might be an issue for you.

  Cameras which support TTL flash:
  The T90 and virtually all EOS film cameras except the EF-M and the Rebel T2/EOS 300X/EOS Kiss 7. The digital cameras - all cameras with a D in the name (including the D30, D60, 1D, 1Ds, 10D, 300D/Digital Rebel/Kiss Digital, 1D mark II, 1Ds mark II, 1D mark II, 1D mark IIN, 1D mark III, 20D, 20Da, 350D/Digital Rebel X/Kiss Digital N, EOS 400D/Rebel XTi Digital/Kiss X Digital) do *not* support TTL.

  Flash units which support TTL flash:
  All "E' series Speedlites plus the 300TL: 160E, 200E, 220EX, 300EZ, 380EX, 420EZ, 420EX, 430EZ, 430EX, 540EZ, 550EX, 580EX, 580EX II, 480EG, MR-14EX, MT-24EX and 300TL.

Refinements to TTL flash, including Canon AIM.

TTL metering is typically more reliable than systems which rely on external sensors, but it can still be fooled. For example, a highly reflective subject or a subject in white surroundings can result in a lot of light reflecting back, so the resulting picture may well be underexposed as the camera quenches the flash too soon. An off-centre subject poses similar problems. Another issue is that the flash metering occurs while the shutter is open, so the camera can't accurately factor flash in with ambient light metering.

Canon refined TTL control on their multiple focus point cameras by adding a feature they call AIM, ("Advanced Integrated Multi-point Control System") which is basically multiple-segment flash metering. This lets the camera bias the flash exposure to the currently selected focus point, thereby increasing the chances of getting accurate flash exposure for off-centre subjects.

The AIM system means that it's best to rely on selecting off-centre focus points for flash photography rather than using the centre point and then recomposing the image. (unless you use flash exposure lock, explained below) For more information on AIM consult the flash metering patterns section. Note that older EOS cameras with multiple-segment flash metering didn't use the term "AIM" in their documentation - Canon came up with the marketing term sometime in the mid 90s - so the fact your multiple focus point camera doesn't mention AIM doesn't mean it hasn't got it.

Nikon improved their TTL flash metering system by incorporating subject distance into flash calculations - their "3D" system. This system determines distance information by reading the current focussing distance from the lens. Canon did not incorporate a similar distance-data system in their flash technology until 2004, with the introduction of E-TTL II. However, while distance data is valuable, it's important to keep in mind that distance data isn't very useful when using a flash in bounce mode or when using any diffusion system in which the light from the flash unit does not travel directly to the subject, since both cases increase the flash to subject distance over the lens to subject distance.

A-TTL (advanced TTL).

Canon's first step in altering flash exposure design was the creation of A-TTL, or "advanced through the lens" flash metering, which was introduced with the T90 camera and continued on to the EOS series of film cameras.

A-TTL flash units (300TL and EZ series Speedlites only) send out a brief burst of light during the metering phase. (ie: when the shutter release button is pressed halfway) This preflash is recorded by an external sensor on the front of the flash and used to determine a reasonable aperture to ensure adequate depth of field, particularly at short distances. The flash unit then sends out the actual scene-illuminating flash once the shutter has opened.

The A-TTL sequence of operation is as follows:

- When the shutter release is depressed halfway the current light levels are metered by the camera. In P and Tv modes the ambient aperture value is determined and stored, but not set. In Av and M modes the ambient aperture value is user-set.
- The flash unit fires a preflash (either near-infrared light from a front-mounted secondary flash bulb or white light from the main flash bulb, depending on the flash unit and operating mode) in conjunction with the ambient light metering, in order to determine the approximate distance from the flash to the main subject. In P mode only, the correct aperture value to expose the main subject is then calculated.
- In P mode only, the two aperture values (ambient and flash) are compared when the shutter release is fully depressed. The camera typically sets the smaller of the two apertures, particularly if the distance to the subject is determined to be fairly close. In Av and M modes the aperture is determined by the user setting and in Tv mode the aperture is determined by the ambient light meter settings.
- If the photo is being taken under bright lighting conditions (10 EV or brighter), auto fill reduction is applied. (unless it has been disabled by a custom function, as is possible on some bodies) This can reduce the flash output by anywhere from 0.5 to 1.5 stops.
- Finally, the camera flips up the mirror and opens the shutter, exposing the film.
- The flash unit then sends out the actual scene-illuminating flash. The start time of the flash pulse depends on whether first or second curtain sync has been set. Duration of the flash pulse is determined by the standard OTF sensor - exactly the same as TTL flash.
- The shutter stays open for the full duration of the shutter speed time.
- The shutter closes and the mirror flips back down. If the flash unit has a flash exposure confirmation light and if the flash metering was deemed adequate then the light glows.

Camera bodies which support A-TTL:
All EOS bodies which support TTL (see above).

Flash units which support A-TTL:
Speedlites 300EZ, 300TL (T90 only), 420EZ, 430EZ, 540EZ.

Limitations of A-TTL.

Sadly A-TTL, despite its name, offers little over regular TTL. For one thing, use of A-TTL in bounce mode on some flash units such as the 420EZ and 430EZ results in blinding flashes of white light from the main bulb each time you press the shutter halfway, which can be very annoying to human subjects. Although these flash units use a small separate A-TTL tube to flash fairly discreet near-infrared red light during the preflash stage when the head is pointed straight on, they flash the main flash tube (white

light) instead when the flash head is tilted or swivelled.

If that weren't enough, the preflash isn't even really used by most EOS cameras when it's in Av, Tv or M modes, since unlike P mode you aren't setting aperture automatically for flash metering purposes. And, unlike E-TTL, the A-TTL preflash is never used for actual flash metering. The original purpose of the A-TTL preflash in those modes was to provide information to the flash out of range warning light in early EOS cameras - the 630, RT and 1. Canon had to drop that whole system for patent reasons by the late 80s, but the A-TTL preflash in non-P mode still lives on as a kind of useless appendix in most A-TTL flash units.

It's interesting to note that the 540EZ flash avoids these problems simply by ditching A-TTL in bounce mode altogether and reverting to TTL. In fact, the 540EZ doesn't use A-TTL for Av and Tv modes either, unlike the earlier flash units. Presumably by that point Canon decided that most 540EZ buyers weren't going to be 630, RT and 1 owners as well.

Since the A-TTL sensor is on the front of the flash unit - behind a recessed plastic lens and not inside the camera, metering through the camera lens, it's conceivable that a very heavy filter on the lens might result in some metering problems since the filter doesn't cover the sensor as well. And, speaking of the flash-mounted sensors, be sure not to block it with your hand or anything for the same reason. Some flash diffusers can also present a problem in that the light spilling downwards from the diffuser can enter the A-TTL sensor inadvertently.

Finally, despite the additional complexity of the preflash circuitry, A-TTL simply ends up setting a pretty small aperture most of the time, to assure wide depth of field, which isn't always what you want.

In short, A-TTL adequately assures reasonable flash exposure and depth of field in a point and shoot fashion in P mode. It isn't so useful for more subtle or complex lighting techniques and isn't useful at all in Av, Tv and M modes.

