

Micro-Adjusting Autofocus for Sharper Images

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Figure 1 A red-breasted merganser approaches my floating blind in a mostly frozen lake at my Idaho home. When I had the composition I wanted, I selected a single AF point inside my viewfinder that coincided with the bird's eye. Naturally, since the merganser is swimming slowly, my autofocus is set to continuous autofocus. By using an AF microadjusted camera and lens, excellent technique with enough shutter speed (around 1/1000 second) and selected the AF point that coincides with the eye of this merganser, sharp images for me are the rule and not the exception. It can be that way for you too!

Since at least 2010, Canon began providing a focus adjustment in their cameras to improve autofocus accuracy. It is called AF Microadjustment. (Nikon calls this feature AF Fine-tune.) What does this mean? First, the autofocus in your camera is made to strict specifications and does a remarkable job. But, manufacturing tolerances are allowed. From my experience, nearly always the focus is not as precise as it could be for a **camera/lens combination**. Assume the autofocus is

reasonably good to begin with, but if you notice the focus is a little in front of the spot where focus should be right on, or a little past that spot, and either problem is consistent, then AF microadjusting the autofocus will improve sharpness. So far, all my telephoto lenses with a specific camera benefit from microadjusting the autofocus. Currently, I am using two cameras - the Canon 5D Mark IV and the 1DX Mark III. I must individually AF microadjust focus for each lens and camera combination I

use with autofocus to consistently achieve sharply focused images.

Since I teach many photography workshops where I show clients how to run an AF microadjustment test with their gear, I seldom find a camera/lens combo that does not benefit from setting some AF microadjustment. In other words, if you think you don't need it, you probably aren't checking closely enough. The odds favor you do need AF microadjusting.

Though, it does happen, only once have I found a camera and lens focusing precisely with the default values set in the camera.

What does Microadjusting do?

The factory sets the camera to focus on the target. But sometimes the focus is a little behind the target or in front of it, instead of right on the spot that should have sharpest focus, like a bird's eye. If the focus is slightly behind the target, then the camera is back focusing. Conversely, if focus is slightly in front of the target, then the camera and lens together are front focusing. Microadjusting the camera and lens combination makes the lens focus on the target consistently most of the time. Bear in mind that autofocus does vary a little from shot to shot, even when all conditions remain the same. You could lock your camera and lens up tightly on a tripod, not vary the composition at all, use superb shooting technique with high shutter speed, and still the focus might vary a little in a set of otherwise identical images. Therefore, to run the tests, I always shoot at least three images at each adjustment value and hope a majority (two of them) are focused without any variation from where it should have focused. Note I did not say proper focus. Instead, if the lens/camera combination is back focusing a little, hopefully two images show the same amount of backfocus.

Because autofocus does vary a little, even with the best technique, I often use manual focus with a magnified live view on my camera's LCD whenever possible. My focus is quite precise this way. Also, autofocus in live view is also precise because the focus is achieved at the sensor plane, and not up in the viewfinder. But, of course, photographing wildlife and even landscapes from a moving boat generally require autofocus. In that case, I focus on the exact spot where I want the sharpest focus, shoot several images, then quickly refocus on something at a different distance, and then return to the subject to make the camera focus the lens on the target again and shoot a few more images. Focusing on the same spot more than once increases the odds that some images will be sharply focused where they should be. And most of the time when using long lenses, I have the camera set to continuous autofocus rather than one-shot focus. Continuous autofocus continually adjusts the focus as the distance between the camera and the subject changes.



Figure 2 An American avocet is actively feeding. Since its head is continually in motion, it is difficult to keep a single active AF point on the face of the bird, so I set a small group of about five AF points to help me hold focus on its head.

How I run my test!

1. Make sure the exposure is ideal.

It is hard to check sharpness if the image is overexposed or underexposed. I shoot the image and adjust the exposure until the first blinkies appear in the \$20 bill – my preferred test target.

