Flash Photography with Canon EOS Cameras - Part I.

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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.

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'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 don't - unless you're wearing a caving helmet. 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.

3) Are my friends 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 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' eyes glow an evil red in real life and not just in your flash photos of them then you're reading the wrong document and probably should do a Web search on exorcism.

4) I took a flash photo and there's a curved shadow at the bottom of the photo.

You're using the camera's internal flash and you also have a very large lens installed or a lens with a big lens hood. Either way, something is blocking the light from the internal flash.

To fix the problem you could try a different lens, zoom wider if the lens is extended (ie: shorten the lens if it's a zoom lens), remove the lens hood or use an external flash unit. It's also possible that you're too close (a metre or less) to the subject.

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

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.

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.

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.

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) My camera meters 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 283 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 later included TTL flash metering in their T90 camera a decade later, and added 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 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.

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 mirror flips down and the shutter closes. 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 all EOS film cameras except the EF-M. The digital D30, D60, 1D, 1Ds, 10D, 300D/Digital Rebel/Kiss Digital and 1D mark II cameras 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, 540EZ, 550EX, 480EG, MR-14EX, MT-24EX and 300TL.

Refinements to TTL flash, including Canon AIM.

TTL metering is 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 mirror flips down and the shutter closes. 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, is of rather limited value. 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. 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.

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 mirror flips down and the shutter closes. 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).

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

Limitations of E-TTL.

One drawback of E-TTL is that the preflash can cause people who blink quickly to be photographed mid-blink - what EOS list member Julian Loke has referred to as the BEETTL syndrome, for "blinking eye E-TTL." The preflash normally occurs an extremely brief period of time before the main flash, but when using second-curtain sync with slow shutter there's enough time for rapid blinkers to react to the preflash. This apparently can also be a problem for nature photographers who photograph birds.

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 550EX 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) 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.

Flash units which support E-TTL II:
All EX series Speedlites: 220EX, 380EX, 420EX, 550EX, 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 1.8 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 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 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 28-200mm 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 70-210mm 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

If your lens doesn't appear on the list above then it may not have distance data capabilities. Here are a few current lenses in the EF lineup which don't have distance data. Note the 50mm 1.4 USM and the 85mm 1.2L USM 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 550EX 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 the flash burst is so incredibly brief. However when you use FP mode flash, the flash unit pulses the light output 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, 550EX, MR-14EX, MT-24EX.

TTL and E-TTL and EOS film cameras.

All film-based Canon EOS cameras at the time of writing support TTL flash metering - the one exception being the oddball Canon EF-M, which 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) All film-based EOS cameras with built-in flashes 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:

- First, 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.
- Second, since all EOS film cameras (both type A and type B) 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).
- Third, 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 (or both E-TTL and E-TTL II) and do not support either TTL or A-TTL. 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.

Unfortunately, E-TTL has been a particular problem for digital EOS users. Many users report serious problems with wildly varying exposure when using an E-TTL flash unit with their Canon DSLRs, particularly the D30 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 digital EOS users have given up on E-TTL and gone back to the old-style autoflash units. Others routinely set their lens to manual focus once focus has been achieved, since the camera uses a centre-weighted average metering pattern for flash metering when in manual focus.

Still, at least with digital you have a rear-panel preview and histogram, so you can tell right away if a flash photo failed to work. And Canon are aware of the problem. The EOS 10D has revised E-TTL algorithms which rely on centre-weighted average metering for E-TTL flash, even if the lens is 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.

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.

While Canon have officially divided their camera bodies into types A and B there are subvariants of type A cameras. Specifically, the first generation of type A cameras does not have support for wireless E-TTL flash ratios and modelling flash; the second generation does. There is also a third generation which supports E-TTL II.

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

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 and 10D (digital)
EOS 1D and 1Ds (digital)
EOS 300D/Digital Rebel/Kiss Digital (digital)

As above plus support for E-TTL II:

EOS 1D mark II (digital)
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)

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, 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) 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.

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.

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. Here’s a good brief introduction to a typical monolight studio flash, if you’re interested.

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. One camera, the 10/10s, has a motorized flash unit which both pops up and retracts 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.

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 (D30, D60, 10D, 300D/Digital Rebel/Kiss Digital), though their internal flash units do not support FP mode.

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. Flashes end 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 420EZ and 420EX 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 has no manual controls.

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.
These flash units have more power and have zooming flash heads but 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 both tilts and swivels. The 420EX can also serve as a slave unit in wireless E-TTL flash.

The high-end units - 420EZ*, 430EZ*, 540EZ, 550EX.
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. 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 550EX 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 six flash units compatible with Canon EOS. Two are TTL - the EF-430 ST and the EF-500 ST, and two are E-TTL - the EF 430 Super and the EF-500 Super. 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 Super and the EF-500 Super DG 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.

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. Finding useful information on the massively amateur-looking Tocad America Web site, their US distributor, is pretty hopeless, though. Good luck.

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, so you're basically on your own there.

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.

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 mostly 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 the incredibly tiny size of the 160E.
- 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're best off buying an EX-series (E-TTL capable) flash to take full advantages of the newer features. 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 such as a D60 or PowerShot 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 420EX is great for general-purpose fully-automatic flash photography. It can also serve as a wireless E-TTL slave. However it lacks manual controls and only supports flash exposure compensation (FEC) on midrange and pro EOS bodies (ie: those cameras with custom functions).
- The top of the line 550EX flash is quite powerful and can do anything a portable flash unit can be expected to do, but it's very large 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 the 420EX instead, since the 420EX usually doesn't cost much more.

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, tela design.

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 and Martijn Stol for valuable suggestions to this document. Any errors or omissions are purely my own, however.

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Flash Photography with Canon EOS Cameras - Part II.

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

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EOS flash photography modes.

The four main Canon EOS “creative” zone modes (P, Tv, Av and M) each handle flash metering in very different ways. These differences are probably one of the primary sources of confusion in the world of Canon EOS flash photography.

Here are a few important terms and concepts that you need to know before understanding how these confusing points originate.

Subject and Background in flash photography.

The typical flash photograph is assumed to have two basic regions. The *foreground* or *subject* is the area around the autofocus metering point - perhaps a person. *Background* ambient lighting is just everywhere else.

This is an important distinction because all portable flash units have a limited range. As noted in the FAQ section, you can’t expect a small flash unit on your camera to illuminate the Eiffel Tower or the Grand Canyon or even a large space such as a ballroom. The camera, therefore, handles the subject and background metering differently and independently.

Fill flash.

Flash photography takes on two very basic forms. In regular flash photography, the flash is the primary light source for the photo. Flash metering is done for the foreground subject, and the background is metered by the camera’s regular exposure metering system. This can lead to the background being underexposed and dark if ambient light conditions are low. This is how most people think of flash - as a way of taking photos in dark places.

However, flash can also be used in bright locations or in daylight to lighten shadows, reduce the harsh contrast of full sunlight or brighten up dull images without being the primary light source for the photo. This is called “fill flash.” And it’s often a source of surprise for non-photographers, who don’t expect to see photographers using flash units outdoors on sunny days on in brightly lit settings. In such situations the fill flash is being used as a sort of portable reflector - shining a little extra light in certain areas.

A typical example might be a person who's wearing a hat outdoors on a sunny day. Hat brims often cast dark shadows over the subject's face, and a little flash can lighten up this shadow nicely. A backlit subject is another common use for fill flash - you can't simply crank up the exposure compensation to expose the subject correctly as then the background lighting would be too strong. Or perhaps you want a little sparkle of light reflecting back from a person's eyes - the "catchlight." Sometimes wildlife photographers use flash units at great distances from their quarry for the same reason - they aren't using the flash to illuminate the animal but to provide a lively catchlight to the eyes.

In all these cases you are, from the point of view of the camera, using two light sources at the same time. There's ambient lighting, which is all the available light around you - reflected light from the sun or artificial light sources. And there's the light from the flash unit, which is supplementing this existing light. As always, ambient light levels hitting the film are governed by the lens aperture and shutter speed and flash levels are governed by flash metering. By adjusting the output of the flash unit you're essentially adjusting the ratio between flash-illuminated and ambient light-illuminated scene.

In fact you could argue that the two cases I present above - flash as primary light source and ambient light as primary light source - are an artificial distinction and that all flash photography is fill photography in a sense; just that in the first case the ambient lighting is so low as to be insignificant, whereas in the second case it's the reverse. This is true enough, but I think the distinction is useful to make, particularly in terms of the way full auto and P modes work versus Tv, Av and M modes.

Unlike certain other camera systems (particularly Nikon), Canon EOS cameras always default to fill flash mode when the camera is in Tv, Av and M modes. They also perform fill flash in P mode if ambient light levels are high enough. There's no separate switch or pushbutton to engage fill flash. For details have a look at the section on EOS flash photography confusion below.

Fill flash ratios.

The "fill flash ratio" is commonly described in terms of the ratio of ambient light plus fill flash combined, compared to the fill flash alone. Canon EOS gear, however, usually lets you adjust the fill flash in terms of stops of flash output, in either 1/2 or 1/3 stop increments. What's the relationship between the two ways of describing fill flash?

- A ratio of 1:1 would mean that the flash unit is the sole source of light (0 ambient + 1 flash) and therefore you wouldn't have a fill flash situation.
- A 2:1 ratio would mean that the ambient light and flash are at the same level (1 ambient + 1 flash). That basically means 0 stops of compensation given a fairly flat-lit scene, and usually results in rather unnatural looking fill flash.
- A ratio of 3:1 means that there is twice as much light from the ambient source as the flash (2x ambient plus 1 of flash). Such a ratio requires a -1 stop fill flash setting on the flash unit, since each stop means a doubling or halving of the amount of light.
- A ratio of 5:1 means that there is four times as much light from the ambient source as the flash (4x ambient plus 1 of flash). This is a -2 stop difference.

> Typically photographers use between 1 and 2 stops of fill flash to lighten shadows without creating a phoney flash-illuminated look.

However, the term “ratio” is confusing and seems to mean different things to different people. Sometimes people talk about a 1:1 ratio when the ambient and fill lights are of equal intensity. So a 2:1 ratio might mean -1 stop fill flash and 4:1 would mean -2 stop fill flash. In this case they’re talking more about the light output than they are about the reflected light.

The concept of ratios works well in studio situations where you have total control over the lighting. You can turn off the main light and measure the fill lighting with a meter, you can move lights around to vary their strength, etc. But if you’re taking a candid photo outdoors you have no such control. You can hardly turn off the sun, and automated TTL flash is going to have its own ideas as to what constitutes correct lighting.

For those reasons I prefer not to deal with ratios at all for non-studio flash photography but just in terms of the number of stops compensation used by the flash. Note that the term “ratio” is also used in flash photography in conjunction with multiple flash setups, particularly multiple wireless units in the case of wireless E-TTL flash.

Auto fill reduction.

Also called “automatic reduction of flash output” in some Canon documentation. Canon EOS cameras automatically use regular flash exposure with no compensation when ambient light levels are low - 10 EV or lower. However, when ambient light levels are brighter - 13 EV or higher - the camera will switch to fill flash mode and reduce the flash unit’s output level. It does so in TTL mode by dropping flash output by 1.5 stops. Between 10 and 13 EV the camera will smoothly lower the flash unit’s output by half a stop for each EV.

E-TTL flash works in a similar fashion, though apparently flash output will be lowered by as many as 2 stops when ambient lighting is bright. Canon have not, however, divulged their secret E-TTL fill reduction algorithm, so it’s total guesswork exactly how it works. Apparently, though, the algorithm compares the brightness level of each zone both before and after the preflash, in part to compensate for highly reflective areas.

Some mid to high end EOS cameras allow you to disable this auto fill reduction by means of a custom function. See the section on flash exposure compensation for details. Note that any flash compensation you may apply manually is in addition to this auto fill flash reduction, unless of course you’ve disabled it via a custom function.

Slow shutter sync.

There are two basic ways in which a camera can take a flash photo when light levels are low. The camera can either use a short shutter speed to minimize camera motion blur and have the flash blast out enough light to illuminate the foreground objects whilst leaving the background dark, or the camera can extend the shutter time to

allow more of the background to show up and flash-illuminate the foreground subject. This latter technique is called slow sync, slow shutter sync or “dragging” the shutter.

It’s only possible in Tv, Av and M modes - you can’t use it in P mode or most of the PIC (icon) modes. The one exception is the night scene PIC mode on many EOS cameras, which uses slow shutter exposure with first-curtain flash.

A typical example is a tourist snapshot of someone standing in front of a famous landmark at night. If you keep the shutter speed fast then you’ll have a nice flash-illuminated photo of your friend against a pitch black backdrop, unless the landmark is extremely brightly lit or unless you’re using very fast film. However, by slowing down the shutter speed you can take a photo of the person standing against a properly exposed background.

The drawback is obvious, of course. By slowing the shutter speed you’re going to need a tripod to avoid blur induced by camera movement, especially with long shutter speeds like 1/15 second or slower.

Sometimes slow shutter sync is used to provide a dynamic motion effect in flash photos. A photo taken with flash and a slow shutter speed can provide an interesting mix of flash-illuminated subject and ambient-light-illuminated motion blur. The effect is difficult to predict, but can be very striking and exciting when it works.

Take my photo of fire performers for example - the flash freezes the motion of the performers but the slow shutter captures the swirling motion of their fire chains. Have a look at the discussion of colour temperature theory to find out why the right-hand flash-illuminated performer has a bluish tinge to his skin whereas the rest of the photo is illuminated with very yellow-orange light. Steve Mirarchi also has some interesting examples on his Photo.net article on concert photography.

X-sync (flash sync) speed.

Timing is critical for flash photography. The burst of light from a flash unit is extremely brief (in milliseconds), and must occur when the shutter is fully open. If the flash burst occurs when the shutter is still opening or closing then the shutter itself may prevent the entire image area from being fully exposed.

Modern SLR camera shutters are equipped with a pair of moving curtains which wipe across the opening to the image area. They travel vertically because the travel distance is less than if they travelled horizontally, and there are two curtains to make fast shutter speeds possible. At high shutter speeds the opening is actually an open slit between the two curtains, travelling the height of the image area.

This presents a problem with flash photography. If you have only a slit exposed at the time the flash happens to go off then you won’t be able to illuminate the entire image area with the flash burst. An electronic flash burst is always much briefer than the fastest shutter speed motion that the shutter mechanism can achieve.

Different cameras have different shutter designs - some are faster than others. But each camera will have a maximum shutter speed at which a flash burst will expose

the full image area of the film. This maximum flash-compatible shutter speed is called “X-sync speed.” X-sync and flash sync are the same thing on modern cameras, since they all use electronic flash.

Maximum X-sync speed and EOS bodies.

1/90 second.
All low-end Canon EOS cameras. These are cameras of the Rebel series in North America (eg: Rebel G, Rebel 2000), the Kiss series in Japan (eg: EOS Kiss, Kiss III), and the EOS three-digit series (eg: EOS 300, 500 but *not* the EOS 100, 600 series or 750/850) and all EOS four-digit series (eg: EOS 1000, 3000) elsewhere.

Note, however, that some users report that their Rebel/EOS three/four-digit cameras are actually physically capable of attaining a 1/125 second X sync. That is, the shutter mechanism can sync that fast but the camera’s computer has been deliberately programmed not to allow flash sync at speeds faster than 1/90 second. It’s not clear why Canon did this. One theory is that it was an intentional move on Canon’s part to cripple their low-end cameras for marketing reasons. (ie: so that they compete less with midrange models) Another theory is that this was done because of flash duration tolerances - Canon decided to play it safe and ensure that their low-end shutters always can record a full flash burst.

Either way you can’t override the camera’s programming and perform flash sync with any dedicated flash unit which meters through the lens. But if you’re using an externally triggered flash with an optical slave or adapter cable you may be able to take advantage of this higher sync speed if your camera falls into this category (non-dedicated flash units do not communicate with the camera concerning flash exposure and thus the programmed 1/90 sec limit is not an issue). Unfortunately empirical testing is the only way to find out.

1/125 second.
Mid-range EOS cameras. These are EOS two-digit cameras (eg: EOS 10 and 50) and the Elan series in North America (eg Elan II, Elan 7). Most of the first generation EOS cameras (600, 630, 650, 750 and 850) also have a 1/125 sync, as does the original Elan/EOS 100.

1/200 second.
Semi-pro EOS cameras. These are the single-digit EOS cameras that aren’t in the 1 series - the EOS 3 and 5 (A2 in North America). The digital D30 and D60 also have an X-sync of 1/200 sec as does, surprisingly enough, the APS IX. (apparently the smaller physical dimensions of the IX shutter allow it to reach a higher X-sync speed)

1/250 second.
Top of the line professional EOS cameras - the EOS 1, 1N, 1V, 1Ds and 1D mark II. The one odd one out is the EOS 620, an old camera from the late 80s which nonetheless could sync at 1/250 sec as well.

1/500 second.
The digital 1D camera has a startling 1/500 sec X-sync and a 1/16 000 sec top shutter speed. This is because both X-sync and shutter speed are normally handled electronically by the CCD and not by a mechanical shutter. The 1D does have a mechanical shutter but it’s used for bulb mode. Note, however, that the CMOS-based

1Ds has a top X-sync speed of 1/250 like the 1V upon which it's based - the higher X-sync speed of the 1D derives from its use of a CCD image sensor.

All EOS cameras will deliberately prevent you from exceeding the X-sync value for shutter speed when you're using non-FP flash.

Note the first exception - if you have an E-TTL flash on a type A body with FP mode flash enabled you're fine. You can exceed X-sync at the cost only of lowered flash output. But there is a possible second exception, and that is if you're using third party flash gear, particularly studio flash units that use optical slaves or generic flash units. Such a setup likely won't notify the camera properly of your use of flash, so be careful.

EOS flash photography confusion.

The main area of confusion in EOS flash photography is the fact that P, Tv, Av and M modes handle flash illumination differently, especially when ambient light levels are not bright. Here's a summary of how the modes basically work when you have a flash unit turned on. This summary assumes that you do *not* have FP mode flash enabled if that option is available to your particular camera and flash unit combination.

Mode	Shutter speed	Lens aperture
P	Automatically set from 1/60 sec to the camera's maximum X-sync speed.	Automatically set according to the camera's built-in program.
Tv	You can set any shutter speed between 30 seconds and the camera's maximum X-sync speed.	Automatically set to match the shutter speed you have set.
Av	Automatically set between 30 seconds and the camera's maximum X-sync speed to match the lens aperture you have set.	You can set any lens aperture you like.
M	You can set any shutter speed between 30 seconds and the camera's maximum X-sync speed.	You can set any lens aperture you like.