E-TTL (evaluative TTL).

With the Canon Elan II/50 camera in 1995, Canon introduced another form of flash technology - E-TTL, for "evaluative through the lens" flash metering. While still metering through the lens, E-TTL is completely incompatible with its predecessors and works on a very different technical basis. E-TTL fires a low-power preflash of known brightness from the main bulb to determine correct flash exposure. It measures the reflectance of the scene with the preflash, then calculates proper flash output to achieve a midtoned subject, based on that data. It uses a preflash, but doesn't suffer from A-TTL's drawbacks for two reasons.

First, the E-TTL preflash occurs immediately before the shutter opens and not when the shutter release is pressed halfway. Unlike the A-TTL preflash, therefore, the E-TTL preflash is actually used to determine flash exposure and isn't fired during the ambient (existing) metering stage. Some users may be surprised to learn that E-TTL actually fires a prefire flash before the main flash at all. Using regular settings the process happens so quickly that the preflash is difficult to notice, though you might catch glimpse of it before the mirror blackout - an exception being second-curtain sync.

Second, the preflash light is analyzed by the same evaluative metering system that the camera uses to meter ambient light. This means it meters through the lens and is harder to fool than external sensors, isn't confused by bounced light and does not read anything off the surface of the film. For what it's worth, unlike the TTL flash meter, the E-TTL metering sensor cannot be seen by the curious - it's hidden away up in the pentaprism (or roof mirror in low-end EOS cameras) housing.

E-TTL is also generally superior to TTL and A-TTL when it comes to fill flash. The E-TTL algorithms are usually better at applying subtle and natural fill flash light to daylight photographs. E-TTL exposure is also linked to the current AF focus point, which in theory results in finer-grained exposure biasing than most multiple-zone TTL flash sensor systems. E-TTL support is built into all recent EOS film cameras and all EOS digital cameras since the D30.

The usual E-TTL sequence of operations, not counting the optional flash exposure lock (FEL) feature or wireless operation, is as follows:

- When the shutter release is pressed halfway the current ambient light levels are metered by the camera as usual. Shutter speed and aperture are set by the camera or user depending on the current mode - PIC (icon) modes or P, Av, Tv or M.

- When the shutter release is pressed all the way the flash unit immediately fires a low-power preflash from the main flash tube. (ie: white light)

- The reflected light from this preflash is analyzed by the same evaluative metering system that the camera uses for metering ambient light levels. The appropriate power output (ie: flash duration) of the flash is determined and stored in memory. The entire sensor area is evaluated and compared to the ambient metering, and the area around the active focus point is emphasized. If you are in manual focus mode then either the central focus point or averaged metering is used.

- If the photo is being taken under bright lighting conditions (10 EV or brighter), auto fill reduction is applied (unless it has been disabled by a custom function, as is possible on some bodies) and the flash output is decreased by anywhere from 0.5 to 2 stops. However, the E-TTL auto fill reduction algorithm has never been published to my knowledge, so nobody outside Canon knows exactly how it works.

- The mirror flips up and the shutter opens, exposing the film - or sensor chip if it's a digital camera.

- The flash tube is then fired at the previously determined power level to illuminate the scene. Start time of the flash burst depends on whether first or second curtain sync has been set. The OTF sensor in the camera, if present, is *not* used in E-TTL mode.

- The shutter stays open for the full duration of the shutter speed time.

- The shutter closes and the mirror flips back down. If the flash unit has a flash exposure confirmation light and if the flash metering was deemed adequate then the light glows.

  Camera units which support E-TTL:
  All type A EOS cameras (see below) including all EOS D-series digital cameras.

  Flash units which support E-TTL:
  All EX series Speedlites: 220EX, 380EX, 420EX, 430EX, 550EX, 580EX, 580EX II, MR-14EX, MT-24EX.

Limitations of E-TTL.

By far the biggest drawback of E-TTL is that the preflash can cause people who blink quickly to be photographed mid-blink. The preflash normally occurs an extremely brief period of time before the main flash, but there's still enough time for rapid blinkers to react. The problem is heightened when using second-curtain sync with slow shutter. It's not uncommon for group photographs to have a number of people with droopy or closed eyelids. A similar problem can affect nature photographers who photograph skittish birds. The only reliable way around the issue is to fire the preflash manually by pressing the FEL button, waiting a moment, then taking the actual photo. If you do this it's wise to warn your subjects that there'll be two flashes because otherwise they might look away after the preflash, thinking the photo has already been taken.

Another problem is that the use of preflash can trigger studio slave flash units which work by detecting the light from the triggering camera - analogue optical slaves. This results in flash exposure going very wrong, since the optical slave is triggered too soon. The preflash can also confuse handheld flash meters, making manual flash metering very difficult.

More abstractly, E-TTL is a very automated system and isn't well documented for the user. For instance, as noted above, Canon have never published details on the E-TTL auto fill reduction algorithm. It takes a bit of experimenting to figure out how the system is likely to respond. And there's relatively little user selection or choice in operation modes. Most flash units don't, for instance, let you manually choose TTL, A-TTL or E-TTL flash metering at will.

E-TTL has also been a problem for a lot of digital users (see TTL and E-TTL and digital EOS cameras below) because of the way E-TTL flash metering is performed. Some of these issues are addressed by E-TTL II, which is described in the next section.

Finally, not every E-TTL feature is supported by every type A body and E-TTL flash unit. Some wireless E-TTL features and other functions such as the modelling light, for example, require both newer type A EOS bodies like the EOS 3 or EOS 30 and flash units like the 580EX or 420EX. Part III of this article describes which features are available for which combinations of camera body and flash unit.

E-TTL II.

Introduced in 2004 with the EOS 1D mark II digital camera and the EOS Elan 7N/EOS 30V/7S film camera, E-TTL II is an improved version of regular E-TTL which includes two key innovations.

Improved flash metering algorithms.

First, E-TTL II examines all evaluative metering zones both before and after the E-TTL preflash goes off. Those areas with relatively small changes in brightness are then weighted for flash metering. This is done to avoid the common E-TTL problem of highly reflective materials causing specular highlights in a flash-illuminated image and throwing off the flash metering. Normally E-TTL II uses evaluative algorithms for its flash metering, but the EOS 1D mark II has a new custom function (CF 14-1) that lets you use centre-weighted averaging rather than evaluative metering for flash metering if you prefer.

Distance data incorporated into some calculations.

Second, E-TTL II can use distance data when it's available. Many EF lenses (see list in next section) contain rotary encoders that can detect the current focus distance. For example, if your camera is focussed on an object 4 metres away then the lens will send this approximate focus distance data to the camera body.

Under certain conditions the distance data is factored into the calculations for determining proper flash output. This is particularly useful if you use the focus and recompose method without setting FEL - the new system can help minimize flash metering errors under these conditions. Canon describe the new system as essentially metering flash data across a flat plane rather than a point.

Up until now distance data hasn't really been used much by EOS cameras. Some PIC (icon modes) apparently incorporate distance data into their exposure calculations, but that's really been about it. E-TTL II is the first really useful application of this information that Canon have implemented, and is obviously very similar to the fashion in which Nikon have long relied on distance data for their flash metering system.

