

EFFECTS OF STRAY LIGHT ENTERING YOUR CAMERA'S VIEWFINDER EYEPIECE

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Note: If you use a rangefinder, mirrorless or other non-reflex camera that does not have an optical viewfinder, there is no need to read further; this document does not apply to you.

As a DSLR user, you have most likely heard or read comments about needing to put a cover on your DSLR viewfinder eyepiece during long exposures or under other circumstances. Some camera makers, maybe all, include an eyepiece cover when you buy the camera. Canon has a rubber cover that is attached to the camera strap so that it is always at hand ready for use. Well, almost ready. You first have to remove the rubber eyecup that is on the eyepiece.

It is first necessary to understand if, when and why it is necessary to block light from the eyepiece. There are three very different effects to be avoided, and this essay will describe why and when precautions are necessary. Although the effects are probably the same or very similar across the various camera manufacturers, this essay is written based on Canon models.

The three effects mentioned above are 1) light coming in through the viewfinder eyepiece immediately prior to the mirror going up, interfering with and causing errors in the camera's metering system, causing errors in exposure settings and possibly ISO setting; 2) light coming in through the viewfinder eyepiece during the exposure (while shutter is open and the mirror is up) finding its way onto the camera sensor and contaminating the image with non-scene light; and 3) light coming in through the viewfinder affecting the focus system.

Because not everyone wants to read through the explanatory material and the test descriptions and results, I will begin with the end: a summary of the findings and conclusions (based on two recent Canon models):

1. When the camera is in A, P, Av, or Tv mode, stray light entering the viewfinder at the time the shutter button or exposure lock button is pressed can interfere with the metering system and cause an underexposed result. This effect occurs during a very brief time between when the shutter button is pressed and the reflex mirror goes up, which is the time period when the camera makes its exposure measurement. (Metering is not performed during an exposure, only before it.)
2. If the camera is set to Auto ISO, the above effect can also occur in M (manual exposure) mode due to the stray light causing the metering system to change the ISO.
3. None of the previous effects on exposure occur in Bulb mode.
4. The above effects do not occur when shooting from Live View (unless flash is used, see discussion near the end).

5. Light entering the viewfinder *during* the exposure (while the shutter is open) will not affect exposure or ISO, but the stray light can leak onto the sensor and corrupt the image.
6. The significance of the effect of light entering the viewfinder depends on the scene brightness relative to the brightness of the light entering the viewfinder, and often the photographer's head, when looking through the viewfinder, blocks most light that could be a problem. But tripod work with sun behind the camera can certainly be a problem, and #5 is worse during long exposures such as night sky or when using very dense neutral density filters.
7. Light entering the viewfinder eyepiece can affect the focus system.
8. It is easy to perform the experiments and test your own camera.
9. While not a light leakage issue, it might also be noted that Auto is not always fully auto and Manual is not always fully manual. Read the instruction book carefully. Unexpected things can happen.

To explore those effects, we should first briefly discuss the camera's through-the-lens metering system. Light from the scene being photographed enters through the lens and is focused on the sensor. But before the exposure is made, the camera measures the light coming from the lens so it knows what settings of lens aperture, shutter time and possibly ISO to use for the exposure. So at first, the shutter is closed and the reflex mirror is "down", meaning in the light path at a 45 degree angle to the lens axis so that it reflects the incoming light onto a ground glass viewing screen at the top of the mirror box, which is the bottom of the optical viewfinder. The camera is designed so that when the image is focused on the ground glass, it will also be focused on the sensor when the exposure is made. A prism system transports the light from the viewing screen out the viewing eyepiece so you can see it. So how is the metering done? The light measurement apparatus is located in the viewfinder and pentaprism area; in my cameras, right above the viewfinder eyepiece. Normally that measurement is made when you press, or half-press, the shutter release button, while the mirror is still down. When the shutter button is fully pressed, and the light measurement has been made, the mirror flops up, covers the ground glass (which is why the viewfinder goes black during the exposure), gets out of the way of the light trying to get to the sensor, and then the shutter opens. When the exposure is complete, it all flops back down, ready for the next picture.