And here are the details:

Program (P) mode flash.

The overriding principle of Program (P) mode in flash photography is that the camera tries to set a high shutter speed so that you can hold your camera by hand and not rely on a tripod. *If that means the background is dark, so be it.*

Program mode operates in one of two modes, depending on the ambient (existing) light levels.

1) If ambient light levels are fairly bright (above 13 EV) then P mode assumes you want to fill-flash your foreground subject. It meters for ambient light and uses flash, usually at a low-power setting, to fill in the foreground.

2) If ambient light levels are not bright (below 10 EV) then P mode assumes that you want to illuminate the foreground subject with the flash. It sets a shutter speed between 1/60 sec and the fastest X-sync speed (see above) your camera can attain. The aperture is determined by the camera's built-in program.

Because the camera tries to keep the shutter speed at a reasonable speed for handholding the camera you will end up with dark or black backgrounds if you take a flash photo in P mode when ambient light levels are not bright.

On most if not all EOS cameras, P mode is not shiftable when flash (internal or shoe-mounted Speedlite) is used. Note also that DEP mode cannot work correctly with flash - its metering settings basically revert to P mode if you try it.

Tv (shutter priority) mode flash.

In this mode the camera lets you change the shutter speed. It then automatically chooses an aperture setting to expose the *background* correctly. Flash duration (flash output) is determined by the flash metering system. In other words, the camera always works in fill flash mode when it's in Tv mode - it always tries to expose the background adequately, unlike P mode.

If the maximum aperture value of your lens starts flashing in the viewfinder it means the *background* of the scene you're shooting is too dimly lit. If you want to try and expose the background then you should decrease the shutter speed to compensate. Otherwise the camera will just try and expose the foreground with flash and the background will come out dark. Naturally at slower shutter speeds you'll need to use a tripod to avoid blurring caused by camera shake.

As always, the camera will prevent you from exceeding its built in X-sync speed unless FP mode is available to you and engaged. If the minimum aperture value of your lens starts flashing then your scene is too brightly lit. You must then either engage FP mode if it's available or perhaps put a neutral density filter on the camera or use slower film. Or turn off flash altogether and simply use a reflector of some type to bounce ambient light onto the subject.

The 420EZ and 430EZ flash units will operate in A-TTL mode in Tv mode, but the 540EZ works only in TTL mode. Note also that some people have reported that in this mode their type A camera bodies underexpose the background by up to a stop when light levels are low and an E-TTL flash unit is engaged. If this is the case try testing by comparing the aperture setting with M mode, which does not do this. You may need to apply exposure compensation if this effect exists on your camera and is undesirable.

Av (aperture priority) mode flash.

Av mode lets you set the depth of field by specifying the lens aperture. The camera then chooses a shutter speed ranging from 30 seconds to the camera's X-sync

speed, in order to expose the *background* correctly. *If that means the shutter speed is some really low value so that you need to use a tripod to avoid camera-shake blur, so be it.* In dark conditions, therefore, Av mode works in slow sync mode.

Flash duration (flash output) is determined by the flash metering system. Like Tv mode the camera always works in fill flash mode when in Av mode.

There is one exception to this. A number of EOS cameras have a custom function you can set to ensure that the shutter speed in Av mode when using flash is locked to the X-sync speed. The EOS 10/10s and Elan II/EOS 50, for example, have such a custom function, which lets your camera behave more like P mode when in Av mode. However this custom function will only lock the camera to X-sync in Av mode and will not choose a shutter speed from 1/60 sec to X-sync, the way P mode does.

As always, the camera will prevent you from exceeding its built in X-sync speed unless FP mode is available to you and engaged. If the shutter speed value of 30" flashes in the viewfinder then there isn't enough light to expose the background correctly and you'll need a larger aperture or faster film. If the camera's X-sync flashes in the viewfinder then you'll need to decrease the lens aperture, engage FP mode if it's available or use slower film.

The 420EZ and 430EZ flash units will operate in A-TTL mode in Av mode, but the 540EZ works only in TTL mode. Note also that some people have reported that in this mode their type A camera bodies underexpose the background by up to a stop when light levels are low and an E-TTL flash unit is engaged. If this is the case try testing by comparing the shutter speed setting with M mode, which does not do this. You may need to apply exposure compensation if this effect exists on your camera and is undesirable.

Manual (M) exposure mode flash.

In manual exposure mode you specify both the aperture and shutter speed, and your exposure settings will determine how the background (ambient lighting) is exposed. The subject, however, can still be illuminated by the automatic flash metering system since the flash can automatically calculate flash output levels for you. This is a marked contrast to the olden days, when photographers would carry around little flash exposure tables with them in order to work out manual flash settings.

This is how flash works in manual mode. Note that we're talking about the manual *exposure* mode setting only, which can use automatic TTL flash metering (it will not use A-TTL metering in manual exposure mode). Also, we *aren't* talking about setting the output of the flash manually - that's manual flash and a different topic altogether.

- Set your camera to M for manual exposure mode.
- Set the aperture and shutter speed to expose the background correctly.
- Press the shutter button down halfway if your flash has a rear-panel LCD (liquid crystal display). The flash coupling range will appear in the flash unit's LCD. This range is the distance that can safely be covered by the flash.
- If your lens has a distance scale you can check the current focussing distance to ensure that the distance to your subject falls within this range. Otherwise you'll have to estimate.

- If the “flash ready” lightning bolt symbol appears in the viewfinder you can press the shutter all the way to take the photo. The flash’s TTL or E-TTL system will determine the flash exposure level of the subject.

If your flash lacks a rear-panel LCD you won’t have a preview of the flash coupling range, of course. Also, LCD-equipped flash units will not calculate the flash coupling range if you’re using bounce flash, and the coupling range will not necessarily be correct if you have a diffuser on the flash head.

Some Speedlite flashes, such as the 540EZ and 550EX, can display the coupling range in either feet or metres, depending on which measurement system has been set by the small switch in the battery compartment. Others, such as the 430EZ, are hardwired to one measurement system or the other, depending on where the flash was sold. US market flashes used feet and all other countries on the planet* had only metre flashes available to them.

* Trivia note - even countries such as Canada and the UK which are officially metric but which are nonetheless full of people who still use imperial measurements. Also Yemen, Rwanda, Burundi and Burma, which used to stand proudly with the USA as the planet’s only officially non-metric countries and which have now given up and are switching over to metric. Liberia is the only holdout I can find, and even there it’s only the government - apparently businesses and schools use metric.

Multiple flash units.

As noted above, the basic problem with balancing ambient light and shutter speed requirements is that the output from a flash unit is only sufficient to illuminate the foreground, unless you’re in a small interior space in which you can bounce the light.

If you’re in a larger space or an area in which you can’t bounce light effectively you could consider using multiple flash units - a unit or two for subject illumination and another unit or two for the background. Such a setup gives you increased range and affords more control over the lighting.

There are three common ways to do this - wired, optical slaves and wireless.

Wired multiple flash.

With a wired system you buy the necessary connecting cords and adapters to hook up more than one unit to your camera. Each flash unit fires simultaneously when you take a photo, and you can use TTL metering or configure the output for each flash unit manually (assuming the unit in question has the ability to have its output set manually). For details check out the extension cord section.

Optical slave multiple flash.

With optical slaves you position your various flashes - big AC-powered studio flash units or small battery-powered units - around the scene and connect tiny optical sensors to each one. These sensors respond to a flash being fired and trigger their own flash units immediately. For more information have a look at the slave flash section.

Wireless multiple flash.

Finally, you can use a wireless control system to trigger your flashes. A number of companies manufacture radio remote systems that let you do this - the Pocket Wizard Multimax and the Quantum Radio Slave being popular products. These third party systems have a long range and can be used in conjunction with optical slave units if necessary.

The most recent option is Canon's own wireless E-TTL, which lets you set up multiple Speedlite flash units and trigger them remotely using light pulses. (ie: this system does not use radios) The Canon system essentially requires E-TTL and supports all associated features - FP flash, FEL and so on. On certain camera bodies, ratio control between different flash units and modelling flash is also available. For more information consult the wireless E-TTL section.

Metering patterns for the background when using flash.

EOS cameras have different metering patterns, depending on the model. These metering patterns include evaluative (varying number of zones from 3 to 35), partial (from 6.5% to 10.5%, sometimes centred around the active focus point), centre-averaged and spot. When you aren't using a flash these metering patterns are used for metering the *subject* of a photo.

However, in flash photography the camera needs to meter for the *background* and not the subject, so the metering pattern should change when possible. This varies from camera to camera.

EOS cameras with single zone ambient metering such as the T90 and the original Rebel/1000 cameras use centre-weighted average metering for TTL and A-TTL flash. EOS cameras with multiple metering zones for ambient metering use the outer segments of their evaluative metering sensor for TTL and A-TTL flash. (their evaluative sensors are divided into patterns depending upon the number of zones and the segments closest to the edge of the frame are selected)

Note that most EOS cameras with partial metering buttons won't use the outer evaluative zones for ambient metering when the button is pressed. Instead they use partial metering patterns for ambient light metering in flash photography as well. The T90, EOS 1, 700, 750 and 850 are exceptions - they do not let you switch to partial metering for flash.

Unfortunately, the way in which E-TTL meters ambient lighting has not been publicly documented by Canon, so far as I know.

Flash metering patterns.

As above, information on flash metering patterns is fairly scarce, particularly for E-TTL flash.

TTL and A-TTL flash metering patterns:

The flash metering pattern is determined by the type of flash sensors built into the camera. If the camera has only one focussing point then it will have a single zone flash sensor. Flash metering is conducted using this sensor in a centre-weighted averaging pattern.

If the camera has multiple focussing points then it will have multiple zones; what Canon call their AIM system. The number of flash metering zones depends on the camera model. For instance, the EOS 10/10s has three focussing points and three flash metering zones, and flash metering uses whichever corresponding autofocussing point or points are active. However, the EOS 5/A2 uses the same sensor as the 10/10s so it too has 3 flash metering zones even though it has 5 autofocus points. The Elan II/EOS 50 has 3 AF focussing points and a 4 segment/3 zone flash sensor. (this latter means that the flash sensor has 4 segments but it chooses two consecutive segments, yielding 3 possible zones)

These multiple zone flash sensors let the camera bias the flash exposure to the currently selected AF point. When you focus manually the camera does not bias any flash zone but chooses the central zone instead.

Note that the A2/5 is somewhat different from other multiple AF point cameras in that it will only bias flash exposure correctly to the nearest AF point if that point was manually selected. In automatic and ECF modes it apparently always chooses the centre zone.

E-TTL flash metering patterns:

The camera uses its evaluative metering system to meter the flash output, based upon the preflash. When in autofocus mode most EOS bodies which do not use E-TTL II bias flash metering toward the currently selected AF point, but always in an evaluative mode pattern - they don't use spot or partial metering patterns. When in manual focus mode it appears that at least some EOS bodies switch to centre-weighted averaging.

Note, however, that this biasing of E-TTL metering to the active point is potentially problematic, since it means that the flash metering is done in almost a spot-metering fashion. Many user complaints regarding flash metering problems in E-TTL mode appear to be linked to this issue. If the camera happens to be over a dark object, for example, flash metering can be considerably overexposed, and vice-versa. The standard answer to this problem is to use FEL and meter off something mid-toned, but this is clearly not a solution for rapid-shooting situations such as weddings and sports. Another approach is to set the camera lens to manual focus, since the body apparently switches to centre-weighted average metering in that mode, but that's obviously not a useful answer much of the time either.

Users of the digital D30 and D60 have been particularly unhappy with E-TTL flash metering. The 10D apparently reduces this problem by defaulting to a centre-weighted averaging metering pattern in E-TTL, even when the lens is set to autofocus.

E-TTL II addresses this problem by altering flash metering considerably. It examines each evaluative metering zone before and after the E-TTL preflash. It then calculates the weighting for each zone independently, biasing against those zones with high

reflectivity in the preflash. This means that E-TTL II does not have a flash metering pattern as such, since it's calculated dynamically.

Note that since I've been unable to find definitive published statements from Canon on this topic it isn't as authoritative as it could be. Please contact me if you have further information about E-TTL flash metering.

Do not focus and recompose.

The fact that the camera biases flash exposure to the nearest focus point, if the camera has multiple focus points, is important to keep in mind. If you're in the habit of using the old "focus, lock AE and recompose image" technique, be sure not do this when taking flash photos.

Flash metering occurs *after* ambient light metering, so in this case you're locking AE but not flash metering, and therefore recomposing messes up your flash metering. Instead, select the focus point that's closest to your subject in order to bias flash exposure to that area.

There are two exceptions to this rule, however. First there are type A bodies which support FEL. You can use FEL in such situations to lock flash exposure to a given area of your photo before recomposing. Second, cameras with support for E-TTL II are supposedly less vulnerable to this problem because they can include distance data in flash metering.

Flash terminology.

Here are a number of other terms and concepts related to EOS flash photography and flash photography in general. For more information on the principles of electronic flash, check out Toomas Tamm's page.

Strobe and flash.

We have a little UK/US terminology problem here. In the UK a "strobe" is something which emits blinking pulses of light whereas in the US a "strobe" is any electronic flash unit, whether it fires once or continuously.

We also have the additional confusion that arises from "flash" having four meanings - a verb meaning to produce a pulse of light, a flash of light, flash-based photography in general and a flash-producing device. Finally, we have "Speedlite" and "Speedlight," which are the tradenames used by Canon and Nikon respectively for their series of electronic flash units.

So. In this document I adopted the following convention:

- I don't use the word "strobe" at all in order to minimize confusion.
- I refer to electronic devices designed to emit pulses of light for photographic purposes as "flash units" if there's any possibility for ambiguity with any other meaning of the word. Yes, that leaves me vulnerable to crappy adolescent jokes. Oh, well.

- I refer to electronic flash units that are emitting pulsating flashes of light as “stroboscopic.”
- Finally, speaking of UK/US stuff, I’ve used the antiquated convention of referring to corporations in plural form (as groups of people) rather than independent entities. Since everyone assumes I’m just making a grammatical error rather than a feeble ideological point I might change that...

Inverse square law.

Light dropoff from a light source always seems very rapid. Consider a campfire at night - a pool of light surrounded by darkness. Or a flashlight (electric torch in the UK) being shone into the night sky - a bright bar of light that rapidly fades to nothing. You might think that when you double the distance from a light source you get half as much light, but it doesn’t work like that - you actually get just a quarter as much light.

Space is three dimensional, so imagine a sphere drawn around a light source that’s producing photons. As you get further away from the light source this imaginary sphere increases in size. The surface area of the sphere also increases, but it’s being illuminated by the same amount of light - the same number of our photons. It’s not a simple 1:1 relationship - the sphere is not twice as large when you get twice as far from it.

The actual relationship between distance from the light source and size of the imaginary sphere can be described mathematically as the *inverse square law*. It states that light output is proportional to the inverse square of the distance. (ie: divide 1 by the distance, then square the result) So if you double the distance you get $1/2^2$, or one quarter as much light. If you quadruple the distance you get $1/4^2$, or only one sixteenth as much light.

All light sources follow this rule, which is why light from a flash unit tends to drop off in intensity pretty rapidly. It also explains why you don’t necessarily gain much more flash range when you buy a moderately more powerful flash unit, and why foreground objects are much more brightly illuminated by your camera-mounted flash unit than distant objects.

Guide number.

The maximum distance range of a flash unit is indicated by its guide number. If you use automatic flash metering you may never have to deal with guide numbers at all, except when you’re shopping for a flash unit and want to know how powerful each one is. But guide numbers are critical for all manual flash work.

The guide number is used in flash calculations to determine the appropriate aperture required to cover a certain distance or vice-versa. Note that technically the guide number describes the distance coverage of a flash, *not* its actual power output as such. Because of the inverse square law of light falloff, a flash unit has to have four times the power output in order to throw light twice as far.

To find the aperture (*f* stop number) required to take a photo of a subject you divide the flash unit’s guide number by the distance to the subject. To find the maximum

distance that can be reasonably illuminated using the current aperture setting you divide the guide number by the *f* stop number. In each case it's the distance from the flash to the subject that's important, *not* the distance from the camera to the subject. These two distances may be the same with on-camera flash, but not with off-camera flash or when using bounce flash.

f-stop number = GN / distance
distance = GN / f-stop number

Canon's guide numbers are measured in metres and are for ISO 100 film. Their Speedlite product names, for example, include the highest guide number of the flash (which is the guide number for the flash when on maximum zoom in the case of zooming flashes) multiplied by 10 - eg: 550EX. Note, however, that Canon USA express guide numbers in feet in their material, so always double-check the measurement system. For example, US advertising material says that the Elan 7's built-in flash has a guide number of 43, which sounds quite remarkable until you realize that that translates to a metric guide number of 13. (the built-in flash units in EOS cameras typically have a guide number of 12 or 13 unless they have a zoom motor)

I refer solely to metric guide numbers in this document. Here are approximate metric conversion values:

1 metre = 3.3 feet
1 foot = 0.3 metres

An important point is that the guide number is rated for ISO 100 film. So if you're using film of a different speed you have to factor that in to your calculations. Once again the math is based on the inverse square law - quadruple the film speed and you double the guide number. Thus the maximum range possible with your flash unit increases when you use faster film. Here's a quick way to do the conversion if you want to avoid thinking about square roots:

Film speed doubles: GN x 1.4
Film speed halves: GN x 0.7

Another thing to remember when comparing flash units is that zooming flash heads affect the advertised guide number. For instance, the 480EG flash contains more powerful flash tubes than the 540EZ, even though the former has a guide number of 48 and the latter a maximum guide number of 54. This is because at 35mm coverage the 540EZ's guide number is only 36. However, the 540EZ's zooming head can concentrate the unit's light output at longer focal lengths, whereas the 480EG's non-zooming head essentially wastes light by illuminating areas not covered by lenses with focal lengths longer than 35mm, except when an optional lens is installed. Such flash extenders, which can concentrate the light to a tighter area and thus throw light even further distances, are available as add-on accessories for other flash units as well.

As noted above, the guide number does not describe the amount of light output as such. Flash unit capacity is also described in terms of light output units such as beam candlepower seconds (BCPS) or effective candlepower seconds (ECPS) or in terms of energy capacity units such as joules or watt-seconds. None of these measuring

systems are commonly used with portable electronic flash units, so I'm not going to cover them here. They also measure different things and are, therefore, not convertible or interchangeable units.