Cases in which distance data is not used.

Distance data is not always used by E-TTL II. There are three very significant cases in which distance data is not used, aside from the obvious case when it isn't available because the lens doesn't provide it. These three conditions are bounce flash, macro flash and wireless E-TTL flash.

When you're using bounce flash (ie: when the flash unit's head is in basically any position other than full-on straight or, with those flash heads which support it, with 7 degree downward tilt) then there is no way for the camera to know the distance the light took to reach the subject from the flash. Light will be scattered off walls or ceilings or reflectors and won't travel directly to the subject. Since bounce flash is a common technique to improve the quality of a flash-illuminated scene it means that the primary advantage of E-TTL II in this situation is just better evaluative flash metering.

The other two conditions are similar. With macro flash you're too close to the subject for the lens to determine useful information, and with wireless E-TTL flash the camera will have no idea where the flash units are positioned in relation to the subject. Note that E-TTL II can still use distance data if the flash unit is connected to a camera via an Off-Camera Shoe Cord. (there was some confusion about this early on, but Canon USA's Chuck Westfall has confirmed it) This means that users of flash brackets won't be left out, though it does mean that if you position the flash unit closer to or further from the subject than the camera, or if you point the flash unit away from the lens axis while keeping the flash head locked in a straight ahead position, then you might throw off the flash metering slightly. You can't directly disable the use of distance data if the lens has it, though in this case you could take the simple precaution of setting the flash head to a very slight off-centre bounce position that would disable distance data while not significantly altering the flash coverage.

To summarize, there are two important points to keep in mind. First, E-TTL II does not *require* any changes to either the flash units or lenses used with an E-TTL II camera - the changes are all basically internal to the camera body. And second, while E-TTL II does use distance data when it's available and when it's appropriate (eg: when using direct non-bounce flash), it doesn't prevent you from using older lenses.

Camera units which support E-TTL II:
EOS 1D mark II, EOS 30V/33V/7S/Elan 7N/Elan 7EN, EOS 20D/20Da, EOS 350D/Rebel X Digital/Kiss N Digital, EOS 400D/Rebel XTi Digital/Kiss X Digital, 1D mark IIN, 1Ds mark II, 1D mark III, 5D, 30D.

Flash units which support E-TTL II:
All EX series Speedlites: 220EX, 380EX, 420EX, 430EX, 550EX, 580EX, 580EX II, MR-14EX, MT-24EX.

Canon EF lenses with distance data for E-TTL II.

The following lenses are capable of returning distance data for use with those cameras which can use

them. This list was published by Canon USA's Chuck Westfall in March 2004 and is reasonably comprehensive, though does have a few omissions.

Note that most of the lenses with distance data capabilities contain ring USM focus motors. In fact, the first three lenses with distance encoders were introduced in 1990 along with the EOS 10/10S - the 35-135mm 4-5.6 USM, 70-210mm 3.5-4.5 USM, and 100-300mm 4.5-5.6 USM. It's also not clear what the resolution is of a typical lens distance decoder. Photos I've seen of the decoder rings (not quite like children's toys in a cereal packet) in one lens suggest that the distance data is fairly approximate, with each combination of distance contacts returning a certain distance range.

I have no information as to whether any third-party lenses compatible with the EF lens mount are capable of returning distance data.

EF 14mm 2.8L USM
EF 20mm 2.8 USM
EF 24mm 1.4L USM
EF 28mm 1.8 USM
EF 35mm 1.4L USM
MP-E 65mm 2.8 1-5x Macro
EF 85mm 1.2 II L
EF 85mm 1.8 USM
EF 100mm 2 USM
EF 100mm 2.8 Macro USM
EF 100mm 2.8 Macro (discontinued)
EF 135mm 2L USM
EF 180mm 3.5L Macro USM
EF 200mm 2.8L II USM
EF 200mm 2.8L USM (discontinued)
EF 300mm 2.8L IS USM
EF 300mm 4L IS USM
EF 300mm 4L USM (discontinued)
EF 400mm 2.8L IS USM
EF 400mm 4 DO IS USM
EF 400mm 5.6L USM
EF 500mm 4L IS USM
EF 600mm 4L IS USM
EF 1200mm 5.6L USM

EF 16-35mm 2.8L USM
EF 16-35mm 2.8L II USM
EF 17-35mm 2.8L USM (discontinued)
EF 17-40mm 4L USM
EF 20-35mm 3.5-4.5 USM
EF 24-70mm 2.8L USM
EF 24-85mm 3.5-4.5 USM
EF 24-105mm 4L IS USM
EF 28-70mm 2.8L USM (discontinued)
EF 28-80mm 3.5-5.6 USM (discontinued)
EF 28-105mm 3.5-4.5 USM (discontinued)
EF 28-105mm 3.5-4.5 II USM
EF 28-105mm 4-5.6 USM
EF 28-105mm 4-5.6
EF 28-135mm 3.5-5.6 IS USM
EF 28-200mm 3.5-5.6 USM
EF 28-200mm 3.5-5.6 (discontinued)
EF 28-300mm 3.5-5.6L IS USM
EF 35-135mm 4-5.6 USM (discontinued)
EF 70-200mm 2.8L IS USM
EF 70-200mm 2.8L USM
EF 70-200mm 4L USM
EF 70-200mm 4L IS USM
EF 70-210mm 3.5-4.5 USM (discontinued)
EF 70-300mm 4.5-5.6 DO IS USM
EF 90-300mm 4.5-5.6 USM
EF 90-300mm 4.5-5.6
EF 100-300mm 4.5-5.6 USM
EF 100-400mm 4.5-5.6L IS USM

EF-S 18-55mm 3.5-5.6 USM (Japan only)
EF-S 18-55mm 3.5-5.6
EF-S 18-55mm 3.5-5.6 II
EF-S 60mm 2.8 USM macro
EF-S 17-55mm 2.8 IS USM
EF-S 17-85mm 4-5.6 IS USM
EF-S 10-22mm 3.5-4.5 USM

If your lens doesn't appear on the list above then it may or may not have distance data capabilities. However, here are a few current and recently discontinued lenses in the EF lineup which definitely do not have distance data. Note the 50mm 1.4 USM and the 85mm 1.2L USM mark I (not mark II) are in this list.

EF 15mm 2.8 fisheye
EF 24mm 2.8
EF 28mm 2.8
EF 35mm 2.0
EF 50mm 1.4 USM
EF 50mm 1.8 II
EF 85mm 1.2L USM
EF 135mm 2.8 SF

EF 28-80mm 3.5-5.6 II
EF 28-90mm 4-5.6 II USM
EF 28-90mm 4-5.6 II
EF 35-80mm 4-5.6 III
EF 55-200mm 4.5-5.6 II USM
EF 75-300mm 4-5.6 IS USM
EF 75-300mm 4-5.6 III USM
EF 75-300mm 4-5.6 II
EF 80-200mm 4.5-5.6 II

FP (focal plane or high speed sync) flash mode.