Now consider, just for example, that you have set the camera to aperture priority exposure mode (Av), and the aperture at, say, f/8. ISO is at 100, fixed. Before you press the shutter button, you now shine a flashlight into the viewfinder eyepiece. (Why would you do that? You wouldn't, except for testing, but maybe it was direct sunlight shining on it.) That light goes through the prism onto the ground glass viewing screen and lights it up. If you look into the end of the lens, you will see light from that brightly-lit ground glass being reflected out through the lens by the main mirror. The undesired light coming in through the viewfinder eyepiece passes through all the optics in the viewfinder assembly and some of it will find its way onto the metering system located in that area. That is not by design, it just happens. The metering sensors don't know that bad light from the good light coming in from the scene through the lens, so they faithfully measure the total light when you press the shutter button, triggering the light

measurement. The added light from the flashlight through the viewfinder will make the camera think the scene is brighter than it really is, and will drive the exposure down and make the image come out too dark. Once the exposure has begun, the flashlight won't have any further effect on the exposure time or aperture.

Things work differently in Live View, where the camera uses the main sensor for metering and focus.

Here's what happened in a series of experiments with four recent Canon DSLR models. Av mode, not live view. I pointed the camera across the room and made an exposure, it looked normal on the camera LCD screen. Then I shone a flashlight into the viewfinder and made an exposure. It came out very dark, due to having used a shorter exposure time in response to the added light from the flashlight, but was otherwise unaffected. This is consistent with the foregoing explanations. I performed more tests without a flashlight. With the camera set up on a tripod in my living room, about 4 feet from a picture window, eyepiece toward the window, lens toward the living room illuminated by the windows, on an overcast snowy day. No direct sunlight. The camera was set in Av mode, mirror lockup, 2-second shutter delay, and the lens aperture was adjusted so that the exposure time was 5 seconds with the viewfinder blocked. With the viewfinder exposed to the window, the exposure time dropped to about 1/5 second or less, but the room illumination was unchanged and the image was very dark. If the shutter button was pressed with the viewfinder eyepiece exposed and then the eyepiece was covered as soon as I heard the mirror go up and before the shutter opened, the exposure time was still reduced to the 1/5 second. With my head in viewfinder viewing position or my hand three inches or so behind the eyepiece, the exposure time was 5 seconds. That was enough blockage of the stray light to prevent the problem. In this test, there was no direct sunlight on the viewfinder nor a flashlight shining into it, just ambient light. So be careful in tripod work when you may not be looking through the viewfinder. Put your hat over the camera or put your hand behind the viewfinder, not touching the camera.

The Canon 1D series cameras have a viewfinder eyepiece shutter, a little lever you can move to close off the viewfinder. Fixes all these problems if you remember to do it. They haven't seen fit to include that in their lower model cameras.

Another test, using manual exposure (M mode), not live view. Using fixed ISO, the flashlight had no effect. Expected, since the camera does not need to measure light in M mode, because the exposure settings are made manually by the photographer. But using Auto ISO, the photo went dark. The camera changed the ISO setting. I didn't realize Auto ISO was effective in Manual mode; I thought Manual means Manual, silly me, so lesson learned. It can be learned from the camera instruction manual if it is read carefully enough. Very carefully. It didn't just jump out at me.

In Bulb mode, the photographer sets the aperture and determines the exposure time by holding down the shutter release button for the desired exposure time. Unwanted light from the viewfinder getting to the exposure metering sensors has no effect on exposure in Bulb mode, because those sensors are not being used. On the Canon 5Ds and 6D, if the ISO mode is set to Auto in Bulb mode, it uses a fixed ISO of 400, and unwanted light in the viewfinder does not change the ISO. Just like autoexposure, Auto ISO makes no sense in Bulb mode, so the camera designers decided on a default action if the photographer

inadvertently sets it to Auto. Just RTFM. (Maybe automatically going to a fixed predetermined number is still considered automatic?)

In Live View, the mirror is up when the shutter button is pressed, and the camera meters and focuses using the main sensor. This eliminates any issues resulting from stray light reaching the metering sensors in the viewfinder assembly; they are just not being used.