Finally, a fair bit of subjectivity goes into determining the guide number, which is presumably why it's called a "guide." After all, how is an "adequately exposed" subject determined? Guide values are, therefore, not a very reliable way to compare flash units built by different manufacturers. Particularly since manufacturers tend to be wildly and cheerfully optimistic when it comes to assigning guide numbers to their products.

Exposure value (EV).

The sensitivity of camera gear at autofocussing or determining correct exposure metering is rated in terms of EV - exposure value - for a given lens type and film speed.

Since the amount of light hitting the surface of film is determined by exposure time (shutter speed) and lens aperture, exposure values are simply combinations of shutter speeds and apertures. For example, f4 at 1/30 sec has an EV of 9, which is the same EV as f2 at 1/125. Toomas Tamm has a complete EV table on his Web site.

Both speed/aperture combinations let the same amount of light hit the film - the only differences between the two are depth of field and type of motion recorded. Depth of field decreases as the aperture increases and subject motion blur increases as shutter speed decreases.

However, it's only meaningful to compare exposure values when they're rated for the same film speed. Canon rate EV values in their documentation for a standard 50mm f1.4 lens using ISO 100 film.

Dedicated or non-dedicated flash units.

In the olden days of electronic flash, when the flash sensor was self-contained in the flash unit itself, the flash trigger controlled by the camera was the only control the camera had over the flash. The output level and shutoff time were both determined by the flash unit itself since two-way communications between camera and flash unit were not possible. For this reason a lot of generic flashes were sold and basically worked the same way on every manufacturer's camera.

However, by the 1980s camera makers started designing dedicated flash systems which would only work with their own cameras, in order to achieve more precise control over the final results. (and also probably to sell more of their product by discouraging third-party sales) Canon's Speedlite flash units are, therefore, dedicated flash units since they can communicate digitally with EOS cameras. They can work on other cameras in the most basic of ways, but advanced through the lens metering and other features reliant on two-way communication will not work on cameras built by another manufacturer.

Some makers of third party flash units, such as Metz and Sigma, get around the dedicated interface problem by figuring out the camera system-specific protocols and

either building generic units with custom flash adapters designed to work with specific camera makes or else building different flash models for each camera make.

Shoe mount.

Most SLRs today have a squarish slide-in socket on the top of the prism or mirror housing which accommodates external flash units. These are called hotshoe mounts - “hot” because they contain a flash-triggering electrical contact. (though it should be noted that no modern camera lacks this contact, so this term exists now for historical reasons) Despite the dramatic name the contacts do not carry any significant electrical current when a flash unit is not installed, so there’s no risk of electrocution from a hotshoe.

EOS cameras have shoe mounts containing 4 additional small contacts in addition to the large central flash-triggering contact. These small contacts carry digital signal data, proprietary to the Canon EOS system, to the flash. They aren’t compatible with flashes made by Nikon, Pentax, Minolta, etc.

Another Canon feature is the presence of a small hotshoe locking pin on most EOS flashes. This pin extends out when the tightening wheel is rotated, fitting into a small hole on most EOS bodies and preventing the flash from sliding accidentally out from the shoe. The pin is spring-loaded so the flash will still fit in hotshoes which lack the locking pin hole.

Note that the plastic shoe of external flash units isn’t quite as sturdy as it should be. It’s a bad idea to pick up a camera and flash by the flash unit. Pick up the camera body to be on the safe side.

The redeye effect.

Redeye, the common bane of snapshots, occurs when the light from the flash unit bounces off the blood vessels lining the retina of a person’s eye and makes it back to the camera. The result is the familiar evil satanic glowing red eye effect that shows up disconcertingly often with point and shoot cameras. It happens a lot in restaurant and living room photos because the low ambient light levels mean that the subject’s pupils tend to be dilated fairly wide to let in more light. The problem doesn’t occur in daylight partly because the pupil of the eye contracts and reflects less light and partly because the relative brightness of flash illumination to ambient light is much lower during the day.

The problem of redeye is intensified the further you are from your subject and so becomes very apparent when shooting portraits using telephoto lenses. The greater the distance from the subject the further you have to lift the flash away from the lens to eliminate redeye. This is because it’s an issue of how narrow the angle between the subject-flash and subject-lens distances is. The smaller this angle - whether because you’re a long way away from the subject or because the flash is too close to the lens or both - the greater the chance of redeye. Built-in flash units, located very near to the lens, are thus extremely likely to cause redeye.

Interestingly enough, flash photography of cats and dogs can involve a similar, but slightly different, problem. Cats and dogs have a reflective membrane in their eyes

called the tapetum lucidum, which helps their night vision. The tapetum reflects light from a flash unit very efficiently, and tends to colour it green, yellow or blue. The membrane also explains why the eyes of animals like cats or deer by the side of the road at night are clearly visible as brilliant points of light. Humans lack this layer and so we don't have tapetal reflections.

Redeye reduction.

There are a number of ways of dealing with redeye. The first, and generally most effective, way is to move the flash as far away as possible from the lens or point the flash head away from the subject (ie: bounce the light). As noted above, the closer the flash source is to the lens axis the worse redeye is going to be. So if you detach the flash unit from the camera and lift it up in the air a short distance you're likely to reduce redeye considerably. This is one reason why wedding and news photographers tend to mount their flash units on external metal brackets attached to the camera itself - flash brackets. And bounce flash eliminates redeye by definition.

One drawback with moving the flash, aside from the inconvenience of moving the flash unit, involves low-light photography. When light levels are low the pupil of the eye will dilate to let in more light, just like a lens diaphragm. If you take a photo of a person with flash their irises don't have enough time to react to the burst of light, so their pupils will remain dilated. The result is a photo of someone with huge pupils, as if they were on drugs.

Another way of reducing redeye (and also minimizing the huge pupil problem) is to have the subject look at a bright light shortly before taking the flash photo. This usually sort of works because the person's pupils will contract in response to the bright light, reducing the amount of light reflected back from the retina to the camera. For this reason many EOS cameras have bright white lamps built into them which the photographer can illuminate at will.

On some EOS cameras, such as the Elan/100 or Elan II/50/55, the redeye reduction lamp is mounted in the built-in flash housing and cannot work with external flash units. On other cameras, such as the D30, the redeye reduction lamp is mounted lower on the body and also works with external flashes. On other bodies the redeye reduction lamp won't work with external flash units even though it's body mounted. However, redeye reduction lamps aren't so useful with external flash units anyway, as they tend to be raised fairly high off the lens axis and are often used in a bounce mode which spreads light across a wide area. And if the subject is some distance away the redeye lamp won't be of much use. It's for this reason that no Speedlite external flash unit has any form of redeye reduction lighting system - it's really just a feature for point and shoots and built-in flash.

The downside to redeye reduction lights is quite severe - people tend to look stunned and glazed after staring at an intensely bright light for a few seconds. Stunned and glazed or evil and satanic - with onboard flash photography, the choice is yours!

You can also colour over the redeye with a black pen on the final prints or scan the image into a computer and use an image editing program to correct the redeye, but obviously these are rather clumsy ways to solve the problem.

The first curtain sync problem.

As noted in the section on X-sync, Canon EOS cameras (and basically all SLRs) have two moving “curtains” in the shutter mechanism. The first curtain opens the shutter and the second curtain closes it.

Let’s say you take a flash photo of a static object combined with a long shutter speed. Normally the shutter opens, the flash fires, time passes and then the shutter closes. Now let’s say you’re taking a photo of a moving object. The object is illuminated enough to leave light trails recorded on the film as the object moves along. But if you fire the flash immediately *after* the shutter opens then you’ve got a bit of a problem, since the light trails will appear to be moving in front of the flash-illuminated object. The object will actually sort of look like it’s moving backwards.

Second-curtain sync.

To solve the first-curtain sync problem mentioned above, and to get the light trails looking like they’re following behind the moving object as they should, you need to fire the flash right *before* the shutter closes. This is called second curtain or rear curtain sync flash since the flash is fired about 1.5 milliseconds before the second curtain of the shutter starts to close. The result is a photo which expresses motion nicely - it will show light trails *following* the moving object. The Canon T90/Speedlite 300TL was apparently the first camera/flash combination to support this feature.

The drawback to second curtain sync is that it can make it harder to take a photo if you’ve got a really long shutter period. With first curtain sync you can see the moving object in the viewfinder and can thus trigger the shutter at the exact moment. But with second curtain sync you a) can’t see the moving object when the shutter is open, because with SLRs the mirror flips up out of the way and b) you have to predict accurately whether or not the object will still be in the frame at the end of the exposure period. For these two reasons EOS cameras ship with first curtain sync as the default.

There’s one minor issue to be aware of if you use E-TTL flash with second-curtain sync. The E-TTL preflash occurs prior to the shutter opening, and so the flash will visibly fire twice when you’re using long shutter speeds and second-curtain. (the preflash always fires before the shutter opening - it’s just that with a long shutter speed and second curtain sync, the time delay between the two flashes is increased and thus more noticeable)

This delay between preflash and subject-illuminating flash usually doesn’t have any negative side-effects, but there are two cases in which it might be a problem. First, if the subject is moving then the preflash metering obviously won’t be right for the final exposure - FEL may be required. And second, the preflash might confuse human subjects if they’re expecting just one flash. They might assume you’ve taken the photo and walk off or look away from the camera.

See the section on how to enable second-curtain sync, if it’s available on your particular camera and flash combination.

Colour temperature theory.

(nb: this section gets pretty detailed, but it's a useful basis for understanding colour shifts in photography)

The human eye (or, more accurately, the brain) is extremely adaptable. If you look at a sheet of white paper in a room lit only by an overhead incandescent tungsten lamp, the paper will look white. If you carry the same sheet of paper outdoors and look at it in sunlight it'll still look white. But tungsten light and sunlight produce very different types of light - tungsten light is orange in tone whereas sunlight is quite blue.

This is because they are light sources of different colour temperatures - so called because they represent the colour of light produced by a theoretical "black body" object that's heated to a certain temperature, measured in degrees Kelvin. (Kelvin is similar to the Celsius scale but uses absolute zero, -273°C, as the starting point rather than the freezing temperature of water) Note that some of the terminology is a bit confusing here. In colloquial English we say that reddish light is "warmer" than bluish light. But in terms of the colour temperature model, light becomes more blue as the colour temperature *increases*. Note also that we're talking about a photographic colour temperature model, which by dealing just with red and blue light is a huge simplification of the colour temperature model used by physicists.

Regular incandescent tungsten light has a theoretical colour temperature of about 3200 degrees Kelvin, though household bulbs are often a bit lower at about 2900°K. (they go down in colour temperature as they age or when supplied with lower voltages, such as from a dimmer circuit) Tungsten halogen bulbs (usually just called "halogens" even though they have tungsten filaments just like regular incandescent bulbs) and non daylight-corrected photoflood bulbs are usually slightly higher, sometimes reaching 3400°K. The light from a candle flame is quite low in temperature, hovering at around 1400-2000°K.

Daylight has a colour temperature of between 5000°K and 6000°K; often given as 5500°K for the midday sun. Naturally these values can vary. Just as regular light bulbs drop in colour temperature, as noted above, the colour of daylight varies at different times of the day and because of different weather conditions. In fact, natural light can vary from around 2000°K at sunset to over 20 000°K in blue evening shade. Skylight, or the sun's light scattered by the atmosphere, is extremely blue in colour.

Normally the human brain compensates for these differences in colour temperature automatically. One of the few times they become really noticeable is when you encounter both types of light at, for example, dusk. If you're outside looking at the windows of a building you'll see that the tungsten light of a household lamp looks quite orange-yellow in tone and the sky and your surroundings look quite blue.

Colour temperature and film.

Colour temperature isn't a purely theoretical issue. It's a real problem for colour photography, because film records light as it sees it, does not offer interpretation and cannot automatically adapt. So film has to be formulated from the start to assume a certain colour temperature is white.

This is what is meant by “daylight” film and “tungsten” film - they’re film types designed to assume that daylight and regular tungsten light bulbs are white, respectively. You’ll get weird colour shifts if you shoot with the wrong type of film. A tungsten-lit room shot on daylight film will look quite orange and a daylight-lit room shot on tungsten film will look quite blue. So it’s important to use film which matches your lighting conditions. It’s not normally essential to be absolutely precise about this, but pros who need exact colour will buy expensive colour meters to determine the exact type of colour in a given scene.

Colour casts also occur from lighting types other than incandescent tungsten bulbs. Other forms of artificial light yield strange colour casts on daylight film as well. Most fluorescent lamps tend to result in a somewhat greenish tinge unless a special magenta filter is put over the lens, though there are significant colour differences between manufacturers. (indeed there are now daylight-balanced fluorescent bulbs which avoid this problem) High pressure mercury and sodium lamps used for industrial lighting result in somewhat unpredictable colour casts depending on the formulation of the bulbs being used. Note that the term “colour temperature” does not technically apply to fluorescent and high-pressure lamps. However, approximate equivalent colour temperature numbers are often supplied by manufacturers as a convenience. Finally, daytime colour temperature varies throughout the day and depending on weather conditions. A snowy evening can be very blue and a dusty sunset very orange.

Colour temperature issues are one area in which digital photography has a significant advantage over chemical-based photography. Most good digital cameras let you set the white balance - the assumed white point - of your subject at will. The EOS 1D, D30, D60 and 1Ds cameras all let you use auto white balance settings or preset settings for common lighting situations. This sort of adjustment isn’t possible with film-based photography since the colour temperature balance (white balance information) is permanently built into the film emulsion chemistry at time of manufacture and cannot be altered afterwards. All you can really do with film is to put filters in front of the lens to cut out certain wavelengths of light or perform various filtration tricks in the darkroom when printing - or scan the pictures and alter them in a computer.

Colour temperature and flash photography.

Since most photography is done with the sun as a light source, most film is balanced for daylight. Until recently, in fact, tungsten-balanced film was only widely available as slide/transparency film (as two types - the rare tungsten A and the more common B, which have slightly different colour temperatures - 3400°K and 3200°K respectively). And for that reason flash units also have bulbs designed to produce light approximating midday sunlight in temperature. However, since sunlight is more blue than tungsten, light from a camera flash will look quite blue compared to the orange-yellow light of indoor tungsten light.

This difference in colour temperature is particularly noticeable with slow shutter sync photography. If you take a photo indoors using slow shutter sync with flash and daylight-balanced film, you’ll get a normally coloured subject with strange orange-yellow fringing. This results from the subject being illuminated brightly by the daylight-balanced flash and then any motion blur from the slow shutter being illuminated dimly by tungsten light.

You can also exploit these differences in colour temperature to achieve certain effects. For example, shooting with flash and tungsten-balanced film can yield blue-tinged results. Or you could take a photo of someone outdoors with tungsten film and an orange tungsten-light compensation filter on the flash head. The result would be a normal coloured person with a cold, bluish background.

Colour filters.

There are specific filters you can use to perform this type of colour temperature conversion when you take a photo; the type of filter depending on the kind of effect you want to achieve. You might want to balance the light of a flash unit to match ambient lighting, for example. Or you might want deliberately to make the two types of lighting very different in colour for creative effect.

You can put the filters in different places. For instance, if you want to affect the look of the entire scene you could put a filter over the lens. To affect the output of a specific lamp you could buy a gel filter and put it over the lamp only. Or you could tape a filter or coloured diffuser over your flash unit's head to affect just the light it produces.

A great way to alter the light colour from a flash unit on the cheap is to go to a theatrical lighting store and ask for a Lee or Rosco gel swatch booklet. This is a little bound collection of gel filter samples - each coincidentally just large enough to cover the lens of a typical flash unit. The booklet lists the exact properties of each gel, and quite often you can get one for free.

This sort of colour temperature conversion can go in either of two ways, of course. If we want to go from yellow-orange light (tungsten) to blue light (daylight) we want a *cooling* filter. To go the other way we want a *warming* filter. As noted earlier these are somewhat confusingly named since cooling involves an increase in colour temperature and vice-versa, but the names reflect ordinary casual usage of the words and not colour temperature theory. Naturally, cooling filters are blue and warming filters orange-amber (light orange-yellow filters are sometimes called "straw").

Limitations of filters.

One important thing to remember about filters is that they cannot shift colours over along the spectrum, as it were. All a filter does is simply prevent certain wavelengths of light passing through - hence the name. So by definition colour-correction filters always cut the amount of light entering the lens.

Filters can change the colour of white light since white light consists of colours from across the spectrum, as Newton discovered with his famous prism experiments. But if you're taking a photo of a scene illuminated by, let's say, pure red light you can't simply slap a filter on the lens to make everything a different colour. Filters can't add light of any wavelengths or convert incoming light to a different wavelength.

Taking photos of scenes illuminated by yellow-orange sodium and mercury vapour streetlights is a real problem for this reason. Such lamps produce light of very

narrow spectral bands. You can't alter this light much by putting a filter on your lens, since filtering out the yellow light doesn't leave much else.

This problem of filtration limits your colour-correction choices considerably when dealing with chemical-based photography. There are ways of doing colour alteration in the darkroom, but they're expensive and cumbersome. So again, moving your images into the digital realm has real advantages. Once your photo is inside a computer you can alter the colours as much as you like.

Mireds.

Colour temperature of light is usually measured in degrees Kelvin. But another unit you often see in photography is the mired, for "micro reciprocal degrees," and pronounced "my-red." To obtain the mired value for a colour temperature simply divide 1 million by the colour temperature. So, for instance, 5500°K is the same as 182 mired, since 1 000 000 / 5500 = 182.

Mireds are commonly used for converting light from one colour temperature to another using a colour conversion filter. For example, let's say we want to take a photo using electronic flash but we have tungsten film in our camera. So we need to tape a coloured gel over the flash head. The question is, what kind?

Let's assume the light from the flash unit is 5500°K and the tungsten film wants 3200°K light. These are 182 mired and 312 mired respectively, so the difference we want to make up is about +130 mired, our mired shift value. (a positive number is a warming filter; a negative number a cooling)

Now we consult a gel filter catalogue or swatch book (as noted above, available from theatrical lighting shops) and see what the closest filter to a +130 mired shift is. If we went with Rosco we could buy a "Roscosun CTO" gel that performs a +167 mired shift. Or if we went with Lee Filters we could go with a "Full C.T. Orange" gel to get +159. Neither gel is precisely the same as our calculation, but they're close enough for print film, where you can always do some adjustment in the lab. And when using slide film you might want to overcompensate on the side of warm like this anyway, unless you're deliberately looking for a cool blue look. But this is all assuming the flash unit actually has a colour temperature of 5500°K - it's probably slightly higher.

Of course, lots of filter companies simply specify the colour temperature conversion range so you can avoid the whole conversion to mireds altogether if you're just doing a simple tungsten to daylight conversion, say. But the mired model is useful for more complex colour conversion tasks where multiple filters are involved.