Synchronizing flash exposure with both curtains of focal plane shutters was as much of a problem in the days of single-use flash bulbs as it is today with electronic flash units. For that reason flash bulbs designed to work with focal plane shutters were developed. Such bulbs produced light quite rapidly and sustained their light output for the full duration of the shutter opening. They were called FP bulbs.

With E-TTL Canon introduced an implementation of an electronic FP flash mode, which is a way of circumventing the X-sync limitation in certain cases, and another flash technology pioneered by Olympus. FP flash lets you take flash photos at any shutter speed you like, and works by pulsing the flash bulb at an extremely high rate - 50 KHz - simulating constant light at the cost of total light output. FP stands for "focal plane," by analogy to the old FP flash bulbs, though Mark Overton memorably refers to it as "fast pulse" mode in his FAQ, since that's exactly how it works today.

This mode is useful for shooting with fill flash outdoors with wide apertures. Normally you can't shoot outdoors and use fill flash unless you stop down the lens or use very slow film. However, changing film is a nuisance and stopping down the lens increases the depth of field. If you're shooting a portrait, say, you probably want to blur the background and the only way to do this is to shoot with a wider aperture. But the wider aperture lets in more light, and you can't compensate by increasing the shutter speed if you then bump up against the camera's X-sync limit.

FP mode flash solves this problem by letting the shutter speed exceed the X-sync limit and reach the camera's maximum shutter speed (usually 1/2000 or 1/4000 sec) instead. The primary drawback is that pulsing the light causes a reduction in overall light output and thus range.

When you have FP mode engaged you typically get about a third less range than you would if you were shooting with normal flash. With a powerful flash unit like the 580EX this may not be a big problem, particularly if your flash subject is fairly close to you. But this loss of range could be a serious impediment if you're using a smaller flash unit (eg: the tiny 220EX), if the subject is far away, or if you're using slow film. Of course, if you're using FP mode simply for a little fill flash (rather than relying on it to illuminate your subject) then this loss of range shouldn't be a huge problem.

Note an important point - FP mode does not help you freeze motion; the name "high-speed sync" is a bit misleading in this regard. Normal flash photography is very good at freezing motion on film, since a burst of electronic flash is so incredibly brief. When a scene is illuminated primarily by a really brief

flash of light then you aren't going to get much motion blur - it's almost as if you used an incredibly high shutter speed in the thousandths of a second. However when you use FP mode flash, the flash unit pulses the light output over a longer period of time in order to simulate a longer-duration burst of light. Since the flash burst is no longer particularly brief you can't freeze motion as easily, even with high shutter speeds. The mode is called high-speed sync since it lets you synchronize flash exposure with high *shutter* speeds, not that it lets you take high-speed photographs.

Since Canon's FP mode is tied in with E-TTL technology it's only available when using EX-series flashes attached to A-type bodies. There are two exceptions to the "type A gives you FP flash" rule. First, the type B EOS 1N body can be reprogrammed by Canon at great expense to support FP mode but cannot support any other feature associated with E-TTL even when so reprogrammed. And second, the digital SLRs with built-in flash (10D, 300D, etc) support FP mode on external flash units but have E-TTL compatible internal flashes which cannot support FP mode.

FP mode is indicated on type A cameras and flash units by a small lightning bolt symbol and the letter H, for "high speed sync."

Camera units which support FP mode flash:
All type A EOS cameras plus the EOS 1N if reprogrammed as above.

Flash units which support FP mode flash:
All EX series Speedlites: 220EX, 380EX, 420EX, 430EX, 550EX, 580EX, 580EX II, MR-14EX, MT-24EX.

TTL and E-TTL and EOS film cameras.

Most film-based Canon EOS cameras support TTL flash metering. The exceptions are the latest consumer EOS film cameras and the oddball Canon EF-M. (the EF-M was a manual-focus camera that could accept EF-mount lenses but which lacked both autofocus and TTL flash circuitry as a cost-saving measure; you had to buy an optional flash unit with an external sensor, the Speedlite 200M, if you wanted to do flash photography with the EF-M) Those film-based EOS cameras with built-in flash units and TTL support rely solely on TTL for flash exposure control of those internal flash units.

Canon cameras designed prior to the Elan II/EOS 50 of 1995 don't support E-TTL. With the release of this camera Canon divided their camera bodies into two types - A and B. Type A bodies are bodies which support E-TTL, FEL and FP flash technologies. Type B bodies are bodies which do not.

With flash units it's easy - if the name of the flash unit ends with the letter X (eg: 550EX, MT-24EX) then it's an E-TTL unit. If it ends with anything else (eg: 430EZ, 480EG) then it is not.

However, there are three points of note here. First, Canon continued designing and selling type B bodies for many years after the introduction of the Elan II/EOS 50, such as the EOS 3000 and venerable EOS 5/A2, so the date you bought your camera won't determine if it's a type A or B body. Second, since Canon came up with the whole A/B naming convention in 1995, older cameras are obviously not described as being "type B" in their manuals. And third, type A simply means support for E-TTL, FEL and FP mode - it doesn't mean that the camera necessarily supports other recent flash features such as wireless flash ratios or modelling flash.

So the upshot of all this is the following:

- TTL/A-TTL and E-TTL are incompatible flash metering systems which can't be combined in any way. Some film cameras support both technologies, but you can't use them simultaneously.

- All EX-series (ie: E-TTL capable) flash units also support TTL metering and automatically revert to TTL metering when used with an older type B camera body. However, no EX-series flash units support A-TTL metering.

- Since virtually all EOS film cameras (all type B and nearly all type A bodies) support both TTL and A-TTL metering they can all use E-series flash units in TTL mode and EZ-series flash units in A-TTL mode. All EOS digital cameras support either E-TTL or both E-TTL and E-TTL II (see below).

- If both the camera and flash unit support E-TTL (ie: the camera is a type A body and the flash an EX series) then they will use E-TTL unless specifically overridden (see "disabling E-TTL" below).

TTL and E-TTL and EOS digital cameras.

All current Canon digital cameras with hotshoes - both the interchangeable-lens SLR cameras and the

point and shoot digital cameras - support E-TTL only flash metering (or both E-TTL and E-TTL II) and do not support either TTL or A-TTL flash metering. Even Canon digital cameras with internal popup flashes are E-TTL only. (though if you want to use flash with a non-EOS camera you should probably check out Kevin Bjorke's page for its limitations. Canon have also written a letter to D30 users concerning proper use of EX flash units)

Since digital bodies lack film they can't use regular off the film flash sensors for TTL metering. The mirrorlike surface of a CMOS or CCD imaging chip has very different reflective properties from film. Besides, Canon have clearly switched to E-TTL, only supporting TTL for back compatibility with older products.

This means that *only* Canon EX flash units or third-party flash units with E-TTL support can be used with Canon's current lineup of digital cameras. Older E and EZ flash units will *not* work correctly - no automatic through the lens metering is possible. You can get manual-capable EZ flash units like the 540EZ to fire in manual flash mode but this requires external flash metering; not a practical option for most beginning or amateur photographers.