Stray light coming into the viewfinder illuminates the ground glass viewing screen. While the mirror is up, it covers the bottom of the viewing screen and blocks that light from progressing any further into the camera. Almost. When I take the lens off my camera, in a dark room, push and hold the shutter button in Bulb mode, shine the bright little flashlight into the viewfinder eyepiece, and look inside the camera at the top of the mirror box, I can see a little light leaking around the edges of the mirror. During the exposure, it no longer matters if the light reaches the metering sensors, because the exposure measurement was made before the mirror went up, or from the main sensor in live view. But some of the leaked light can still find its way to the main sensor, where the image is being recorded, and will corrupt the image. It doesn't take much leakage to corrupt a long exposure. I can't see any effect on an image at 1/10 second at high ISO, but a 30 second exposure is highly corrupted.

Ok, so the long-exposure lesson may seem silly: just don't shine a flashlight into the viewfinder when shooting the Milky Way. But it's a little more than that. Stuff happens, and photographers often wear headlamps at night and it is easy to accidentally shine the beam onto the back of the camera. Not for long, but still something. You really don't want to risk an exposure like that when it may last for 20 minutes with another 20 minutes for a blackframe used for long-exposure noise reduction. Also, it can happen in daylight if you are using, say, a 10-stop neutral density filter for 30 seconds with the sun shining on the back of the camera. No need to take chances, keep bright light out of the viewfinder.

Now we need to examine another detail of how the camera is made and works (again, this is for Canon DSLRs, may not apply to other brands). The autofocus sensors are located in the bottom of the mirror box. Light from the lens arrives at the reflex mirror, one function of which is to reflect the light into the viewfinder system at the top of the camera, including the metering sensors. Another function is to route some of the light onto the autofocus sensors at the bottom of the camera. It does this by a half-silvered area on the mirror that lets some of the light pass straight through the mirror. On the back of the reflex mirror is a secondary mirror which then reflects that light down to the autofocus sensors. When the reflex mirror goes up, the secondary mirror folds neatly up onto the back of the main mirror, out of the way of light going to the sensor in the back of the camera, and blocking any (or most) light from coming through the mirrors from the viewfinder. When the shutter button (or other button commanding a focus action) is depressed, but before the mirror goes up, light from the lens that is directed onto the focus sensors allows the camera to perform its focus actions. If there is light entering the viewfinder eyepiece, it will travel down to the mirror assembly. It goes through the half-silvered portion of the main mirror directly down to the focus sensors.

In an experiment, I set the camera up on a tripod with the lens pointing at a stone fireplace. The camera/lens would autofocus on the fireplace just fine. When I shone a flashlight into the viewfinder

eyepiece, and triggered a focus action, the autofocus was completely disabled; it searched for focus from one end of the focus range to the other. I did not explore the issue further; just seeing that the focus can be disturbed by viewfinder light was enough for me to conclude that it is another reason to block stray light from entering the viewfinder eyepiece.

In Live View, if Quick Mode AF is used, the camera will flip down the mirror, focus using the phase-detection autofocus sensor as it would in viewfinder shooting mode, then flip up the mirror again. This can be faster than the contrast focus technique normally used in Live View. The same issues with viewfinder stray light apply. Note: Canon models 1Dx Mk II, 5D Mk IV, 5DS and 5DSR do not have Quick Mode AF, so this issue does not apply. The 7D, 6D and probably some earlier models do have Quick Mode AF.

Another characteristic of Live View shooting appears when flash is used. The camera uses the main metering sensor for flash, even in Live View. In Live View, the mirror is up, shutter is open, and a live image appears on the rear LCD display. If flash is used, when the shutter release is pressed, the camera will drop the mirror (the live display will black out temporarily), fire a preflash to measure flash exposure with the normal exposure sensor, return the mirror up, then make the exposure. Thus the flash exposure metering is vulnerable to viewfinder stray light. I confirmed this with experiment using a flashlight in the viewfinder. I set the camera for three stops of ambient light exposure compensation and took an E TTL flash exposure. The image looked good, most of the scene lighting was provided by the flash. With the flashlight in the viewfinder, the image was dark since the flash exposure had been driven down by the light leakage onto the normal exposure sensor located in the viewfinder area.

The experiments described herein are easy and quick to perform, and doing so will teach you another aspect of your own equipment and techniques and help you make another step in improvement of your photography.