Wratten numbers.

Many filter companies follow the Wratten series of numbers to describe their colour conversion products. Frederick Wratten was a British inventor who developed a fairly arbitrarily-numbered series of colour filters a century ago. His company was bought by Kodak in 1912, though Wratten-branded filters are now sold by Tiffen.

80 series: blue-coloured cooling filters. For daylight film with tungsten light sources.

Wratten number	Colour temperature increase	Typical light source to be converted	Approximate mired shift
80A	3200-5500°K	Tungsten	-131
80B	3400-5500°K	Non-blue photofloods	-112
80C	3800-5500°K	Old flash bulbs	-81
80D	4100-5500°K		-56

85 series: yellow/amber-coloured warming filters. For tungsten film with daylight.

Wratten number	Colour temperature decrease	Typical use	Approximate mired shift
85	5500-3400°K	Converting type A tungsten film	+112
85B	5500-3200°K	Converting type B tungsten film	+131
85C	5500-3800°K		

These filters are fairly dark and cost 1 stop (80 series) to 2/3 stop (85 series) of light.

There are also more subtle and commonly used filters for cooling and warming, such as the 81 warming filters and 82 cooling filters. These filters aren't used for colour conversion but for less extreme applications - minimizing unwanted colour casts. For example, an 81B is useful for reducing the blue cast of daylight film shot in the shade.

German manufacturers use their own system in which KB is a cooling (blue) filter and KR is a warming (orange) filter.

Trigger circuit voltage.

Old flash units - both studio and hotshoe-mount - used pretty high voltages between the camera and the flash - often from 25 to 250 volts. This is because the flash units were fired by simple switches - electrical contacts.

Modern cameras, however, rely on electronic circuitry rather than electric switches. This allows for more flexibility and the possibility for computerization, but the circuits can't withstand high trigger circuit voltages (anything above 6 volts, in the case of EOS cameras, according to Canon) and can be damaged by units with high trigger voltages.

Note that this 6 volt limit does not necessarily apply to PC sockets. Canon states that its 1D digital camera, for example, is capable of withstanding trigger voltages of up to 250 volts when firing flash units with its PC socket. The 6 volt limit applies to the camera hotshoe only. Unfortunately Canon doesn't always state what trigger voltage the PC sockets on all of its PC-socket-equipped cameras can withstand, so if this information is not supplied in the manual you should probably contact Canon.

Anyway. If you intend to connect an old flash to your EOS camera's hotshoe be absolutely sure that its trigger voltage does not exceed 6 volts. You can measure this with a voltmeter. Various accessories, such as the Wein Safe-Sync HS hotshoe unit, can be used to protect the camera from these high voltages if you want to use such a flash. Even safer are optical triggers, since there are no physical connections between the camera and flash unit at all.

Note that the damage to the camera can be subtle and cumulative - simply hooking up the flash and seeing if it works is no guarantee that the high voltage isn't slowly damaging your camera's flash circuit - arcing and pitting connectors and breaking down internal components. (of course, Canon is probably being a bit conservative with its 6 volt limit, so you might not be taking a huge risk if the voltage of your flash unit is a tiny bit over) Note also that the power supply used by the flash is irrelevant - it has no bearing on the trigger voltage. Many Canon Speedlite flash units, for example, can use high voltage battery packs but they still have low trigger voltages. And portable battery-powered flash units may require 6 volts in battery power but nonetheless may step up the trigger voltage considerably.

An additional problem is that some older flash units have reversed polarity. EOS cameras all have a negative ground and a positive centre pin on the hotshoe itself, though some pro models have polarity-detecting PC connectors that can work with either type of flash unit.

Finally, some flash units have all-metal hotshoes. This can be a problem if they inadvertently short out any of the four small data contacts on EOS cameras. If you have such a camera you could cover up the contacts with electrical tape or use a PC cord adapter so the flash unit doesn't plug directly into the camera's hotshoe mount at all. The same applies if your flash unit has a really large central contact. EOS cameras have fairly small hotshoe central contacts with four tiny data contacts below it. If your flash unit's hotshoe contact is so large that it shorts out any of the data contacts you may damage your camera.

The old Canon EOS FAQ also has a great deal of information on the subject of trigger voltages, and Kevin Bjorke maintains a comprehensive table of trigger voltages for various flash units.

Slave flashes.

Slave flashes are simply self-contained flash units which respond to external triggers of some kind. They're frequently used in studio situations. For example, you might have a multiple-flash setup - one flash to illuminate the subject and another unit or two to illuminate the background separately.

Many slave flashes are triggered by light: optical slaves. They have small sensors built in or attached that detect the light pulse from another flash unit and then

trigger immediately themselves. Since they respond so rapidly, the time delay between the trigger flash and the slave flashes going off does not affect the exposure of the photo. The Wein Peanut, a tiny and inexpensive accessory, is a popular optical trigger that's basically compatible with most flash units out there. (though ironically not entirely compatible with a lot of Canon Speedlites - see further down in this section for details)

Since the sensors watch for flash bursts, you use one flash unit as the triggering flash - typically the built-in flash unit on your camera or an external unit connected to the camera's hotshoe or PC connector. The triggering flash can be set to a low power output so that it doesn't affect the scene if you want - optical slaves are usually sensitive enough. The slaves are also usually sensitive to infrared energy, so another popular trick is to tape an infrared filter gel over the internal flash unit. This lets you trigger the flash units with a burst of energy that's invisible to the human eye and to most types of film.

Canon E-TTL flash metering poses a problem for optical slave setups, since standard analogue optical slaves are likely to be triggered by the flash unit's metering preflash rather than the actual flash. And since the slave flash requires time to recharge it may not have enough power to fire in response to the actual flash. The usual solution to this is to switch over to regular TTL flash in lieu of E-TTL. There are two problems to this approach, however. For more details have a look at the section on disabling E-TTL mode. The other option is to use FEL to trigger the slaves once, then wait for them to recharge and then take the photo. (or use FEL to trigger the slaves, immediately use FEL again, before the studio units recharge, to set the correct flash exposure lock and *then* take the photo) This can be rather inconvenient, however.

Standard optical slaves are also a problem outside the controlled environment of the studio. They're a real nuisance in wedding photography when, for instance, Uncle Charlie's point and shoot camera flash triggers your optical slaves. Situations like that call for expensive radio-controlled wireless systems or, if battery-powered slaves have enough power output for your needs, Canon's E-TTL wireless system. An alternative is the new generation of optical slaves, such as the Wein Digital Smart Slave products, which are capable of distinguishing between a preflash and a genuine scene-illuminating flash and only respond to the latter.

A significant problem with multiple slave flash photography (at least, one which doesn't rely on automated metering like Canon's wireless E-TTL) is that it's difficult to preview or visualize the final result without a lot of testing and experience. Usually each flash unit has to have its output set manually. In fact, unless you're replicating a predetermined lighting formula that works for you or you're configuring a fairly simple one or two flash setup with a light meter, I'd say that it's pretty well a requirement that you have a Polaroid back for your film camera or a digital camera to do this sort of thing well. Digital is particularly beneficial here since you can take dozens of test photos at no cost and determine exactly how the various flash units are illuminating your scene, where the shadows fall, etc.

However, using cheap optical slave flash units can be an affordable way to set up your own studio. Buy a few old battery-powered Vivitar 283s or second-hand studio units, slap some cheap optical triggers onto them and you're in business.

Canon do not build any flash units specifically intended for use as studio equipment. However, you can buy hotshoe adapters - optical or wired - to turn any flash you want into a slave, and the 480EG can be slaved via the optional Synchro Cord 480. Hotshoe adapters aren't always reliable with every camera and flash unit combination, so it's worthwhile doing some testing first. In particular, a lot of people have reported problems with small optical slaves not being able to trigger Canon Speedlite flash units more than once without the flash being turned off and turned on again between each shot. The Ikelite Lite-Link is one device designed to work with Canon flash units that apparently does not have this problem. It also has a sort of simulated TTL feature - it can cut the light from the slave flash as soon as the master flash has quenched its light, rather than simply firing at full power.

Finally, Canon state in their literature that a sync speed of perhaps 1/60 or 1/125 is required for studio flash. There are two reasons why they suggest speeds this low, even if the camera's capable of higher flash sync with TTL-metering portable Speedlite flash units. First, many older studio units take quite a while to attain full brightness or have slight colour shifts depending on the flash duration. And second, the triggering delay (the time that elapses between the camera triggering the flash and the flash unit actually firing) with slaved studio flash units is often longer than the very brief and known triggering time with TTL flash units.

For these reasons you're probably best off doing a series of tests with a new slaved flash unit setup at different shutter speeds to determine what the top shutter speed for your configuration is going to be. Particularly with optical and radio slave units or older flash units.

Note that Canon do sell a number of flash units that can serve as slave units in a wireless E-TTL setup - see the section on wireless E-TTL for details.

Flash meters.

Regular light meters cannot measure the split-second burst of light from a flash unit. For that you need a specialized flash meter, though of course many devices can meter for both ambient and flash light.

These are useful in studio situations, when you're using flash units that don't have any TTL or E-TTL capabilities. You might, for example, have a large studio flash unit bouncing light onto the subject by means of a flash umbrella. You could use the handheld flash meter to determine accurately the correct flash output settings to expose the subject properly.

Since this article deals primarily with automated through-the-lens metered flash I don't deal with flash meters. There are many other online resources and books to help you learn more about flash metering, however.

Flash sync trivia.

I haven't been able to find out why shutter sync with electronic flash is referred to as "X" sync. Some random reason lost in the mists of time, no doubt. Really old cameras also had M-sync connectors, which were designed for non-electronic single-

use flash bulbs (the kind of bulbs which contain a metal filament or piece of metal wool which burns out).

Unlike electronic flash, which achieves maximum brightness almost instantaneously, old electric flash bulbs required a longer period of time to reach maximum brightness. So with “M-sync” the shutter opening was delayed by 20 ms or so after the bulb was fired, to provide adequate time for the light output to build. No EOS camera has M-sync capabilities, since hardly anybody uses electric flash bulbs these days. Apparently the M stood for “medium” speed flash bulbs.

On to Part III.

Back to Part I.

- NK Guy, tela design.

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Back to Photo notes.

Flash Photography with Canon EOS Cameras - Part III.

Version 1.6. February 11, 2004.

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

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Common EOS flash features.

Here are some features found on various Canon EOS Speedlite flash units. Note that not every flash has every feature, and some features only work in conjunction with certain camera bodies.

Bounce flash - swivel and tilt.

Many of Canon's external flash units have the ability either to tilt or both tilt and swivel the flash head independently of the flash body. The 430EZ, for example, lets you tilt the head from 0° (straight on) to 90°. Left swivel goes from 0° to 180° - facing backwards! Right swivel only goes from 0° to 90°. There are click stops at various detent positions, and a spring-loaded bounce latch keeps the flash head pointed head-on.

Tilt and swivel let you bounce (reflect) the flash unit's light off walls, ceilings, reflectors, etc, in order to soften the light. Non-bounced flash light tends to be fairly harsh, since it originates from a relatively small area. This harsh light tends to result in unflattering photos of people, for reasons outlined in the quality of light section.

Bounce flash softens light nicely, but does have some disadvantages. For one, you obviously can't bounce flash outdoors unless you carry a reflector or something with you - it's most immediately useful in interior spaces. Some interiors, in fact, aren't much good either if they have really dark surfaces or high ceilings. Another drawback is that coloured surfaces (such as painted ceilings or walls) can end up tinting the light from the flash, resulting in unwanted colour shifts. Relying on ceiling bounce flash can sometimes result in unattractive shadows appearing under the eyes and nose - some photographers elastic-band an index card around the back of vertically-pointing flash heads in order to bounce a little bit of light forward to minimize this problem. And finally, bouncing the light obviously reduces the amount of light hitting the subject and this costs about half your range. For this reason you may want to use faster film or larger lens apertures when using bounce flash.

Low-end flash units which lack tilt and swivel heads can also be used for bounce flash - you simply attach an Off-Camera Shoe Cord 2 and then you can point the flash unit in any direction you like. Note, however, that this technique doesn't work well with flash units that rely on external sensors such as A-TTL devices since the

sensors will be recording the light bouncing back from the reflective surface and not the subject.

You probably won't want to use bounce flash in manual flash mode. You can do it, but you have to perform the flash calculations manually, as described in the section on manual flash.

Flash units which neither tilt nor swivel:
Speedlites 160E, 200E, 220EX, 300EZ, ML-3, MR-14EX, MT-24EX*.

Flash unit which tilt only:
Speedlite 380EX.

Flash units which both tilt and swivel:
Speedlites 300TL, 420EZ, 430EZ, 540EZ, 420EX, 550EX, 480EG.

Flash units with an additional downward tilt for macro shots:
Speedlites 540EZ, 550EX.

* The MT-24EX macro flash unit has independently movable swivelling arms with detachable heads. So it's not fixed, but it doesn't tilt or swivel in the way that shoe-mount Speedlites do. As a macro flash it's not meant for illuminating rooms with bounced light, though it can be used for lighting small spaces.

Zooming flash heads.

Canon's mid to high-end external flash units contain small motors which move the flash bulb closer to or further away from the clear plastic screen at the front. This allows the flash to alter the coverage area of the light emitted from the unit - the closer the bulb is to the screen, the wider the coverage angle and vice versa. It also means that the flash's light output can be concentrated for greater distances and used more efficiently. (ie: you aren't wasting light by illuminating areas not covered by longer focal-length lenses)

Typically the zooming motor covers the range used by 24 to 80mm lenses or 24 to 105mm, and does so in several fixed steps matching popular prime lens focal lengths, such as 24-28-35-50-70-80mm. (continuous zooming control to arbitrary focal lengths is not supported) Remember that a flash unit's upper zoom limit doesn't *prevent* you from using the flash with longer lenses. All it means is that the zoom can't concentrate its light beyond a certain point for more efficient coverage of a narrower area. At least, not without a flash extender accessory. The reverse is not true for the wider end, however. If you use, for example, a flash unit with 24mm coverage at the wide end with a 17mm lens you'll get a kind of vignetting effect (darkening of the edges) since the flash will not be able to illuminate the entire coverage area of the wide angle lens.

Some zooming flashes have manual controls that allow you to override the automatic zoom setting by pressing a button. Others are only automatic - they zoom to a setting near to the current lens focal length when you press the shutter halfway. Canon flash units usually default to a 50mm zoom setting when in bounce mode and to 35mm when no EF-compatible lens is attached.

For some strange reason camera bodies with image areas less than that of 35mm film (APS cameras and most EOS digital cameras) do not compensate for the cropping factor of their image areas. So you are, in effect, wasting light when taking a photo using such a camera body and a zooming flash unit, since areas outside the edges of the picture will be illuminated. This isn't a huge issue, but it does seem a bit odd that no compensation was built in. Perhaps Canon were concerned that this could lead to confusion, since turning a zoom lens on such a body would result in the flash head zooming to a different focal length on its LCD screen.

Remember that the flash head will zoom to the nearest zoom setting that is *less or equal to* that of the focal length of your attached lens. So if you have a 100mm lens attached, say, and the flash unit can zoom to either 80mm or 105mm, then it will automatically go to 80mm only. It will not narrow the light cone down any further by zooming to 105mm, as you would risk getting darkening around the edges of the picture if it did.

Wireless-capable units with zooming heads (420EX and 550EX) will zoom to 24mm when in wireless slave mode. The 420EX has no manual zoom controls and so always shoots at 24mm. However, the 550EX's manual zoom controls are very useful in wireless mode since they let you set up your slave units around the scene, override the default zoom setting and adjust the coverage angles for each unit independently. They aren't so commonly used outside a wireless context but they allow you, for example, to create a sort of spotlight/vignetting effect by narrowing the flash coverage down to a tighter circle than that required by the focal length of the lens. (an intentional use of the problem outlined above) You can also use manual controls to adjust the zoom setting so that you can work with manual lenses which don't transmit focal length information to the camera.

All Canon flash units which have names ending in Z, such as the 540EZ, contain zooming flash motors. However, some later E-TTL flashes such as the 420EX and 550EX also have zooming heads, so Z Speedlites aren't the only ones with the feature.

Two EOS cameras, the Elan/100 and the A2/5, have three-position zoom motors built into their internal flash units. It's this zoom capability that explains why the Elan/100's built-in flash has a maximum guide number of 17 at 80mm. When the flash isn't zoomed out it has a guide number of 12; typical for a camera's built-in flash. Canon have not carried this feature through to any later bodies, however. Presumably the expense and bulk of the zooming mechanism were deemed to outweigh the benefit of improved guide numbers.

The primary disadvantages of a zooming flash unit are that the zoom motor makes a loud buzzing noise when adjusting coverage angles and that the flash head has to be larger to accommodate the motor.

Flash units with motorized zooming heads:
300EZ, 420EZ, 430EZ, 540EZ, 380EX, 420EX, 550EX.

Flash head coverage:

Flash units.

Flash unit with 28mm fixed coverage (no zoom motor):
Speedlite 220EX.

Flash units with 35mm fixed coverage (no zoom motor):
Speedlites 160E, 200E*, 480EG**.

Macro flash units (no zoom motor):
Speedlites ML-3, MR-14EX, MT-24EX.

Flash unit with hand-operated four-position 24-85mm (24-35-50-85mm) zoom head (no zoom motor):
Speedlite 300TL.

Flash unit with automatic-only four-position 28-70mm (28-35-50-70mm) zoom coverage:
Speedlite 300EZ.

Flash units with automatic six-position 24-80mm (24-28-35-50-70-80mm) zoom coverage with manual override:
Speedlites 420EZ, 430EZ.

Flash units with automatic-only six-position 24-105mm (24-28-35-50-70-105mm) zoom coverage; no manual override:
Speedlites 380EX, 420EX.

Flash units with automatic seven-position 24-105mm (24-28-35-50-70-80-105mm) zoom coverage with manual override:
Speedlites 540EZ, 550EX.

* The 200E can be augmented by an optional accessory clip-on adapter (Wide Adapter 200E) which extends its 35mm flash coverage to 28mm.

** The 480EG ships with two accessory clip-on lenses which can be used to alter its default 35mm coverage. The Wide Panel 480EG-20 takes you to 20mm and the Tele Panel 480EG-135 takes you to 135mm.

Cameras.

Cameras with fixed 35mm internal flash coverage, GN 12:
EOS 750 (first EOS camera to sport a built-in flash), 700, 10/10s, Rebel S/1000F, EOS 5000/888.