To summarize, if your flash unit ends with E or EZ then it will not work with a digital EOS camera. If you have a third party flash unit you must consult its user manual and see if supports TTL flash metering only (no good) or E-TTL flash metering (great).

E-TTL flash metering issues with digital

Unfortunately, E-TTL was a particular problem for early digital EOS models. Many users reported serious problems with wildly varying exposure when using an E-TTL flash unit with earlier model Canon DSLRs, particularly the D30 (not the later 30D) and D60. Some of these problems stem from the users focussing and recomposing and failing to use the flash exposure lock (FEL) feature, which sets the wrong area around which the flash will meter. But many problems can't be blamed on this. The main problem appears to stem from the way in which E-TTL on these bodies biases flash exposure heavily to the focus point. For more information please consult the section on E-TTL flash metering patterns. For this reason some early digital EOS users gave up on E-TTL and went back to the old-style autoflash units. Others routinely set their lens to manual focus once focus had been achieved, since the camera uses a centre-weighted average metering pattern for flash metering when in manual focus.

This issue is no longer as prominent as it was. The EOS 10D brought revised E-TTL algorithms which relied on centre-weighted average metering for E-TTL flash, even with the lens set to autofocus mode. And E-TTL II, introduced with the EOS 1D mark II, analyzes all metering zones before and after the preflash for improved flash metering. These later digital cameras seem less vulnerable to metering errors caused by bright highlights. Some, such as the EOS 5D, also let you choose centre-weighted averaging or evaluative modes for flash metering through a custom function.

Note that this applies to the wholly Canon-designed generation of digital SLRs - the D30 onwards. It's not clear how the first generation of Canon digital SLRs (developed in conjunction with Kodak), the long-discontinued EOS DCS1, DCS3 and D2000 cameras, support flash. It seems the DCS cameras theoretically support TTL, albeit poorly, and the D2000 and D6000 support E-TTL as well, but Canon's Web site doesn't really go into much detail.

Type A and type B bodies.

As noted above, Canon cameras built before 1995 don't support E-TTL. With the introduction of E-TTL flash metering, Canon officially divided their camera bodies into two groups - types A (support for E-TTL) and B (support for TTL only).

However there are also subvariants of type A. Specifically, the first generation of type A cameras does not have support for wireless E-TTL flash ratios and modelling flash; the second and third generations do. The third generation adds support for E-TTL II. To confuse matters further, most type A film cameras support legacy TTL flash, but some later type A cameras including all modern EOS digitals do not. Finally there are sometimes subtle variations in E-TTL functionality between one specific camera model and the next, but that obviously goes beyond the scope of simple type A and B categories.

Type A bodies

Support for E-TTL flash, FEL and FP mode:

EOS Elan II(E), EOS 50(E)/55
EOS D2000, D6000 (digital)
EOS IX, IX 7, IX Lite, IX 50 (APS)

EOS Rebel G/500N/New EOS Kiss, Rebel G II
EOS Rebel 2000/EOS 300/Kiss III, Kiss IIIL
EOS 300V/Rebel Ti/Kiss 5
EOS 3000N/Rebel XS N/EOS 66
EOS 3000V/Rebel K2/Kiss Lite
EOS EOS 300X/Rebel T2/EOS Kiss 7 (no TTL support)

As above plus support for wireless E-TTL flash ratios and modelling flash:

EOS 3
EOS Elan 7(E)/EOS 30/33/7
EOS 1V
EOS D30, D60, 10D (digital; no TTL support)
EOS 1D, 1Ds (digital; no TTL support)
EOS 300D/Digital Rebel/Kiss Digital (digital; no TTL support)

As above plus support for E-TTL II:

EOS 1D mark II, EOS 1Ds mark II, EOS 1D mark IIN (digital; no TTL support), EOS 1D mark III (digital; no TTL support)
EOS 20D, EOS 20Da, EOS 30D (digital; no TTL support)
EOS 350D/Rebel XT Digital/Kiss N Digital (digital; no TTL support)
EOS 5D (digital; no TTL support)
EOS 400D/Rebel XTi Digital/Kiss X Digital (digital; no TTL support)
EOS Elan 7N/Elan 7EN/EOS 30V/33V/7S

Type B bodies

Support for TTL and A-TTL only:

EOS 600 series - 600, 620, 630, 650, RT
EOS 700, 750, 800
EOS 1
EOS 10/10S/10QD
First generation Rebel series - Rebel, Rebel S, EOS 1000 and all 1000 variants, Rebel II, Rebel X, XS/EOS 500/Kiss
EOS Elan/100
EOS A2(E)/5
EOS 1N, 1NRS
EOS 3000/88, 5000/888
EOS DCS3, DCS1 (first generation digital)

Neither type A nor type B

Canon EF-M

Disabling E-TTL.

There are times when TTL metering may be more desirable than E-TTL. A common example is a studio setting where analogue optical slave units can be fooled by the E-TTL preflash. The 550EX, 580EX, 580EX II, MR-14EX and MT-24EX let you disable E-TTL via a custom function, but they're the only Canon Speedlites with this ability. All other EX flash units (220EX, 380EX, 420EX, 430EX) will always operate in E-TTL mode when mounted to an E-TTL-capable camera, even if the camera is also capable of supporting TTL and even though they'll work in TTL mode just fine on a type B camera. (though the 430EX can also be used in manual mode if you wish)

One way around this is to buy Canon's Hot Shoe Adapter for wired multiple-unit flash. This adapter works only in TTL mode, so putting an E-TTL flash unit onto an HSA will force it to work in TTL only. This is a pretty expensive approach, however. Another option is to tape over one of the data contacts in the hotshoe. Covering the lower left contact (the left contact out of the hotshoe's group of four that's closest to the back of the camera when looking at the camera from the top) will disable all E-TTL functionality. (though it'll also disable second-curtain sync along with FP flash and FEL) For more details have a look at this article on EOSDoc.

Note that digital EOS cameras will not fire the flash if the flash is in TTL mode. Digital EOS cameras work with E-TTL or E-TTL II flash only and support neither TTL nor A-TTL, but they can fire flash units which are set to manual flash metering mode.

EOS system compatible flash units.

This document is concerned primarily with two types of flash technologies built by Canon for use with their EOS cameras - the pop-up integral flash units built into most low and midrange EOS cameras and the external shoe-mounted Speedlite flash units which can be attached to any EOS camera.

I do not discuss studio flash units (large flash units for studio photography, usually powered by AC current and not batteries, and called "studio strobes" in North America) in any detail here.

Internal flash.

Most low to mid-range Canon EOS cameras contain integral flash units, built into the top housing that contains the camera's prism or mirror. Some are motorized and pop up immediately in all basic (PIC or icon) modes except sports and landscape if the camera thinks you need flash, or upon the touch of a button if you're in an advanced (creative zone) mode. Others require the user to lift up the flash manually. A few early EOS models, specifically the 750, 700 and the 10/10s, had motorized flash units which could both pop up and retract mechanically, for those interested in trivia.