Cameras with fixed 35mm internal flash coverage, GN 14:
EOS Rebel II S/1000FN*.

Cameras with fixed 28mm internal flash coverage, GN 12:
Rebel X/EOS 500/Kiss, Rebel 2000/EOS 300/Kiss III, EOS Kiss III L, EOS 300V/Rebel Ti/Kiss 5 (high profile), Rebel G/EOS 500N/New Kiss, EOS 3000/88, 3000N/66.

Cameras with fixed 28mm internal flash coverage, GN 13:
EOS Elan II(E)/50/55, Elan 7(E)/30/33, Elan 7N(EN)/30V/7S.

Cameras with automatic-only three-position 28-80mm (28-50-80mm) internal flash zoom coverage, GN 12 or 13 to 17:
EOS Elan/100 (GN 12-17), A2(E)/5 (GN 13-17).

Cameras with fixed 22mm** internal flash coverage, GN 11 or GN 10:
EOS IX/IX E (GN 11), IX Lite/50/7 (GN 10).

Cameras with fixed 18mm** internal flash coverage, GN 12:
EOS D30, D60.

Camera with fixed 18mm** internal flash coverage, GN 13:
EOS 10D.

Camera with fixed 18mm** internal flash coverage, GN 13, high profile:
300D/Digital Rebel/Kiss Digital.

Cameras with no internal flash:
EOS 650, 620, 850, 600/630, 1, RT, Rebel/1000, Rebel II/1000N, Rebel X, 1N, 1NRS, 3, 1V, 1D, 1Ds, 1D mark II.

* Seems odd that this particular low-end camera should have a higher guide number than all other EOS cameras with built-in flash, but that's what the Canon camera museum claims.

** Note that these coverage areas are related to the dimensions of the image area - APS film for the IX cameras and the sensor chip for the D30, D60 and 10D digital cameras. All have smaller image areas than 35mm film. The digital cameras would have a 28mm coverage area if they were 35mm cameras, for example.

AF assist light.

It's very hard for cameras based on passive autofocus mechanisms (this includes all EOS cameras except the manual-focus EF-M) to focus when it's dark, since they rely on contrast between light and dark areas. For this reason many EOS cameras have a built-in light that automatically illuminates in low light situations to help the autofocus system to work. On some cameras this is a relatively discreet patterned red light from a bright red LED (light emitting diode), on some it's an irritating bright white incandescent light and on others it's an even more irritating pulse of the built-in flash. (for a list of these cameras please see the next section)

All of Canon's Speedlite flash units for EOS cameras have patterned red AF assist lights - sometimes called AF auxiliary lights in older Canon manuals - built in. These are clear red panels on the front which use one or two high-brightness LEDs to project red circles of light striped with dark lines, in order to give the camera a high-contrast pattern to focus on. Red is chosen in part because high-output red LEDs are readily available, but also because red light does not cause the pupils of the eye to dilate as much as does white light. The red light is sometimes described as being "near infrared," though it is in fact visible.

An important thing to remember is that the AF assist light works only if your camera is in One-shot mode - it *will not illuminate* in AI Servo or in any icon AE mode which

employs AI Servo, such as the Sports mode. This is because the camera is constantly focussing and refocussing when in AI Servo mode, in order to track subject motion.

Also, if you have a camera body with multiple focussing points and your flash unit's AF assist light isn't lighting up in low light it's probably because the AF light on the flash you happen to be using cannot cover your currently selected (ie: non-centre) focussing point. Many flash units have AF assist lights which can only illuminate the area around the central point. Switch to the central focussing point and the flash unit's AF assist light should start working. Two exceptions are noted in the next section - the A2(E)/5 and the 10/10s.

As for the coverage area of these AF lights and multiple focus points, the coverage varies but depends in part on when the flash was introduced. For example, the 430EZ flash was introduced when Canon's cameras all had one focussing point only, and so the 430EZ's AF assist light cannot cover all the focussing points built into, say, the Elan 7/EOS 30. The 420EX, however, has an AF assist light which covers all 7 points used by the newer camera. There is a full list below.

The maximum range of the AF assist light varies from unit to unit, but is typically a distance of around 5-10 metres from flash unit to subject. Flash units which cover more than one focus point have lower AF assist ranges for outer points. The MR-14EX and MT-24EX macro ring light flashes have small white incandescent bulbs for modelling and focussing rather than red AF assist LEDs. The Macro Twin Lite MT-24EX can be configured so that pressing the shutter release halfway turns these lamps on. The MR-14EX requires a press of the controller-mounted "lamp" button to enable the lamps.

Flash units with 1 (central) point AF assist light coverage:
Speedlites 160E, 200E, 220EX, 300EZ, 380EX, 420EZ, 430EZ.

Flash unit with 5 point AF assist light coverage:
Speedlite 540EZ.

Flash unit with 7 point AF assist light coverage:
Speedlite 420EX.

Flash units with 45 point (area) AF assist light coverage:
Speedlites 550EX, ST-E2. (see the note below concerning the EOS Elan 7/30/33/7)

Flash units with white incandescent focus assist bulbs:
Macro Speedlites MR-14EX and MT-24EX.

Flash units with no AF assist lights:
Speedlites 480EG, 300TL.

Camera-specific notes on AF assist lights.

The EOS 5/A2/A2E and 10/10s: these older cameras never activate the AF assist lights on external flash units - they will only illuminate the camera body's built-in AF assist light. The reason for this limitation is because the camera bodies have multiple selection points and the flash units sold at the time could not cover all of the points.

The 10/10s is also unusual in that its external two focussing sensors look for horizontal lines and not vertical lines, whereas many flash units project only vertical striped lines.

Sadly, this restriction was pretty short-sighted, since later Speedlite flash units handily cover all the focus points of multiple focus point cameras, but these older camera bodies still doggedly rely on the body AF light only - even if the central focus point is the only one selected. And the body's AF assist light can be blocked by larger lenses or lens hoods. Luckily, the body's AF assist light has a reasonable range - only slightly shorter than most external flash units.

The EOS 300/Rebel 2000, EOS 30/Elan 7 and other EOS cameras which lack a red AF assist light on the body: you can always use the AF assist light on a flash unit if you want to avoid the irritating main flash pulses used by your camera as an AF assist light. Some of the smaller Speedlite flashes are quite compact and can easily be packed in a camera bag, though the tiniest don't cover multiple focussing points, limiting you to the central point. The ST-E2 transmitter covers all 45 of the EOS 3's focussing points, all of the D30/D60 points, and 5 of the 7 points of the Elan 7/EOS 30/33/, so it's a better bet for most newer cameras if all you want is AF assist. A rather unfortunate and inconvenient (and expensive, in the case of the ST-E2) way to deal with the camera's shortcomings, but there you go. The EOS 30/33/Elan 7/EOS 7 is most suitable for use with an external flash unit's AF assist light, since this camera has a custom function which disables the external flash while maintaining the operation of the AF assist.

The EOS D30/60: the primary weakness of these otherwise excellent digital cameras is their weak autofocus performance, particularly in dim light. Many D30/60 users advocate carrying an ST-E2 wireless flash transmitter and using its AF assist light to help the camera focus in low-light situations. Other users carry a 550EX set to TTL mode. In TTL mode the 550EX will not fire but the AF assist light will still work. These are somewhat expensive options. You could always use one of the tiny and inexpensive Canon flash units like the 160E or 200E for this, but their AF assist lights cover only the central focussing point of the D30/60.

The Elan 7/EOS 30/33/7: this camera has 7 focussing points - five in a row and one point above and one point below the row. However, the Speedlite 550EX flash unit and ST-E2 unit predate the Elan 7/EOS 30/33/7. So, although they cover all 45 points of pro cameras they do not adequately cover the upper and lower AF points on the Elan 7/EOS 30/33/7. This is because they project horizontal patterns across the area read by the upper and lower AF points of the Elan 7/30/33/7, but these points want vertical patterns. At time of writing the 420EX is the only flash unit which adequately illuminates these upper and lower AF sensors.

Cameras with red patterned (LED) body-integral AF assist lights:
EOS 10/10s, A2/A2E/5, Elan/100, Elan II/IIE/50/50E/55.

Cameras with bright white incandescent body-integral AF assist lights:
EOS Rebel XS/500/Kiss, EOS 3000/88, EOS 3000N/66/Rebel XS N, D30, D60.

Cameras which fake AF assist by pulsing the internal flash unit:
EOS Rebel 2000/EOS 300/Kiss III, Kiss IIIL, EOS Elan 7/30/33/7, EOS Rebel Ti/300V/Kiss 5, EOS 10D, EOS 300D/Digital Rebel/Kiss Digital.

Cameras with no body-integral AF assist lights:
EOS 650, 620, 700, 750, 850, RT, 1, Rebel/EOS 1000, Rebel S II/1000FN/1000S, Rebel X, EOS 5000/888, Rebel G/500N/New Kiss, IX, IX Lite, 1N, 1N HS, 3, 1V, 1D, 1Ds, 1D mark II.

Flash exposure compensation (FEC).

There are times when you may want to adjust the total flash output from a flash unit above or below what the assumed mid-tones that the camera thinks you probably want. For example, a scene that's mainly white or mainly dark will fool automated sensors, so you may want to override the flash unit. This is flash exposure compensation; referred to as "fill-in ratio control" or "flash level control" in older Canon material.

As noted in the section on fill flash, a common application for flash is lightening shadows and toning down the high-contrast nature of full sunlight. Adding a subtle catchlight in someone's eyes is another. For cases like this you might want to dial in an additional minus stop or two of flash compensation over the camera's built-in flash program since you don't want to blast out a ton of fill flash that will wash out the subject's face or cast flash shadows. Or perhaps you want to take a harshly lit flash photo, like old paparazzi photos from the days of non-electronic bulb flash. You could then dial in additional flash compensation. Yet another common situation is overriding the default flash controls in situations that are hard for the flash system to meter. Wedding photos of a man in a black tuxedo in a large room or a woman in a white dress next to a white cake are typical examples.

FEC is adjustable in half or one-third stop intervals, depending on the camera and flash. You can apply both positive (more light from the flash) or negative (less) compensation, usually by up to three stops. Remember that, on cameras which have it, FEC is completely independent from regular exposure compensation on your camera. (cameras which lack FEC simply adjust flash and ambient compensation simultaneously) It's quite possible to, for instance, apply plus 1 stop FEC and dial in minus two stops exposure compensation at the same time. Just like regular light metering, one stop represents a doubling or halving of light output. Altering FEC means altering power output, not distance. (see the section on guide numbers for more information)

As noted earlier, EOS bodies automatically apply by default auto fill reduction under brighter ambient lighting conditions. So it may not be necessary to dial in any FEC if you just need fill flash - particularly if you're using E-TTL rather than TTL. E-TTL is generally agreed to have improved and more subtle fill flash when ambient light levels are bright. You'll probably want to run some tests to see how your camera and flash combination works for you. Remember that any FEC you apply manually will be in addition to any auto fill reduction that the camera may apply.

However, most pro and semi-pro EOS cameras have a custom function that can disable automatic fill flash reduction if you desire. This is useful when shooting backlit objects, where you don't want fill flash reduction.

Cameras which disable auto fill flash reduction with custom function 10:
EOS D30, D60.

Cameras which disable auto fill flash reduction with custom function 14:
EOS 1N, 1NRS, 3, 1V, 1D, 1Ds, 10D, 1D mark II.

Camera which disables auto fill flash reduction with custom function 16:
EOS 5/A2(E).

Which bodies/flashes have FEC.

Flash exposure compensation may or may not be available to you, depending on which camera body and flash you have. Most midrange EOS cameras support FEC for internal flashes, but most low-end EOS cameras do not. Also, remember that FEC will not work in the basic (PIC) metering modes - just P, Tv, Av and M modes.

For FEC to work with an external flash you need one of the following two cases:

- either both a camera capable of supporting FEC on external flash units and a flash unit capable of receiving FEC commands, or
- any EOS camera except the 620, 650, 750 or 850 and an external flash unit with FEC switches built in - the Speedlites 430EZ, 540EZ, 550EX, MR-14EX or MT-24EX.

The next section has a comprehensive list of which cameras and flash units have which features.

For instance, let's say you have an Elan 7/EOS 30 with a Speedlite 420EX external flash. In this case you can use the FEC controls built into the camera to control the flash exposure levels on the external flash.

Or let's say you have an original Elan/EOS 100 with a Speedlite 540EZ external flash. In this case you can't use the camera's on-board FEC controls, because the Elan/100 is the only EOS camera with FEC controls that can't send FEC signals to external flashes. But the 540EZ happens to have controls that let you set the FEC levels directly on the flash itself, so you're fine.

However, if you have, say, a Canon Rebel G and a Speedlite 380EX then you're out of luck. The Rebel G can't send out FEC commands to a flash, and the 380EX lacks external FEC controls. You can't directly adjust the flash exposure settings independently of the exposure metering. You can only fake FEC by altering the ISO value.

Some bodies display the FEC setting in the viewfinder and others only display it in the top-deck LCD. If your flash unit has its own FEC controls you can look at the flash unit's rear panel LCD for the current FEC setting. Also, remember that if your flash unit has FEC controls then its settings will override those of the camera's custom function setting, if it has one.

List of which bodies/flashes have FEC.

- Camera bodies which do not support any kind of FEC even with flash units with external FEC controls:
  EOS EF-M, 650, 620, 750 or 850.

- Camera bodies which only support FEC when used with an external Speedlite flash unit which has FEC controls:
  EOS 600/630, RT, 700, 1, 10/10s, all EOS 1000 series cameras, all EOS Rebel series cameras, all EOS Kiss series cameras, 300, 300V, 500, 500N, 5000/888, 3000/88, 3000N, IX Lite/IX 50/IX 7, EOS 300D/Digital Rebel/Kiss Digital.
- Camera body which supports FEC on the internal flash but not on external flash units unless they have external FEC controls:
  EOS Elan/100.
- Camera bodies which support FEC on internal flash units and can also control FEC on any external Speedlite flash unit:
  EOS 5/A2(E), Elan II(E), 50(E)/55, IX, Elan 7(E), 30/33/7, D30, D60, 10D.
- Camera bodies which lack internal flash units but which can control FEC on any external Speedlite flash unit:
  EOS 1N, 1NRS, DCS 1/3/5, D2000, D6000, 3, 1V, 1D, 1Ds, 1D mark II.
- Camera bodies with a flash exposure level scale on the right side of the viewfinder:
  EOS 1N, 1V, 1D, 1Ds, 1D mark II.
- Flash units with external FEC controls:
  Speedlites 430EZ, 540EZ, 550EX, MR-14EX, MT-24EX.

Faking flash exposure compensation.

It's possible to fake FEC if your camera and flash combination lacks the ability. It basically involves fiddling with your camera's manual ISO (film speed) override. You can't simply adjust exposure compensation because doing so affects both ambient exposure settings and flash exposure settings simultaneously.

The workaround is thus to do the ambient metering first and locking it into place by going into manual metering mode. This puts both the shutter speed and aperture under your direct control. Once that's done you can manually alter the ISO setting of the camera (if your camera supports this, as the vast majority of EOS cameras do).

If you lower the film speed rating you're essentially tricking the camera into producing more flash output - halving the ISO results in one stop more flash output. If you raise the film speed rating then the camera will produce less flash output - doubling the ISO results in one stop less flash output.

The drawbacks to this technique are obvious and threefold. First, it's rather fiddly since altering ISO isn't a commonly changed thing and thus the interface isn't the easiest to use. Second, you have to be certain to set the ISO value back to its correct setting when you're done or else you risk messing up the exposure settings for the rest of the roll. And third, you can't really use it if your camera lacks manual ISO controls altogether.

Flash exposure lock (FEL).

EOS cameras (type A) which support E-TTL also support flash exposure lock when used with EX flash units. This feature lets you lock flash settings in, then optionally recompose the image before taking the final photo. This allows you to adjust the flash settings in certain difficult to meter cases. Canon first introduced FEL in 1986 with their T90 camera and 300TL flash, but dropped the feature with the first EOS

cameras. It wasn't until 1995, with the introduction of the Elan II(E)/50/55 and E-TTL, that FEL made its return.

FEL works by issuing a preflash when the AE lock button or, if the camera has one, when the FEL button is pressed. (on most EOS cameras the AE lock and flash exposure features are tied together, but top of the line EOS cameras have separate FEL buttons which allow you to set AE lock and FEL independently) The camera then stores flash exposure data, biased towards either the current focus point or the central focus point, for a 16 second period or for as long as you keep the shutter release pressed halfway. During this time you can recompose the photo or you can adjust the aperture and shutter speed (overriding AE lock, which is set when you press the AE lock button, if you like).

FEL is thus useful for taking photos in which the subject is not covered by one of the focus points or photos containing reflective surfaces which can fool flash metering or certain cases in which the subject is moving. It's also useful for scenes in which you want to bias the flash exposure to something other than the current focus point. A major drawback with FEL is that the E-TTL preflash occurs when the AE lock or FEL button is pressed, which can confuse your photographic subjects who may think that the photograph is already taken.

If you lock focus on a scene and recompose you will likely have poor flash metering, since E-TTL biases flash metering to the current focus point. Use FEL instead to avoid this problem.

Some cameras have a custom function (CF 8 on the Elan II(E)/EOS 50/55 and Elan 7(E)/EOS 30/33/7) which lets you specify whether you want partial metering and FEL tied to the central focus point - the default - or to the active focus point instead.

Cameras that support FEL:
All type A bodies.

Cameras with separate FEL buttons:
EOS 3, 1V, 1D, 1Ds, 1d mark II.

Flash units which support FEL with type A bodies:
All EX series flash units.

The T90 and the 300TL flash unit support FEL, but only with each other. Their FEL protocols are not compatible with E-TTL, and so putting an EX series flash unit on a T90 will not give you FEL.

Flash exposure bracketing (FEB).

Recent high-end EOS flashes - the 550EX, MR-14EX and MT-24EX - support flash exposure bracketing. It's a function of the flash unit - the Canon "Flash Work" brochure says that these recent high-end flash units can do FEB on any EOS camera except the 650, 620, 750, 850 - and EF-M.

This is a similar concept to auto-exposure bracketing (AEB), only instead of changing ambient exposure settings you shoot a series of three photographs with normal,

positive flash compensation and negative flash compensation. You can apply the bracketing value in half, third or full stop values.

Enabling second curtain sync.

This depends very much on the camera and flash unit that you're using. Early on, Canon put control for this feature on the flash unit. Later they switched to putting control for this feature on the camera body. So whether you have second-curtain sync available to you depends on a complicated set of permutations.

Many mid to high end Canon flash units, listed below, have a button or switch which lets you enable second curtain sync. It's usually marked with a triple triangle (>>>) symbol or the word SYNC. For instance, on the 430EZ and 540EZ you press the + and - buttons together simultaneously to turn on second-curtain sync. When you do so a triple triangle symbol appears in the LCD. On the 300EZ and 300TL there's a small slide switch - left is first-curtain sync and right is second-curtain.

Most midrange and professional EOS bodies from the A2(E)/5 onwards have a custom function that lets you specify whether you want first or second curtain flash. The exception is the original Elan/100, which had a custom function that can only control the internal flash and not external flash units. In the case of a camera with a custom function and an external flash unit which has a second curtain switch it appears the physical switch on the flash takes priority, though this may vary from model to model.

Low-end EOS cameras, such as the 1000 series or Rebel series, do not have any custom functions and so cannot control second curtain sync options directly. So to take advantage of second curtain sync on such cameras you must have an external flash which has externally-available controls to operate it.

Second-curtain sync cannot be used with any EOS camera in a PIC (icon) mode - you have to be set in P, Av, Tv or M modes. And you can't set second-curtain sync in stroboscopic mode or FP mode, since that wouldn't make any sense. Finally, second-curtain sync requires a dedicated Speedlite flash unit - it isn't supported on flash units connected via a PC socket.

List of which flash units and camera bodies have second-curtain sync.

Note: verifying this information is difficult, since it's not listed on all product specs, and I don't have access to every camera and flash unit that Canon have ever built. I believe this list is accurate, but please let me know if there are any errors.

Flash units which do not support second-curtain sync:
Speedlites 160E, 200E, 480EG, ML-3.

Flash units with external second-curtain sync controls:
Speedlites 300EZ, 420EZ, 430EZ, 540EZ, 540EZ, 550EX, MR-14EX, MT-24EX.

Flash units which can use second-curtain sync when used with any EOS body that has a second-curtain sync custom function other than the Elan/100:
Speedlites 220EX, 380EX, 420EX, 550EX, MR-14EX, MT-24EX.

Camera bodies which cannot support second-curtain sync in any form:
EOS EF-M, 750, 850.

Camera bodies which lack custom functions altogether and so support second-curtain sync only when used with flash units with external controls:
EOS 650, 620, 700, all EOS 1000 series cameras, all EOS Rebel series cameras, all EOS Kiss series cameras, 300, 300V, 500, 500N, 5000/888, 3000/88, 3000N, the IX Lite/IX 50/IX 7*, IX**, EOS 300D/Digital Rebel/Kiss Digital.

Camera bodies with custom functions but which lack a custom function to enable second-curtain sync:
EOS 600, 630, 1, 1N, 1NRS, RT, 10/10S.

Camera body which has a second-curtain sync custom function that works on the internal flash but not on external units:
EOS Elan/100.

Camera bodies with custom functions that enable second-curtain sync on both internal flash and on compatible external flash units:
EOS A2(E)/5, Elan II(E)/50(E)/55, Elan 7(E)/30/33/7, D30, D60, 10D.

Camera bodies with custom functions that enable second-curtain sync on compatible external flash units but which lack internal flash:
EOS 3, 1V, 1D, 1Ds, 1D mark II.

The T90 camera and the 300TL flash unit support second-curtain sync, but only with each other.

* I haven't been able to find out if the IX Lite/50/7 camera supports second-curtain sync with flash units that have external controls, but since it's based around Rebel-style technology it seems unlikely that such support would have been removed.

** The Westfall/Overton FAQ states that the IX can use second-curtain sync with 380EX flash units, which lack external second-curtain sync controls. The Canon "Flash Work" brochure, however, isn't clear on this.

Range warning.

The first type of range warning applies only to the 630, 1 and RT cameras. All other EOS cameras lack this kind of range warning for patent reasons. If the foreground subject is too close to or too far from the flash to be illuminated by it, it's said to be "out of coupling range." If the subject is too far away then both the shutter speed and aperture values will blink in the viewfinder display. If it's too near then the distance display will blink.

The second type of range warning is built into the FEL feature with type A bodies. If the lightning bolt icon in the viewfinder blinks when you set FEL then you know that you don't have enough flash output to illuminate the subject correctly.

Manual flash.

High-end Canon flash units can also work in full manual mode, which lets you set the flash output by hand rather than relying on an automated system like TTL or E-TTL. Note that manual flash metering is *not* the same thing as the camera's manual exposure (M) mode, which is used for ambient (non flash) light metering. Though having said that, you usually put the camera into manual exposure mode when using manual flash metering, so it can be very confusing.

Traditionally, manual flash units required the user to perform calculations by hand in order to use them. However, Speedlites with manual controls and rear LCD panels can perform these calculations for you. This is how you do it.

- Set the *camera* to either Av (aperture priority) or M (manual exposure) mode. You can set the camera to other "creative" zone modes if you want, but the aperture symbol will flash to indicate a problem and the picture's flash metering will probably be out.
- Set the *flash* to manual mode. On the 430EZ and 550EX, for example, you press the mode button on the flash. The flash mode (TTL or A-TTL) will switch to M.
- Press the plus or minus button to set the correct flash intensity. 1/1 means full power, 1/2 means half power and so on. Different flash models support different numbers of flash intensity - the full list is below.
- Press the shutter button halfway. The flash will display the current aperture and a distance setting. On the 430EZ this distance setting will be a number of metres or feet, depending on whether you bought the flash anywhere in the world but the US or the US. On the 540EZ and 550EX the distance information is shown on a little scale, and the unit type can be changed by a small switch in the battery compartment.
- If you're in Av mode the shutter speed will be the camera's X-sync speed and you can manually set the aperture. In M mode you can set the shutter speed to any value from 30 seconds to the camera's X-sync and the aperture to anything within the lens range.
- Adjust the settings so that the distance information on the flash matches the number on the distance scale on the lens you're using. If the lens lacks a distance scale then you'll have to estimate or measure the distance.
- Once everything's set correctly you can press the shutter release all the way to take the photo, assuming the "flash ready" lightning bolt is displayed in the viewfinder.

The flash can't help you in bounce mode - you have to perform the calculations manually by measuring the flash to subject distance. Remember that in bounce mode it's not the distance from the flash to the subject that's important - it's the distance that the light actually has to travel from the flash to the reflecting surface and then to the subject. You also have to factor in the light loss from the reflecting surface, which can only really be done by experience or judicious use of a flash meter. Also don't forget that the flash unit's guide number is measured in metres and for ISO 100 film. If you want to use feet and/or film of a different speed you will need to do some additional arithmetic.

Flash units with manual controls:
Speedlites 420EZ, 430EZ, 540EZ, 550EX, 480EG, MR-14EX, MT-24EX, 300TL.

Two levels of manual power - MHi (full power) and MLo (1/16):
Speedlite 300TL.

Five levels of manual power - full power to 1/16:
Speedlite 480EG.

Six levels of manual power - full power to 1/32:
Speedlites 420EZ, 430EZ.

Seven levels of manual power - full power to 1/64:
Speedlites MR-14EX, MT-24EX.

Eight levels of manual power - full power to 1/128:
Speedlites 540EZ, 550EX.

Flash exposure level.

The most recent high-end Canon cameras have the ability to display the flash exposure level in the viewfinder. When you press the FEL button near the shutter release a sliding scale will appear in the viewfinder on the right side. Typically this is done with a grey card filling the spot metering circle.

The flash exposure level will be displayed on the far right bar of this scale. You can then adjust the output on the flash unit manually to match the standard exposure level.

Cameras with viewfinder flash exposure level scale:
EOS 3, 1V, 1D, 1Ds.

Rapid-fire mode.

Electronic flashes work by charging up a capacitor with electricity, then releasing the stored-up power in a split-second burst of light. This charging process, the “recycle time,” takes up to a few seconds on larger units - which can be a problem if you need to take several flash photos in fairly rapid succession, such as at a wedding.

Many EOS flashes have the ability to be triggered even if not fully recharged, on the theory that there are times when you’re better off being able to take a photo without a full flash charge available (ie: at a lower guide number than maximum) than having the flash not fire at all. Flash units capable of this feature have a two-colour flash ready (“pilot”) light. If the light is red then the flash is fully charged. If it’s green then the flash is only partially charged but will still fire anyway if you take a photo.

It can be quite frustrating using a flash unit without rapid-fire, in fact. It’s all too easy to take two photos in succession only to find that the second one didn’t trigger the flash and so is totally underexposed.

Rapid-fire mode will not work if the camera is in continuous film winding mode, if the flash is in manual mode at full or half power or if the camera is in stroboscopic flash

mode at a fairly fast setting. The 430EZ does not work in rapid-fire mode if an external battery pack is used.

Flash units with rapid-fire capabilities:
Speedlites 160E, 300EZ, 420EZ, 430EZ, 540EZ, 550EX, 480EG.

Flash units with no rapid-fire capabilities:
Speedlites 200E, 220EX, 380EX, 420EX, ML-3, MR-14EX, MT-24EX, 300TL.

Stroboscopic flash.

In flash photography the term “stroboscopic” refers to a photographic technique whereby a number of brief pulses of light are emitted during the course of a photographic exposure. The result can capture, for instance, half a dozen steps of a dancer in motion. Each step would be recorded on the same frame of film, like a multiple exposure. Here’s a less than thrilling example that I took as a test - a bit poorly done, since the foreground was underexposed because of insufficient flash output, but you get the idea.

To take a stroboscopic photo you need to have a very dark background that doesn’t reflect much light. If you have a bright background you’ll find that the multiple pops of light from the flash will build up cumulatively to overwhelm the foreground subject. You’ll probably also need to experiment a fair bit to determine the ideal number of light pulses to cover your action appropriately and the output settings required to expose the subject correctly. You’ll probably want to use negative (print) film and not slide film for such a photo, since the former has much wider exposure latitude.

Setting stroboscopic flash.

High-end Canon hotshoe flash units have a stroboscopic mode, activated by pressing the mode button until MULTI is displayed on the rear LCD panel.

You can then enter the firing frequency in hertz (ie: the number of flashes per second) and the power output setting. The 5xx flashes also let you specify the actual number of stroboscopic light flashes as well. The 4xx flashes don’t, so you have to calculate that number from the time period the shutter is kept open and the number of flashes per second you’ve set. The maximum firing frequency of the flash varies from flash model to model, but it ranges from 5 to 199 Hz. Power settings also vary - the 430EZ and 540EZ, for example, cannot use stroboscopic flash at full or half power - only 1/4 power and down.

Naturally there’s a relationship between these settings - you can’t fire many times at higher power settings if the firing frequency is high, for example, since the flash needs time to recharge. The flash manual includes a table showing the maximum number of flashes you can expect at different power settings and firing frequencies. There is a risk of overheating and damaging the flash bulb if you pulse the bulb too much, but the flash units have cutoff mechanisms that prevent this from occurring.

Once you’ve set the flash settings you can put the camera into M (manual exposure) mode and determine how long the shutter should be kept open in order to cover the

full field of action for your photo. You can also set the proper aperture. As you do this the flash will display the coupling range on its rear-panel LCD. (press the shutter release halfway if the coupling range information is not displayed) Adjust the power output and aperture so that the coupling range matches the focus distance.

Stroboscopic flash won't work with the EOS EF-M, 750 and 850 cameras.

Flash units with stroboscopic capabilities:
Speedlites 420EZ, 430EZ, 540EZ and 550EX.

Stroboscopic ranges:
Speedlite 420EZ: 1-5 Hz.
Speedlite 430EZ: 1-10 Hz.
Speedlite 540EZ: 1-100 Hz.
Speedlite 550EX: 1-199 Hz.

Flash exposure confirmation.

Not to be confused with flash exposure compensation. Some Nikons have a very handy feature - a small LED which illuminates in the viewfinder to indicate that the flash believes you had enough light to exposure your subject correctly. Unfortunately, for patent reasons no Canon camera bodies have such a feature.

The closest thing in the Canon world can be found on many flash units, not camera bodies. Most Speedlite flash units have a small LED which lights up for two or three seconds, post-exposure, to confirm that there was sufficient light from the flash to illuminate your subject correctly. This is a nuisance since you have to lift your head and peer at the flash back in order to see this light, but I guess at least it's there.

Keep in mind one important limitations of this feature - the LED will glow even if the image was overexposed. It only checks to see that the photo was not underexposed owing to being out of range. So having this LED light up is no guarantee of a perfectly exposed flash photograph.

Flash units with flash exposure confirmation:
Speedlites 480EG, 540EZ, ST-E2 remote transmitter, ML-3 ring flash and all EX flash units.

Wireless remote control.

There are a number of third-party (ie: non-Canon) systems for controlling flash units from a distance such as products from Wein and PocketWizard. However, the newest E-TTL Canon flash units are also capable of being triggered remotely without wires, much like Minolta's pioneering wireless flash system. These wireless E-TTL units work as master or slave units.

And yes, it's kind of unfortunate that the terms "master" and "slave" are used in this context. Unfortunately the terminology is pretty common in the world of hardware engineering to mean a system with a controlling device and a responding device, the grim political and social overtones of the words notwithstanding. However, to minimize confusion I'll use the terms since Canon use them.

How wireless E-TTL works.

Canon's wireless E-TTL system employs brief digitally-encoded pulses of light (either visible or infrared, depending on the master unit used) to transmit commands from a master flash unit to a slave unit or multiple slaves. Since the system relies on digital messages in the light pulses it's immune to the problem that regular optical slave flash units have - that of being triggered accidentally in response to other flash units firing. (unless you're near other photographers who are also using Canon wireless flash units, of course)

Wireless E-TTL doesn't use radio signals like most third party systems, so you can't trigger flashes remotely from great distances, such as the other side of a sports arena. But it's ideal for quick, portable and flexible flash setups in smaller spaces. Canon chose light-controlled wireless rather than radio partly because it's cheaper to implement and partly to avoid the regulatory nightmare of getting licensing approval for radio transmitters from every country in which Canon sell photographic gear.

Canon's wireless system requires at least two wireless-capable flash units in order to work. A master flash unit is attached to the camera's hot shoe (either directly or using the Off-Camera Shoe Cord) and the slave flash unit or units are set up to illuminate the scene as desired. Unfortunately no current EOS camera can use its internal flash unit as a wireless E-TTL master; convenient as that would be. Hopefully future EOS camera bodies will have this ability - it shouldn't require additional hardware to implement, and it'd be very handy. You would then, for example, be able to walk around with a camera in one hand and a flash in the other without any bulky transmitter units or cumbersome cords.

As noted above, the master unit sends command signals to the slave units by using pulses of visible light or infrared, so each slave must be positioned such that the wireless sensor on its front can see these pulses. When shooting indoors with many light-reflecting surfaces (walls, ceilings, etc) the slave should be able to detect the master's control signals even if the two units aren't set up to point at one another, but outdoors or in an un-reflective indoor setting the slave unit's front-mounted sensor must be able to see the front of the master unit, which can be a little inconvenient. It may help to remember that many Canon flash units, such as the 420EX and 550EX, have rotating heads, so it's possible to have the flash head pointing in a very different direction from the body of the unit. You can also put the master unit on an off-camera shoe cord rather than mounting it directly to the camera body if you need to point it in a certain direction.

Command transmission distance depends partly on the angle at which the master is transmitting relative to the slave and whether you're using the units indoors or outdoors. In addition the 550EX, which uses visible white light from the large main flash tube to send data, has greater range than the ST-E2, which uses a smaller flash tube covered by a plastic filter so it emits only invisible infrared energy.

The 550EX has an official transmission range of 8-10 metres (25-30 feet) when used outdoors, with horizontal coverage of roughly 80° and vertical of about 60°, assuming that the flash head is set to its 24mm setting. Naturally you can adjust the flash head zoom setting manually to a tighter coverage than that if you want - or wider if you use the flip-down 17mm panel, though at the cost of dramatically decreased range. There's conflicting data about the ST-E2. Canon USA's spec sheet

claims that the ST-E2 has the same range as the 550EX, which appears to be incorrect. Canon USA's Chuck Westfall has said that the ST-E2 actually has a range of about 3.5-5 metres (12-15 feet) when used outdoors, with coverage of about 40° horizontal and 30° vertical.

The control pulses from the master unit to the slave or slaves are sent at varying points in the period between the camera's shutter release being fully pressed down and the shutter opening. The wireless E-TTL control sequence works as follows:

- Photographer presses the shutter release button halfway.
- Ambient light metering of the scene is conducted.
- Photographer presses the shutter release all the way.
- The master flash unit sends a wireless signal to all slave units in group A, instructing them to issue a low-power preflash.
- Any slave units in group A fire a preflash and the camera records this light output using its evaluative meter.
- The master flash instructs group B slaves to issue a preflash.
- Any slave units in group B fire a preflash and the camera records this light output.
- The master flash instructs group C slaves to issue a preflash.
- Any slave units in group C fire a preflash and the camera records this light output.
- The camera calculates what the final flash output for the scene should be, based on both the preflash data from each slave group (if any) and the user-defined group ratios/flash exposure compensation settings.
- The camera flips up the mirror and opens the shutter.
- The master flash instructs all slave units to fire simultaneously.
- All slave units fire at whatever level the master unit has told them to. Naturally if the master flash unit is flash-capable (ie: not an ST-E2) and is configured to fire then it too will do so.
- The camera flips down the mirror and closes the shutter.

  There are of course differences in the timing of some of these events if AE lock, flash exposure lock (FEL) and/or second-curtain sync are used, but that is the basic flowchart. Naturally these command pulses and prefires occur at an extremely rapid rate. They'll register with the human observer but occur far too quickly to mean anything to a human.

Using wireless E-TTL.

You can specify one of four different data channels for flash control, and each flash unit can be put into one of three groups. The four channels are there so that up to four cameras can use wireless E-TTL in the same physical location without conflicting with each other, and the three groups are there so that independent flash output ratios can be specified (though only with certain cameras; see below). When wireless mode is used with any type A body you have full E-TTL metering, FP mode, FEL and other E-TTL features.

There is no coded limit to the number of slave flash units which can be in each group. This is because there is no two-way communication between master and slave units - each slave simply sits there and awaits commands, and the master only knows what slave units exist in terms of whatever light they produce during the

prefire stage. So you can set up as many slave units as your space and budget can accommodate. The only issue here is the SE (save energy) feature, which will cause slave units to switch to an energy-saver mode after a certain period of time. (see the SE section for details)

You can check whether your slave flashes are within transmission distance or not by pressing the test ("pilot") button on the master flash unit. The camera will instruct all the slave units to emit a flash of light. First the A group units will flash, then the B and then the C. If your camera has modelling flash capabilities (see list in next section) you can use that feature as well, giving you a quick preview of the final scene.