These internal flash units are useful for quick snapshots and the like, but aren't usually useful for quality photography for a number of reasons. First, they're very small and offer very low output levels - low guide numbers such as 11 or 13. Second, they're located quite close to the lens axis and so are very likely to cause the redeye effect when photographing people. Third, since they don't extend very far above the top of the camera body their light is easily partially blocked by large lenses or lenses with large lens hoods. And fourth, they don't offer any tilt or swivel options and generally have coverage areas of only 28mm or 35mm at the wide end.

However, since they're built-in they're obviously eminently portable and handy at a moment's notice. They're useful for applying a touch of fill flash when outdoors. And they recharge very rapidly as they use the camera's lithium battery as a power source. This latter can be a bit expensive, though, as using the built-in flash runs down the camera battery alarmingly quickly.

No EOS camera lets you use the internal flash when an external flash unit is mounted on the hotshoe. In fact, external flash units physically prevent the internal flash from being raised. Additionally, EOS cameras with motorized internal flashes have small electrical switches built into the hotshoe which detect the presence of a device and disallow internal flash popup. So the internal flash won't rise automatically if anything's in there - even, say, a hotshoe-mounted spirit level or something else non-electrical. These switches, incidentally, have been known to stick, rendering the internal flash inoperable. Note that this restriction applies to hotshoe-mounted flash units only. If you connect an external flash via a PC socket, assuming your camera has one, then this issue does not apply and the internal flash can still fire if you want. You might have metering problems if you go this way, since the internal flash will be using automated metering and the external flash won't, but it's nonetheless an option.

None of the professional EOS cameras (1, 1v, 3, etc) have built-in flash units, for the reasons listed above and possibly also because of the difficulty of waterproofing a popup flash mechanism. All EOS film cameras use TTL only for internal flash control. At time of writing the only EOS cameras to use E-TTL for internal flash unit control are those digital EOS cameras with built-in flash though their internal flash units do not support FP mode. Sadly no camera with internal flash at present can act as a wireless E-TTL master, though as far as I'm aware there's no technical reason why not.

Cameras with internal flash units:
Please consult the flash coverage list.

Basic (PIC) modes and external flash units.

Older EOS cameras, such as the 10/10s and Elan/100, have PIC ("programmed image control" or icon) modes that don't handle external flash units correctly. The PIC modes which use flash when necessary (all but landscape and sports) are designed to use the internal flash and are optimized for its characteristics. Check your manual to see if your camera fits in this category - probably pre 1995 or so.

Newer EOS cameras, such as the Elan II/EOS 50 or Elan 7/EOS 30, can use an external flash unit with the PIC modes. But nonetheless for best control you're better off using one of the "creative" zone modes anyway - P, Av, Tv or M. Remember that there are significant differences in the way each of these four modes handle flash exposure.

Because the full auto (green rectangle) and PIC modes afford very little control over the way the camera works I primarily discuss how flash works with the "creative" zone modes.

Canon external flash unit types.

There are three basic types of external flash units considered here - standard hotshoe flashes, handle flashes and macro flashes. (as noted above, studio flashes of the kind that require household AC power are not discussed in this document)

For a complete list of Canon's EOS flashes over the years check out Dave Herzstein's comprehensive EOS flash page.

Nomenclature of external flash units.

Canon have made a number of flash units compatible with EOS cameras. The naming system is fairly logical - they're given names such as "Speedlite 550EX". Here's what the parts of the name mean:

- Speedlite is the product name for all Canon flash devices. (versus "Speedlight" for Nikon)
- 550 is the maximum guide number - output rating of the flash in metres - multiplied by 10 to make it sound cooler. (I very much doubt that Canon marketing measure things in decimetres)
- E means it works with EOS cameras.
- X means that it supports E-TTL flash technology. At time of writing only flash units which end in the letter X support E-TTL.

  Flash units which end with "Z", such as the 430EZ, are flash units with zooming motors and support for A-TTL but *not* E-TTL. The 480EG flash has a built-in grip. Flash units ending in "E" only, such as the 200E, are basic models with neither zooming heads nor E-TTL support.

  Although this naming system is very reasonable it does mean it's easy to confuse different models which happen to have identical guide numbers. For example, the 430EZ and 430EX flash units are very different indeed. The former was top of the line for its time, but supports only TTL and A-TTL and is now quite dated. The latter is considered a midrange flash unit in today's lineup, and although is technologically much more sophisticated as it supports both E-TTL and wireless flash slave mode, it lacks stroboscopic mode and cannot serve as an E-TTL master. The 420EZ and 420EX flash units are similarly easily confused.

Older Canon Speedlite flash units.

Older Canon Speedlite flash units which lack the letter E in their product name were not designed for EOS cameras. There were Speedlite A models (eg: 199A) for old A-series Canons such as the A1 and AE1 and Speedlite T models (eg: 277T) for T-series Canons such as the T50 (but not the T90) and various other special-purpose models.

You can put these older flashes on your EOS camera and they'll trigger OK when you take a photo, but they can't use modern automated flash metering. So you have to either use them in auto mode if they have such a setting (set your camera to a shutter speed up to the camera's X-sync), dial in manual power and calculate the flash distance yourself if they have manual controls or else expect the flash to fire at full power.

I don't know if all earlier Speedlite products have safe triggering voltages or not. The list maintained by Kevin Bjorke on his Web site suggests that T series flash units are OK and most A series and older flash units are in a grey zone, but you should probably check for yourself.

The one exception is the 300TL flash unit. It was designed for the old Canon T90 camera, and its more advanced features (such as its versions of FEL and second-curtain sync) are not supported by EOS cameras. However it can be used with EOS cameras as a basic TTL flash unit even though it lacks an E designation.

Hotshoe flashes.

Canon sell and have sold a number of different standard hotshoe flash units, which can be divided into three basic categories. Have a look here for a brief comparison of E and EZ (ie: non-EX) flash units.

Basic flash units - 160E*, 200E, 220EX.
These small devices have very limited power output - you could think of them as little flash units for those cameras which lack built-in flash. The 160E and 200E support TTL only, but the 220EX supports

both TTL and E-TTL. They do not zoom, swivel or tilt, but are extremely compact and lightweight. The tiny 160E is the only Canon flash unit which does not use four AA cells - it uses a lithium 2CR5 battery instead. That means that it's very small and light, but expensive to operate as lithium batteries are very costly.

Midrange units - 300EZ*, 380EX*, 420EX*, 430EX.
These flash units have more power and have zooming flash heads but, except for the 430EX, no manual controls. The 300EZ supports TTL and A-TTL and the EX units support TTL and E-TTL. When it comes to flash heads, the 300EZ neither tilts nor swivels, the 380EX tilts only and the 420EX and 430EX both tilt and swivel. The 420EX and 430EX can also serve as a slave unit in wireless E-TTL flash. The 430EX is unusual for this category in that it has a rear-panel LCD screen.

The high-end units - 420EZ*, 430EZ*, 540EZ*, 550EX*, 580EX*, 580EX II.
These are of course the largest and most powerful flash units of the standard type. They support the most advanced Canon flash technology at the time they were introduced; TTL and A-TTL in the case of the EZ units and TTL and E-TTL in the case of the 550EX, 580EX and 580EX II. They also have both manual controls and tilt and swivel flash heads. Of these the 420EZ is the most limited - it has no flash exposure compensation, for example.