The 550EX, when used as a master unit, can have its main tube disabled, so it can control the slaves without contributing any camera-mounted light to the scene. In addition, flash units with zooming flash heads (the 550EX and 420EX) automatically zoom out to 24mm coverage when in wireless flash slave mode, though it's possible to override the zoom setting manually in the case of the 550EX.

You *can* use Canon's wireless flash units with older type B bodies, but only if you set the flash output settings manually, (where possible - the 420EX has no flash exposure compensation pushbuttons and so can fire only at full power) which isn't particularly convenient. In other words, Canon's wireless system works only with E-TTL and does not work with either TTL or A-TTL flash metering.

Ratios.

A number of recent mid to high-end type A camera bodies - see full list in next section - are capable of supporting varying light ratios between flash groups. (ie: this is unrelated to fill flash ratios with single flash units) Each slave flash can be in one of three groups - A, B or C. If your camera is ratio-capable you can then specify the ratio of light produced by flash units in groups A and B. This A:B ratio can be set from 1:8 to 1:1 to 8:1 in half-stop increments, which yields a total of 13 stops. The 550EX is also capable of specifying flash compensation for a third and completely independent group - group C. Compensation of group C is adjusted from -3 to +3 stops relative to the A:B ratio, in 1/3 increments.

Note that if you're using a 550EX as a wireless master unit (either on-camera or connected to it using the off-shoe camera cord) then it defaults to group A. If you want to control the ratio of slave unit output to master unit output be sure to put the slave units into group B.

The two Canon EX macro units - the MR-14EX and the MT-24EX - also support wireless flash capabilities. The flash units can both serve as master units in wireless E-TTL setups, though not in the way one might expect. One of the two flash tubes on the macro unit is assigned to the A group and the other to the B group (the tubes are marked on the flash unit) and you can use the macro unit controller to specify the output ratio between the two tubes if you have a ratio-capable camera. You can then assign other slave flash units to group C and adjust flash exposure compensation of these units relative to the two macro unit tubes. You can also use a custom function on the flash to control slaves in groups A and B, but they are linked to the internal tubes.

Unfortunately, the first generation of type A (E-TTL capable) bodies support wireless E-TTL but do not support wireless E-TTL ratio control - all flash units on the same channel will fire at the same power when used with such cameras. However, if you're using a 550EX as a slave there is a partial workaround for this - you can specify flash exposure compensation manually using the flash unit's push buttons.

One interesting side benefit of wireless E-TTL's ability to control multiple flash units is simplifying high-speed photography. If you want to use flash to freeze rapid motion (water droplets, insects, hummingbirds, etc) you often have real range problems, since short duration flash pulses are also effectively low output pulses. If you've only got one flash unit at your disposal this limits the range the camera can be from the light source. However, with E-TTL you can set up a battery of slave units, each at the same distance from the subject, and fire them simultaneously at low power. An expensive solution, to be sure, but one which affords a fair bit of versatility.

ST-E2 wireless transmitter.

Another interesting component of Canon's wireless flash system is the ST-E2 transmitter. This compact unit fits onto a camera's hotshoe and can control external wireless Speedlite flash units, but can't produce any scene-illuminating white light. The ST-E2 contains a small flash bulb, which it uses to send the control signals to other flash units, but the bulb is covered by a filter so that most of its light output is invisible infrared (IR) energy. Since the human eye can't detect IR, the ST-E2 is more discreet in operation than the 550EX when controlling slave units.

Although fairly small and portable, the ST-E2 can't transmit its control signals as far as, and its coverage angle is more narrow than, the 550EX. The ST-E2 is capable of about half the range of the 550EX, in fact, at about 3-5 metres (see coverage details above). This basically limits its usefulness to indoor photography in small rooms or studios. Unlike the 550EX the ST-E2 supports only groups A and B and A:B ratio control - it unfortunately cannot control group C. The ST-E2 also does not support flash exposure bracketing (FEB).

On a more positive front, the ST-E2 also contains a red AF assist light, which makes it a popular accessory for owners of EOS cameras which lack true AF assist lamps - notably the Elan 7/EOS 30/33/EOS 7 and D30 and D60 cameras.

Drawbacks of wireless E-TTL.

On the whole, wireless E-TTL is a powerful and flexible system with a few drawbacks. First, the wireless control pulses can inadvertently trigger analogue optical slave units and flash meters; a problem suffered by E-TTL in general. Both the white light pulses from the flash units (wireless signals are sent as preflashes from the main flash tube) and the infrared pulses from the ST-E2 control unit are sufficiently bright to cause problems with such equipment. Second, another side effect of the light pulses is you must ensure that the various units are correctly positioned so they can see each other, and that the receiving sensors on the front of each slave flash unit are not covered by anything. This also limits the working range compared to radio-controlled wireless units. Third, portable battery-powered flash units are still fairly low-powered compared to studio units and thus not suitable for a lot of complex flash arrangements or larger areas. Fourth, the ST-E2 unit cannot control group C

slaves. And finally and most inconveniently, buying a bunch of Canon flash units is a fairly expensive proposition.

List of wireless-capable Canon flash units and cameras.

Master-capable flash units:
The Speedlite 550EX and the ST-E2 transmitter both have the ability to act as a master (control) unit. The MR-14EX and MT-24EX macro flashes can also serve as masters, but only with slave units in group C or with slave groups A and B linked to the internal tubes and other slave units in group C (see above).

Slave-capable flash units:
Speedlites 420EX and 550EX can both act as a slave flash when using wireless E-TTL. The MR-14EX and MT-24EX can also act as slave flashes, with the two flash bulbs on each unit assigned to slave groups A and B.

Flash units with no support for wireless E-TTL:
The earlier EX flash units - 220EX and 380EX - cannot operate in Canon's wireless mode. No TTL-only or A-TTL flash units (all E and EZ units) can operate in Canon's wireless mode.

Non-Canon wireless-capable flash units:
Metz also build a wireless flash system, but it's not compatible with Canon's implementation. Sigma, however, make at least one flash unit (the EF 500 Super) that's designed to be compatible with Canon's wireless protocol.

Camera bodies with support for basic wireless E-TTL:
All type A cameras.

Camera bodies with additional support for flash ratios and wireless modelling light:
EOS 3, 1V, Elan 7/7E/EOS 30/33/EOS 7, D30, D60, 1D, 1Ds, 10D, 1D mark II.

Modelling flash.

Large studio flash units frequently have incandescent tungsten bulbs built in alongside the main flash tube or tubes. These constant-light bulbs cast light on the subject in much the same way as the actual flash bulb would, only much more dimly. This constant light is known as a modelling light, as it allows you to preview the flash effect in a rough fashion - or at least see where the flash shadows and reflections are likely to fall.

The Canon modelling flash feature lets you simulate the effect of the flash going off before you take the picture - particularly useful for previewing wireless E-TTL flash ratios. It works by pulsing the flash rapidly (at 70 Hz) for a second, much like in FP mode. This obviously drains the batteries and can overheat the flash unit if triggered repeatedly, so it's best used sparingly. Pressing the depth of field preview button fires the modelling light, but you can turn this off with a custom function if you find it annoying. The 420EX must be in slave mode for the modelling light to work.

You need both a camera and a flash unit which can support modelling flash to use the feature. The camera must be in a creative zone mode for this feature to operate

- modelling flash will not work in the PIC modes. Note also that Canon's ring flashes also contain small white incandescent bulbs for focus assist and modelling purposes.

Camera bodies which support modelling flash:
EOS 3, Elan 7/EOS 30/EOS 7, 1V, 1D, 1Ds, D30 and D60, EOS 300V/Rebel Ti/Kiss 5, 10D.

Flash units which support modelling flash:
Speedlites 420EX, 550EX, MR-14EX and MT-24EX.

Save Energy (SE) mode.

Most EOS flashes go into low-power or SE mode (called "Energy Conservation Control" in some Canon material) after a predetermined period of time - usually 90 seconds or 5 minutes - in order to minimize battery drain. Some flash units are always in SE mode when powered on. However, since it can be annoying to have your flash unit turn itself off in the middle of setting up a shot some flash units have a three-position switch - off, on and SE. The ability to override SE mode is very important for wireless flash applications.

Pressing the shutter release button down halfway will wake up the flash and recharge it. If you're using the intervalometer on an EOS 10/10s, a 600-series camera with the Technical Back E, an EOS 1 or 1N with the Command Back E1 or an EOS 1v, 3, D2000, D30 or D60 with the TC-80N3 timer/remote controller, the camera will wake up the flash unit a minute or so prior to taking a photo in order to give it time to recharge.

Note that there is still battery drain associated with the SE mode. If you're going to leave the flash off for more than an hour or so you're probably best off turning it off altogether. Some more advanced flash units like the 550EX have custom functions which allow you to adjust various power-down time intervals.

No power switch at all:
Speedlite 160E. (unit charges up when you press the shutter halfway)

No SE function:
Speedlites 480EG, 200E.

90 second SE timeout:
Speedlites 380EX, 420EX*, 430EZ, 540EZ, 550EX*, MR-14EX, MT-24EX.

5 minute SE timeout:
Speedlites ML-3, 300EZ, 420EZ, 300TL.

SE override capabilities (3 position power switch):
Speedlites 540EZ, 550EX*, MR-14EX, MT-24EX, 300TL.

* These flash units behave differently when they're used off-camera in wireless slave mode. Here the SE timeout is extended to 10 minutes for the 420EX and 60 minutes for the 550EX (unless custom function 4 is set on the 550EX, in which case it's 10

minutes). Pressing the master unit's test button or activating FEL on the camera will wake up a slumbering flash.

High voltage connector.

Speedlites 430EZ, 540EZ, 550EX, MR-14EX, MT-24EX and 480EG have high voltage connectors which allow you to connect large-capacity external battery packs. See the battery pack section for details.

PC terminals/sockets.

Many older flash units and most studio flash units support PC connectors, which are simply electrical connectors and wires used to connect cameras and flash units. They just carry a trigger current and do not carry digital data communications of any kind such as metering information.

All semi-pro and high-end EOS cameras have a built-in PC socket. Lower and midrange EOS cameras generally don't have PC sockets. However you can cheaply buy small adapters which plug into the camera's hotshoe mount which convert to PC cables, so this normally isn't a huge limitation. None of Canon's standard flash units can be triggered via a PC cable without a hotshoe adapter for the flash unit. Only the 480EG can connect to a PC connector via the optional Synchro Cord 480.

The PC here stands for "Prontor/Compur," two manufacturers of leaf shutters used in older and large format cameras. It does not stand for "personal computer" in this context, and so a camera with a PC socket cannot be hooked up to a computer through it. Some of Canon's material refer to it as a "German" socket.

Finally, be aware that many studio flash units use very high trigger voltages, which can damage your camera. Canon recommends that trigger voltages of 6 volts or less only be used with the camera's hotshoe. The PC socket has better high-voltage protection on at least some models, however. The EOS 1D, for example, should not be used with flash units which have a trigger voltage of greater than 250 volts. I don't have information on every PC-equipped EOS camera model, so please consult the manual which came with your camera. (assuming the manual says anything - the D30 manual does not list a safe voltage, so you may need to ask Canon)

EOS cameras with PC sockets:
EOS 1, 1N, 1NRS, 5/A2/A2E, 3, 1V, 1D, 1Ds, D30, D60, 10D, 1D mark II.

Custom functions on flash unit.

The most recent high-end E-TTL Canon flash units - standard hotshoe flash unit 550EX and ring lights MR-14EX and MT-24EX - have custom functions, much like mid and high end Canon camera bodies. These "functions" (settings or parameters, really) allow you to alter the default behaviour of the flash units in certain ways.

For example, custom function 3 on the 550EX and MR-14EX lets you switch from E-TTL to TTL flash metering.

Test flash (manual firing).

If you want to fire the flash manually simply press the illuminated pilot light on the back of the unit. The flash unit will fire a test burst, whether on-camera or not.

Flash units which lack a manual fire button:
Speedlites 160, 200, possibly others.

Manual flash triggering for light painting.

A fun way of taking interesting photos in the dark is to trigger a flash unit manually whilst leaving the shutter open - sometimes called “open flash.” For example, you could set your camera on a tripod, open the shutter by putting the camera into “bulb” mode, and then walk around the scene with a flash unit, painting the scene with light. Coloured gels can be taped over the flash head as well, to illuminate the photo with different colours of light.

Canon Speedlites with manual controls or old flash units with manual metering are ideal for this - you can take the device off the camera shoe, dial in the appropriate manual flash setting (full power, say, or 1/2 power or 1/16 or whatever) and then trigger the flash by hand. You do this on most Speedlite flash units by pressing the illuminated pilot light on the back of the device - other flash units should have similar manual trigger buttons. If you wear dark clothing and point the flash away from you you shouldn’t even appear in the photo. You can’t rely on your camera’s light meter to help you meter the scene, so this sort of thing is largely a trial and error process. It’s helpful to keep the flash the same rough distance from the area to be illuminated for each flash burst.

If you have an E-TTL (type A) camera with an EX series flash unit you can even take advantage of FEL to meter

Naturally you don’t have to use flash unit to do this. People often take outdoor night scenes using high-powered floodlamps or indoor photos with small flashlights (electric torches) or blinky light toys. And it doesn’t have to be used purely for fun or unusual photographs. Here’s a photo, for example, that was primarily illuminated by the full moon and small kerosene lamps. However I had a portable incandescent flashlight with me which I used to brighten up shadow areas. Sort of a really slow fill flash.

Finally, on a somewhat related topic, it’s possible to do high-speed photography - such as photos of a balloon being burst with a pin - using ordinary flash gear. You build or purchase a sound trigger, set up your subject in a pitch-black room, open the camera shutter and let the sound trigger fire the flash. Flash units are capable of extremely brief light bursts, particular at low power settings - remember that power output on portable flash units is determined by the duration of the pulse. There’s a lot of useful information on how to do this at http://www.hiviz.com/.

Noise.

This is sort of a feature; albeit an undesirable one. But flash units always make various kinds of noise. There’s usually a high-pitched whistling whine which increases in frequency as the unit is charged up. This is caused by an oscillator circuit, used to convert DC to AC so that the device can generate the high voltages needed to charge

the capacitor. Some flash units, like the 540EZ and the 550EX, have multiplex circuits which make particularly noticeable humming/clicking sounds when powered on. All flash units also make a soft popping sound when fired.

The other thing you can hear on zooming flash units is the hollow rattling buzz of the small electric motor used to move the flash bulb inside the flash head. This is also totally normal.

Flash safety.

Finally, and this isn't really a flash unit feature as such but just something that doesn't really fit in anywhere else, I'd like to remind you about the need to keep flash safety in mind.

Electronic flash technology involves extremely high voltages - literally thousands of volts. The amperage is fairly low, but nonetheless some of the internal components of any flash unit still have quite a high-voltage kick to them if they've been charged up recently. And it takes a bit of time for this high voltage energy to drain out of the flash unit's capacitors. Even cheap disposable cameras with built-in flash units can shock you if they're disassembled.

So. Don't expose your flash unit to rain or liquids if you can avoid it. And don't open up the device and monkey around with the innards unless you know what you're doing and have drained the capacitors by grounding them. You could literally get a nasty shock - which could be deadly if you have a heart condition.

However, as long as you don't dismantle your flash unit or pour lemonade into it you shouldn't have any problems.

Accessories.

As with any photographic endeavour there are all kinds of add-on accessories you can buy for use with your flash unit.

Extension cords.

There are two extension cord systems which allow you to move the flash away from the camera for more complex flash setups.

The Off Camera Shoe Cord 2.

The OCSC 2 is a simple coiled cord with sockets on either end that lets you attach a flash unit to your camera's hotshoe and move the flash independently of the camera, up to a distance of about 60 cm (2 feet). This cord, though expensive, preserves all flash functions including E-TTL if it's available, and is useful for mounting a Speedlite flash to a flash bracket.

It's pretty short, however. You can connect two of them together if you need more distance, but Canon do not recommend this practice since the electrical impedance (internal resistance) changes. I've heard from other users that worked just fine for them, so you might want to experiment to see if it works reliably for you. Note also

that there was the original Off Camera Shoe Cord (no numeric designation) which lacked a locking hotshoe pin. Despite reports to the contrary online, it appears that the two cords are both fully compatible with EOS cameras except for the note below.

The OCSC 2 has problems with some earlier EOS models. For one thing, it's not fully compatible with the EOS 600, 630 and RT and may behave unpredictably on those cameras. More excitingly, when used on the 10/10s camera the cord can generate more radio-frequency interference than is permitted by US, Canadian and German regulatory agencies. Using a 10/10s camera with an OCSC 2 in those countries makes you an RF outlaw!

Multiple TTL flash.

There's also the camera-mounted TTL Hot Shoe Adapter 3, which runs off a small lithium CR-2025 battery. This adapter connects with various dramatically costly accessories - 60cm and 3 metre connecting cords, the tripod-mount-equipped Off-Camera Shoe Adapter OA-2 for connecting Speedlites to cords and a TTL distributor that lets you hook one camera up to 3 flash units.

The cords must be used in conjunction with the Hot Shoe Adapter 3 and the Camera Shoe Adapter and connect together using mini-DIN style connectors - they don't use, say, PC connectors or anything like that. Note: there was also the original Hot Shoe Adapter (no numeric designation), which worked only with the T90 and does *not* work with EOS cameras, and the Hot Shoe Adapter 2, which does work with EOS cameras.

This system works with TTL only - A-TTL and E-TTL are not supported. In fact, a whole slew of flash features are not supported if you use the TTL Hot Shoe Adapter 3 cable system. You can't use A-TTL or E-TTL, there is no preflash, second-curtain sync does not work, the DEP mode will not work, program shift won't work, automatic flash head zooming is disabled (though manual zooming works if the flash supports it), the aperture and coupling range data is not displayed on flashes with LCD panels and the AF assist light does not work. These features are all disabled because their control signals a) are all sent down one line and b) would result in contradictory instructions from multiple flash units. (though as a side note this device can be used for disabling E-TTL features if you like)

You can't automatically adjust lighting ratios between the individual flash units in TTL multiflash mode - all flashes will fire at the same time and shut off at the same time. There are four awkward workarounds for this problem. First, you could move individual flash units closer to and further from your subject. Second, you could stick neutral density filters or diffusers on the flash heads. Third, you could use manual zoom controls, if available, to zoom the flash head since that reduces the light output on wider lens settings. And fourth, you can use manual controls, if available, to adjust light output of each unit individually. However any flash set to manual will disable TTL flash for all of the flash units. You can't shoot a multiple flash photo with a mixture of manual flash and TTL autoflash.

The TTL Hot Shoe Adapter 3 cord system is really only useful for older (type B) bodies and compatible flashes. In fact, the cord system doesn't work at all on E-TTL only cameras like the digital 1D, 1Ds, D30 and D60. The new wireless system supported by the latest E-TTL flash units is considerably more flexible (it supports

ratios on certain cameras, for example) and convenient (no wires to trip over or limit your placement of slave units).

Flash diffusers.

A number of manufacturers, such as StoFen and Lumiquest, sell various attachments you can clip or tape onto the head of your flash unit. These diffusers usually cost a couple stops of light, easily halving your flash range, but can soften and tame the harsh light of a flash considerably under certain circumstances - see the quality of light section for more information on how they work. There are two basic types - small light redistributors and large panels.

Small diffusers are of the StoFen Omnibounce variety - milky white (or green or yellow) plastic open-ended boxes which fit snugly over the head of the flash unit. These small diffusers redistribute the flash unit's light output so there's more light scattering around and bouncing off walls and ceilings and so on. This type of diffuser is, therefore, good for bouncing light around small interior spaces or for doing macro (closeup) photography without a macro flash. It's not so good if you're shooting outdoors or in dark interior spaces, where there's nothing off which to bounce the light. In such situations you're simply cutting down your usable range, wasting power (and thus batteries and thus money) and increasing flash cycle time by using a small diffuser. It's also not recommended for use in spaces where the walls or ceilings are painted bright colours, as the light bouncing off those surfaces will have a colour cast to it.

The other type of diffuser, such as the Lumiquest ProMax, is a big white stick-on panel. These diffusers essentially enlarge the light output area of the flash, softening the edges of shadows. Unlike small diffusers these larger accessories aren't so reliant on white surfaces off which to bounce light and thus are of more value outdoors or in large banquet halls and so on. However, they're really meant for relatively close-range shooting - they won't help much when taking pictures at a distance and indeed will hinder, as they cut the range of your flash unit by at least half and again, wasting batteries and increasing flash cycle times.

Note that Speedlites 540EZ and 550EX also include flip-down panels that serve as wide-angle flash diffusers and which increase flash coverage to 18 or 17 mm, respectively. Such panels are important for wide-angle photography since flash units aren't typically designed to cover huge areas. Fisheye lenses in particular represent a bit of a problem, since they have such wide coverage (nearly 180° diagonal for 15/16mm fisheyes and nearly 180° vertical for 8mm fisheyes) and so some experimenting with diffusers would be required for successful flash-illuminated fisheye photography.

Be careful if you're using A-TTL flash. A-TTL relies on an external sensor on the front of the flash unit, behind a recessed transparent lens. Certain types of flash diffusers can either block this sensor or reflect light down from the flash head to the sensor. Either way the sensor will get confused, which can lead to problems with your flash metering. Make sure the diffuser doesn't block the sensor. In the case of StoFen's Omnibounce accessory, for example, follow the instructions and tilt the flash head upwards by 45 degrees or so.

Another important thing to remember is that you do not have to adjust flash compensation when using a diffuser in any automatic flash metering mode that works through the lens (TTL, A-TTL or E-TTL) - just put the diffuser on the flash unit and shoot away. The camera will adjust automatically for the stop or two that the diffuser costs you, up to the limits of the flash unit's light output. Of course, if you plan on shooting in manual flash metering mode you'll need to factor in the reduced light output yourself through testing.

Finally, don't think you have to spend the money on these accessories. You can always just slap together a homemade flash diffuser out of a white translucent milk jug or tracing paper or thin fabric or whatever else you have lying around. A common trick is to angle the flash unit vertically, then use an elastic band to wrap an index card around the back of the flash head. This provides some forward light in addition to the light bouncing off the ceiling. The expensive accessories are mainly just more convenient and professional-looking.

Flash brackets.

As noted above, the large metal brackets from companies such as Stroboframe and Newton, and designed for mounting external flash units to a camera, are commonly used by wedding photographers and the press for reducing the risk of the redeye effect. However they also serve other purposes as well.

By raising the flash up above the lens you also reduce ugly flash shadows cast onto walls behind a subject. The shadows still occur; they're simply lowered down below the subject and thus may not appear in the final picture. Many flash brackets also have rotating attachments which allows you to keep the flash centred above the lens at all times rather than having it on the side when you take photos in portrait orientation rather than landscape.

The primary drawbacks of flash brackets are that they're very large and cumbersome and that they make you look like you've got a huge gigantic camera rig - which can frighten your human subjects or make them feel much more self-conscious than they would normally.

Another drawback involves AF assist lights. If you raise the flash off the camera you may find that the assist light on the flash unit no longer lines up correctly with the camera's focus points, thanks to simple geometry. Ironically this isn't a problem for A2/5 and 10/10s users, because those cameras never activate the AF assist light on external flash units.

External battery packs.

Most of Canon's high-end flash units have sockets on the side which can accommodate external high-voltage (270 volts) battery packs. These packs have two basic functions - they speed up the flash's recycle time between shots to a second or two (critical for news or wedding photography) and extend the time you can go between changing batteries. They're also useful in cold weather (battery performance always drops precipitately at freezing temperatures) since you can stuff the pack inside your jacket to keep the cells warm if necessary.

The Compact Battery Pack E requires 6 regular AA alkaline, NiCad or NIMH cells, but the newer Compact Battery Pack CP-E2 can also accept lithium AA cells. Either compact pack can be attached to the bottom of a camera using the tripod mounting screw. The much larger Transistor Pack E can use either 6 regular C cells (with Battery Magazine - lithium cells are not compatible) or nickel-cadmium rechargeable cells (with Ni-Cd Pack) and obviously has much greater capacity than the smaller Compact pack.

A number of other companies also sell high-power battery packs compatible with the Canon Speedlite high-voltage connector. These products include Quantum Instruments' Turbo (lead-acid) and Turbo Z (NiCad), Lumedyne's Cycler and Dynalite's Jackrabbit.

Unfortunately, the packs are all fairly heavy, bulky and inconvenient, (especially the huge Transistor Pack E and third party products) and require that the flash unit be tethered to the battery pack via a coiled cord. Note also that the flash unit will not work with an external pack if the flash unit's internal AA batteries are dead or missing - the high-voltage power is used solely for recharging the unit's capacitors, not for powering its control circuitry.

A number of manufacturers also sell generic battery packs (such as the Quantum Bantam) which can be connected to most AA-powered EOS flash units - even those which don't have special power sockets. They work by replacing the AA batteries with a plastic shell and running a cord to the power pack. However, as they aren't high-power they can't speed up the recycle time as dramatically - they're more useful for extending the number of shots you can accomplish between battery changes.

Keep in mind that portable flash units were not designed for continuous high-power use. You can damage your flash if you fire too many high-power bursts in a short period of time; something an external battery pack may let you do. So try not to fire flash bursts for longer than a few seconds, especially at full power manual or small aperture TTL firing. Remember that smoke emerging from your flash unit is shorthand for "stop immediately."

Flash units with high-voltage sockets:
Speedlites 430EZ, 540EZ, 550EX, 480EG*, MR-14EX and MT-24EX.

* The Compact Battery Packs are not recommended for use with the 480EG.

Flash extenders.

If you're doing nature photography of wild animals or are stalking wild celebrities for a tabloid and need to use flash photography across great distances, you might consider a flash extender, such as the Better Beamer. These accessories are simply plastic Fresnel lenses you can attach to your flash unit's head with tape or velcro. They concentrate the light much like a zooming head and give you an extra couple stops of light, at the cost of coverage area. They're only really useful, therefore, when using very long telephoto lenses - say, 300mm or so or longer. Michael Reichmann's "Luminous Landscape" Web site has some example photos of how this works, and Arthur Morris' "Birds as Art" site sells them.

I've also seen the term "flash extender" refer to devices which let you mount your external flash unit higher up off the camera hotshoe, but that's something different altogether.

Power source options for external flash units.

Most Canon external flash units run off four standard AA (LR6) alkaline cells, though one - the tiny and discontinued Canon 160E - used instead a small 2CR5 lithium battery of the type used by many EOS cameras. Here are some power source options for the AA type of flash.

Remember that all batteries can leak. If they do you'll find your beloved flash unit full of a corrosive liquid that will damage or even destroy it. It's wise to remove any cells from your flash if you aren't planning on using it for some length of time - a few weeks or whatever.

Note also that some flash units can behave erratically when battery power is low. Normally weak batteries just result in long recycle times, but on the 430EZ at least low batteries can result in strange behaviour - the flash triggering randomly, the zoom motor buzzing at odd intervals, etc. So if your flash unit suddenly starts acting strangely try changing the batteries. This can also happen if the flash unit isn't firmly seated in the hotshoe or if the contacts are dirty or corroded.

Standard AA non-alkaline (zinc carbon) cells.

Pros: Available for next to nothing.

Cons: Don't last very long at all and can't be recharged. They also have fairly high internal resistance and so it takes a few extra seconds for the flash unit to recharge between shots.

Standard AA alkaline cells.

Pros: Alkalines are cheaply and readily available anywhere. They store a fair bit of power and let you go a reasonably long time between replacements.

Cons: Last much longer than carbon zinc cells but otherwise have the same disadvantages. Recycle time to full power can range from 6-20 seconds, depending on how new the cells are.

Rechargeable nickel-cadmium (NiCad) cells.

Pros: Relatively inexpensive, rechargeable hundreds of times. They have a fairly low internal resistance and so decrease the recycle time the flash unit will take to recharge to full power to 4-6 seconds. NiCads also have better cold-weather performance than alkalines - their performance suffers when the temperature drops below freezing, but not as badly.

Cons: Don't store as much juice as alkalines, so you have to switch batteries much more often. NiCad cells are also hazardous household waste (heavy metals) and

should not be thrown into the regular garbage system. NiCad cells drain flat ("self-discharge") within a few weeks after charging.

Lithium AA (FR6) cells.

Pros: A fairly new development, these are lithium cells built to an AA shape. They store a lot of power, have long shelf lives, and recharge the flash at roughly the same rate as alkalines.

Cons: Really expensive and not rechargeable. Steep death curves - they'll work fine and then suddenly run out of power unexpectedly. Most importantly, only the latest Canon Speedlites can use them. Older models are not compatible with lithium AA cells owing to power issues, and might be damaged by them. The 540EZ and all EX series flash units can safely use lithium cells; all other flash units cannot.

Rechargeable nickel metal hydride (NiMH) cells.

Pros: Affordable and rechargeable hundreds of times. Higher capacity (1600 mAH) cells have similar capacities to alkaline cells. Not as hazardous to the environment as NiCads. Have a similar recycle time to full charge as NiCads - around 4-6 seconds.

Cons: Require different chargers from commonly available NiCad chargers. Can self-discharge in a couple of weeks.

External battery pack.

Pros: High-power packs can decrease recycle time to a second or two, letting you shoot flash photos more rapidly. Store a lot of power and so mean you don't have to change batteries as often.

Cons: Large, bulky packs linked to the flash via coiled cords. High-power battery packs work only with a handful of high-end flash units with the necessary power socket. Third-party battery packs are required for use with other Canon flash units, but don't have as rapid recycle times.

Flash tips.

Here is a handful of tips and potential pitfall areas. To begin with, however, a brief discussion about the quality of light (the kind; not a value judgement) involved in flash photography.

Quality of light.

I'm sure we've all had the experience - getting a roll of film back from the lab, only to find that the photos are all harshly lit and disappointing. How is that the professionals get such wonderful looking photos? Well, there are many reasons for this, but since this is an article about flash photography I'm going to discuss just one very common reason why amateur photographs can look terrible - flash.

The problem comes down to the quality of light. For a professional-looking photo of a person you generally want very soft light; light which lacks distinct shadows. Hard light, by contrast, tends to produce sharp-edged shadows, emphasizes facial blemishes and generally looks very unflattering.

The difference between hard and soft lighting essentially comes down to the relative size of the light source compared to the subject. Soft lighting is light which originates from a large area. Think of an overcast day, when the sun's light is filtered through clouds covering the entire sky - shadows are very soft. By contrast, a stage spotlight will cast a perfectly sharp circle.

And so this is the crux of the matter. Portable camera flashes are essentially designed to work like spotlights and have pretty small light-emitting areas - just a few square centimetres. This is partly for portability reasons and partly because flash units are designed to achieve the maximum distance range possible, by concentrating their light output with a reflector and lens. Any softening of the light necessarily involves a reduction in efficiency and range. So the light from a flash unit is, therefore, very hard-edged and harsh. Sometimes you want light like that - for illuminating glittery objects and emphasizing specular highlights. But for many things you don't.

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. White walls and ceilings work very well for this, as do large portable folding reflectors. You can also buy diffusers that attach to your flash that can help as well, either by distributing the light in more directions so the light can bounce off walls and ceilings, or by increasing the light-producing area somewhat. Remember that coloured surfaces will add a colour cast to the light - something you should always be aware of when bouncing light in interior spaces. A blood-red wall is going to reflect red light onto your subject.

Studio flash units (the big kind that plug in the wall) are frequently used with photographic umbrellas or softboxes to give the light source a larger surface area. Umbrellas are large folding umbrellas lined with white or silver, off which the light from the flash unit is bounced. (ie: the flash unit is mounted in the middle of the umbrella facing away from the subject, and the light bounces outwards) Softboxes are large boxes with reflective interiors and diffused white fabric front panels.

Portable battery-operated flash units don't really have the power required to illuminate large studios when used with umbrellas and large panel diffusers. But if you're on a budget and working in a smaller space, a photo umbrella - or even a regular umbrella painted silver on the inside and taped to a stand - can be a handy tool. So can directing the light from your flash unit through a simple frame with thin white fabric stretched over it. Experiment to find out what works for you. Here again, incidentally, digital cameras have a huge advantage - you can move things around and experiment constantly and get immediate feedback on the screen as to whether the new configuration works or not.

Remember that it's the relative size of the light source compared to the subject that's important. A huge softbox a long way away from a subject has the same kind of hard light as does a small diffused flash close up. So placing the diffused lightsource close to the subject is important as well. In studio situations softboxes are often positioned just outside the frame of the image area.

General flash photography tips:

- Remove any lens hoods when using an internal flash. If you don't you'll probably notice a dark crescent-shaped flash shadow at the bottom of your photos.
- Don't stand closer than a metre or so (3 feet) to your subject unless you have a macro flash. You'll get similar shadowing at the bottom of the photo. An external unit with a small diffuser can help, though.
- If the tilt/swivel head is not set straight on, double-check its position if you switch from landscape to portrait orientation or vice-versa. If the head is pointing the wrong way for the current orientation you might end up with ugly flash shadows, or half your photo might be properly exposed for flash and the other half not at all.
- If you're shooting in vertical (portrait) orientation and you have a shoe-mounted flash, be absolutely certain that your left hand is not holding the lens or in a position that could block light from the flash unit.
- If your camera has more than one focussing point do *not* use the old "focus, lock AE and recompose image" trick when taking flash photos. Instead, select the focus point nearest to your subject in order to bias flash exposure to that area. The exception to this rule is type A bodies which support FEL. You can use FEL in such situations to lock flash exposure to a given area of your photo before recomposing.
- If you need to shoot a number of flash photos in rapid succession consider using NiMH (nickel metal hydride), NiCad (nickel cadmium) or lithium (if your flash can handle them - many models cannot) batteries instead of regular alkalines. The internal resistance of these batteries is lower and thus the recharge time is faster. Note, however, that NiCad batteries can't store as much power as alkaline batteries so you'll have to replace them more often. Another alternative is an external battery pack, though they tend to be large and cumbersome.

Tips on shooting indoors in a small space:

- Use bounce flash off a low ceiling or a wall to soften the light. Unless the walls or ceiling are painted in strong colours, in which case you'll probably want to avoid bounce flash unless you want to tint the light.
- If you don't bounce the flash try using a small flash diffuser to break up the directionality of the light.
- Be sure you aren't shooting towards something reflective, like a glass window or mirror. Flash glare will bounce off the glass and look like an ugly mess. It will also throw off the flash metering, underexposing the photo.

Tips on shooting outdoors or indoors in a large space:

- Don't use bounce flash if outdoors or if the ceilings are too high or too dark or are painted in colours that will tint the light of the flash. Keep the flash straight on. If you tilt the flash, for example, you'll find the upper half of the image to be brightly lit and the lower half dark. This looks awful. The one exception is if you have a large flash diffuser installed.
- You probably won't want to use a small flash diffuser as it'll just cut the useful range of the flash. Small diffusers are light redistributors and thus most useful when there are nearby white surfaces off which the flash will bounce,

softening the light. Large flash diffusers are mildly useful in that they spread the source of the flash unit's light over a larger area, softening shadows, though the cost in range may not be worth it.

- When photographing people at great distances in low-light conditions remember that the risk of redeye in the photos goes up. This is particularly apparent when taking closeups of people using a telephoto lens from a long way away. (typical example - you're zooming in with a long lens to get a child's face during a school concert in a dimly lit gymnasium and the photo ends up looking like a choir of young Satans) Try to separate the flash as far as possible from the camera - even a large flash on a shoe mount won't be adequate distance.

Links to other useful documents.

Chuck Westfall/Mark Overton "EOS Flash FAQ".

Dave Herzstein's "EOS Speedlites Comparison Table".

Canon EOS FAQ Version 2.4. Section 3: Flash. (very useful, but no longer updated)

PhotoZone flash technology FAQ.

Discharge Graphs of Electronic Flash.

Toomas Tamm's "Electronic Flash Information".

Kevin Bjorke's "PowerShot flash photography". (discussion of flash photography with Canon digital cameras but more generally applicable)

Moose Peterson's "the TTL Flash System". (Nikon oriented, but has some general info)

Kodak Flash Photography. (a series of pages with helpful beginner material)

Cybaea "Colour Temperature and Colour Correction Defined and Explained".

Kelvin scale. (includes a list of colour temperatures)

Photodo's "Take the lights (sic) temperature and avoid colour casts". (interesting description of colour meters and colour temperature)

Photo.net: A-TTL and E-TTL. What is the difference?

Photo.net: Elan IIe and 380 ex fill flash.

Canon "Flash Work" brochure. (online edition from Canon Malaysia)

Vincent Laforet - "Show me the Light." (brief writeup on Canon E-TTL wireless flash. Scroll down 2/3 of the page to find the article)

Photography Tips - guide numbers.

Sam's Strobe FAQ. (total geek information - extremely detailed notes on the electronics found in flash units)

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- NK Guy, tela design.

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