* Discontinued product at time of writing.

Handle-mount (grip) flash.

Canon still make one large flash unit of this type, the 480EG. It's basically a flash bracket with a massive heavy-duty flash attached to the side. The camera sits on the bracket and is held in place via the tripod mount. This type of handle flash is sometimes jokingly referred to as a "potato masher" flash unit.

The 480EG is a high-output flash unit meant for press or wedding photographers, but hasn't been updated in some time and is a TTL-only flash (no A-TTL or E-TTL support). Nowadays people usually just buy flash brackets and put a regular 580EX flash unit on them for this sort of application. This setup also lets you mount the flash unit vertically above the lens rather than to the side only, like the 480EG. But if you want the sheer light output you can't beat the 480EG or similar flash units from manufacturers such as Metz.

The 480EG is also the most powerful flash unit that Canon make, even though its advertised guide number is only 48 and thus seemingly lower than flash units like the 540EZ or 550EX. This is because the 480EG's flash head does not zoom and cannot, therefore, automatically concentrate light output when used with longer focal lengths - it can just blast the same amount of light regardless of lens zoom setting. See the sections on guide numbers and zooming flash for a more detailed explanation.

The unit does, however, ship with a wide-angle attachment and a telephoto attachment which can be clipped on and used to diffuse or concentrate the unit's light output. (the telephoto attachment gives the unit a guide number of 68 at 135mm, so you may occasionally see the 480EG being misleadingly described as a flash unit with a guide number of 68) The 480EG has twin bulbs, a slave connector and full tilt and swivel capabilities, but it does not support second-curtain sync or exotic features like stroboscopic flash.

Interestingly, it also has an old-style external auto flash sensor built in. So if you have an older pre-EOS camera that doesn't support TTL metering - or if you want to avoid TTL metering altogether for some reason - you can still use it. You can even use the optional Synchro Cord 480 to link the flash to a camera via a PC socket.

Macro flash.

Canon sell three flash units for macro (closeup) photography. Two, the TTL-only ML-3 flash and the E-TTL MR-14EX flash, are ring-shaped flashes designed to fit directly around the end of a macro lens. The other, the luxurious and hugely expensive E-TTL MT-24EX "macro twin lite," contains two small flash heads on the end of a pair of short swivelling arms which can be adjusted independently and which can also be clipped to a ring that fits macro lenses. The MT-24EX flash heads can even be detached and mounted separately on other mounts, since each head includes a shoe mount and a standard 1/4-20 tripod mount. Both the MR-14EX and the MT-24EX can control slave flash units in wireless E-TTL mode, which is very handy - you use the macro flash units (the two tubes are assigned to groups A and B) to illuminate the foreground and then use slaved Speedlites (assigned to group C) to illuminate the background. Note that the older and long-discontinued ML-2 macro ring lite flash supports TTL, but only with the T90 camera - Canon states that it cannot meter TTL reliably with EOS cameras.

Macro flashes are specifically designed for closeup photography, and let you take shadowless photos of

small objects. Additionally, since each macro flash has two independent flash tubes you can adjust the lighting ratio between them, for more directional lighting. Unfortunately, only newer-model mid to high end type A cameras support ratio control.

It was trendy for a while in the 1990s to take fashion photos with large ring flashes to get a flat shadowless look to the models, but macro flashes aren't really powerful enough to do this sort of thing well. (though the MT-24EX is bright enough to be used for this in closeup portrait setups if you really want to)

For some bizarre reason people consistently mistype "macro" as "marco," as if the flash unit type were of Italian provenance. Please note that it's not.

Third-party flash units.

A number of manufacturers other than Canon build flash units that can be used with EOS cameras. Here's a bit of information on them.

Note that one problem with third party flashes is that Canon have not published the data protocols used by its cameras, lenses and flashes. So any flash unit designed to be compatible with EOS TTL, A-TTL or E-TTL flash metering has been reverse-engineered based on the behaviour of existing products. It's quite possible that Canon will release a future camera that uses some modification to the protocol and your flash won't work with it.

This may or may not be a big issue for you, but it's worth keeping in mind as it has been a problem in the past. For instance, the EOS 30/Elan 7 does not work with some Metz adapters and the EOS 300V/Rebel Ti/Kiss 5 doesn't work with any Metz adapters - see the note below.

Another common problem involves AF assist lights. As far as I know no third party flash unit is capable of illuminating the AF assist light when a focus point other than the centre point is selected when used with multiple focus point cameras.

Achiever.

Achiever, a Hong Kong third-party manufacturer of flash units, point and shoot cameras and various sundry other products like paper shredders, list a number of flash units that they say work with EOS cameras.

I understand that their products are all TTL only. But useful feature lists of their products aren't published on their site at all, so who knows?

Metz.

Metz, a respected German maker of flash units, sell quite a few "Mecablitz" flashes that work with EOS cameras by means of an adapter system. Photozone list some of them - the 54MZ-3, 50MZ-5, 40MZ-3, 40MZ-1, 40MZ-3i, 40MZ-1i, 40MZ-2, 40AF-4 and 32MZ-3 - and describe their features. The Metz range is, in fact, much more extensive than Canon's, and Metz offers features that Canon do not - such as flash units with memory settings, built-in secondary reflectors, clip-on coloured filters and audio warning signals.

Metz's Web site has an excellent listing of which features are available with which Canon cameras and what adapters are required, though some of the vocabulary has been translated rather literally from German and may be unfamiliar. A "lighting control indicator" is what Canon call a "flash exposure confirmation" light, for example. An "AF measuring beam" is the confusing name for the "AF assist light" or "AF auxiliary light."

Note that some users of Metz products have reported that the SCA3101 adapter, which works using TTL with older Canon-compatible bodies, will not work with the Elan 7/EOS 30. Even though the Elan 7/EOS 30 supports TTL on Canon flashes you must apparently use the SCA3102 Metz adapter. So you're best off consulting the Metz site and, preferably, doing some testing of your own before buying. Note also that Metz have a wireless flash triggering system, but it's not compatible with Canon's.

Finally, I understand that Metz have acknowledged that none of their flash units with the SCA3102 adapter currently work correctly with the new EOS 300V/Rebel Ti/Kiss 5 camera, owing to changes in the design of the flash shoe electronics.

Sigma.

Sigma, Japanese maker of many third-party lenses, build a number of flash units compatible with Canon EOS. The now apparently discontinued EF-430 ST and the EF-500 ST supported TTL only, but the newer models support E-TTL. The EF 430 Super and the EF-500 Super were the first E-TTL models and the later models are the EF 500 DG Super and the EF 500 DG ST. The DG models are E-TTL units designed to be compatible with digital EOS cameras. Some of these flash units are listed on Photozone.

The EF 500 DG Super and the EF-500 DG ST are particularly well regarded by a lot of EOS users, since feature-wise they're nearly identical to Canon's 550EX, which costs twice as much. The Sigma units are not built as sturdily as the Canon, but it's hard to argue with the price. They even have wireless capabilities compatible with Canon's system and has the ability to operate as an optical slave. For more information on EF-500 Super, specifically how it compares with the 550EX, please consult the brief article co-authored by Jim Strutz and myself. Sigma also sell the EM-140 DG Macro Flash, which is a ring flash for macro applications.

Soligor.

German photo accessory marketer Soligor sell a few Canon-compatible flash units; likely rebranded products. Their Web site lists some details. The flashes appear to be TTL only.

Sunpak.

Sunpak, a Japanese marketer of photo products, sell the TTL-only AF4000 and AF5000 flash units. The information on the Tocad America Web site, their US distributor, is fairly limited, however.

Vivitar.

American camera accessory and snapshot camera marketer and designer (they don't build products) Vivitar sell the 283 and 285HV flash units. These are self-contained flashes that rely entirely on their built-in flash sensors - they don't support TTL metering of any kind. In fact, Vivitar apparently pioneered the autoflash concept with the 283, which is probably the best-selling flash unit of all time.

283s and 285s are relatively cheap and commonly used by photo professionals as remote flashes triggered by optical slaves and so on. You should be aware, however, that older models have a very high trigger voltage that can damage EOS cameras. Newer models are fine, but check first before attaching any such flash unit to your camera, just to be sure.

Vivitar also sell a number of EOS-compatible flashes, some of which are said to be rebranded Sigma products. There's a list of their flash units on their Web site, and several are said to be Canon compatible, though TTL only. Their Web site is pretty uninformative.

Other flashes.

Finally, any electronic flash unit that mounts on a camera hotshoe and which has a trigger voltage of less than 6 volts will fit an EOS camera and will be fired when you take a photo. However, it won't work with any form of TTL flash metering. See the section on "Older Canon Speedlite flash units" for details.

I would also be extremely wary of buying a generic flash that's branded as being for Canon EOS. A lot of these cheap flash units are TTL only, which means they won't work on a Canon EOS digital camera. Some of them are even simple autoflash units despite their misleading packaging. Buyer beware.

Which flash unit should I buy?

This question obviously comes down to your light output and feature needs, your budget and your weight and size requirements. Here are a few notes to help you make a decision. If you don't know whether your camera is a type A or type B model, consult this list. All flash units marked with an asterisk are discontinued models.

I have a type B camera with no plans to buy a type A camera in the future.

You should probably stick with an E or EZ series flash unit, since buying an EX unit means you're paying for features you can't use. Also, since EZ units are all discontinued you can get a used unit fairly cheaply.

Recommended:

- The 200E, but only if you need something really tiny for occasional close-range fill flash work. Particularly if your camera lacks a built-in flash unit. I'd avoid the 200E if size and weight are not critical, as it's got feeble output, doesn't tilt or swivel and lacks flash exposure compensation buttons for use on older EOS cameras which lack FEC controls.
- If you want a reasonably powerful and feature-complete unit for cheap then the 430EZ* is your best bet.
- If you want the best you can buy in terms of features and output then the 540EZ is for you. This unit gives you slightly more output and flash exposure confirmation compared to the 430EZ. It also doesn't generate irritating flashes of white light each time you press the shutter release halfway when in creative zone modes other than P.

Not recommended:

- The 160E* offers little unless size and weight are a really serious issue. The 160E uses a 2CR5 lithium battery, which is a costly way to power a flash unit. However it's this small lithium cell which explains its incredibly tiny size.
- The 300EZ* is a fixed unit which can neither swivel nor tilt - get a 430EZ instead. The 430EZ is larger and heavier, but more flexible than the 300EZ.
- The 420EZ* isn't a bad unit but lacks convenient flash exposure compensation buttons. The 430EZ has these plus an external battery socket and doesn't cost much more.

I have a Canon digital camera, a type A camera, or a type B camera but plan to buy a type A camera soon.

If you have a type A camera you should get an EX-series (E-TTL capable) flash. All EX-series flash units will work fine in TTL mode with type B cameras as well - the only missing feature being A-TTL, which is fairly useless anyway. Finally, if you have a digital Canon camera then you don't have a choice - you must get an EX-series flash unit as the earlier models won't work.

Recommended:

- The 220EX, but only if you need something really tiny and lightweight for occasional close-range fill flash work. Particularly if your camera lacks a built-in flash unit. However, I'd avoid the 220EX if size and weight are not critical, since it doesn't produce much light and doesn't tilt or swivel.
- The 430EX is great for general-purpose fully-automatic flash photography. It's surprisingly capable, with full manual controls and a rear LCD. It can also serve as a wireless E-TTL slave. The 420EX is an okay buy if you can find one cheap, but it lacks manual controls, only supports flash exposure compensation (FEC) on midrange and pro EOS bodies (ie: those cameras with custom functions) and lacks a rear panel LCD.
- The top of the line 580EX II flash is quite powerful and can do anything a portable flash unit can be expected to do, but it's quite large (though it's smaller than the earlier 550EX) and both costs more and weighs more than a brand new low-end EOS camera. However it can serve as an E-TTL wireless master, has manual controls and works in stroboscopic mode.

Not recommended:

- The 380EX* can tilt but can't swivel. It also can't be used as a wireless slave. Unless money is a serious concern and you find a 380EX on sale for a really good price I'd get a 420EX or 430EX instead, since the price difference is usually fairly minor.

I have specialized requirements:

Macro photography with a type B body: the ML-3*.

Macro photography with a type A body: the MR-14EX.

Macro photography with a type A body and a huge budget: the MT-24EX.

News or wedding photography for which massive light output is important and subtle control is not: the 480EG. Though Metz offer many high-powered grip models which offer more control over the Canon unit.

What about third party units?

A number of companies other than Canon sell EOS-compatible flash units. The vast majority, however, are TTL only. There is also a small risk of compatibility problems with both current and future EOS camera bodies.

If you're satisfied with TTL operation (particularly if you have a type B camera with no plans to upgrade to a type A) and you've tested the flash unit to ensure that it works with your existing camera body, then an inexpensive third party unit may be the way to go if you're on a tight budget. But I can't offer any recommendations for such cheap units because there are so many different brand names which sell them. Many of these units are actually the same basic product, rebadged and sold by different distributors. So if a cheap third-party product is of interest to you I'd recommend you go to your local camera shop and look around.

There are some better units worth considering as well. Metz make a wide range of well-featured and powerful flash units with interchangeable adapter modules (including an E-TTL capable module for type A cameras), and Sigma sell the popular EF 500 Super, which supports E-TTL and wireless E-TTL operation.

On to Part II.

- NK Guy, PhotoNotes.org.

Please send feedback if you find this article to be of interest or value or if you have any comments, corrections or suggestions.

Please also consider making a donation to help defray some of the costs of building and maintaining this site. Thanks!

Thanks to Jim Strutz, Mark Overton, Gerard Maas, Steve Dunn, Julian Loke, Lewis Macdonald, Martijn Stol and Brian Arthur for valuable suggestions to this document. Any errors or omissions are purely my own, however.

Back to Photo notes.