2. Turn image-stabilization off

You do not want the IS to activate on a tripod and cause image softness because the image-stabilization system is active. IS generally works best if you are shooting in the wind on a tripod or shooting hand-held where real camera vibration is likely to be the case, but do not run an AF microadjustment test with such conditions.

3. Use the maximum aperture

Even though you might wish to stop down more, and f/8 is a sharper aperture than wide open, for test purposes select the shallowest depth of field. This makes it easier to see the change in sharpness from one image to the next. Stopping down increases the depth of field that obscures the small autofocus errors that you are trying to detect, so shoot at the biggest aperture for test purposes as this helps you determine the image that is most sharply focused. The biggest aperture on most lenses fall in the range of f/4 to f/5.6.

4. Single Servo AF or One-shot AF

For test purposes, do not use continuous AF. You want the autofocus to lock in on the target and not hunt for sharpest focus after initially finding focus.

5. Use a solid tripod with head to lock your camera and lens completely still during the test.

6. Run the test outdoors in bright light. Avoid breezy conditions.

Bright light allows a fast shutter speed to minimize camera vibrations that might occur due to the breeze. It also helps the autofocus system “see” the target better.



Figure 3 Calliope hummingbirds are incredibly quick. When they hover above the hummingbird feeder, I put my small group of active AF points on its head and fire short bursts of images quickly. There is no time to study the composition as they do not wait that long.

7. Better yet, use flash to light the target!

Light the test target with steady light – lamp or sun but use flash to expose the target. I realize photographers are used to ambient light, but now I only run my AF microadjustment tests with flash set to short durations such as ¼ power. This eliminates “camera shake” vibration factors. Remember, this test is to determine how well the camera and lens autofocus on the target. It is important to eliminate all other factors as much as possible that can contribute to a loss of sharpness. My results are **far** more consistent now that I use flash! **It is the best idea I have come up with in running these tests.** Light the test target with ambient light, but not so much that it adds much exposure to

the subject. It is only used to let the camera's autofocus system work. Then **light the target with flash to gain the benefit of the short flash duration that eliminates other factors that can cause a loss of sharpness.**

Be sure to set the flash on manual and to $\frac{1}{4}$ power or less. If the flash exposure is too bright, move the flash back and shoot a test image to see if the ideal exposure is obtained. If still too bright, move the flash back again or you could reduce the flash duration even more. If the flash underexposes the target, then move the flash closer to the target. Naturally, you need to use a flash that is separate from the camera with optical or radio controls.

8. Use a perfectly flat target with lots of detail

The camera's autofocus works best if the target has fine detail with contrast. I normally use a \$20 bill because I find the sketch of Andrew Jackson's face is an easy target to evaluate. The fine markings in his hair on the left side of his face work well for detecting image sharpness. If you just paid your bills, you could get by with a \$1 bill as George Washington's hair has fine detail too.



Figure 4 Andrew Jackson is my test target. I activate a single AF point that coincides with Andy's hair on the left

side of this bill. When I check for sharpness, I only look at the hair on the left side. Nothing else matter. The hair is the test target. Due to the fine detail, it is easy for me to determine if one image is sharper than another, especially when shooting increments of five in the initial testing. Once the increments get down to one in the second testing, then it is much more difficult to see the differences, but I can see slight differences now that I use flash to light the target and thereby eliminate camera vibration factors.

9. The camera's sensor must be perfectly parallel to the flat target.

That means the camera must be at the same height as the bill, so the focus nicely covers the surface of the flat bill. I attach the \$20-dollar bill with duct tape to a flat wall. When I am home, I have a huge garage and tape a \$20 bill to the cement wall. I prefer doing this test in the garage because there is no wind, rain, hail, snow, or rapidly changing ambient light factors to deal with. I can run the test any time I need to. I light the \$20 bill with an LED lamp so the camera can autofocus on the bill, but not so bright that the lamp adds any exposure. I use a Canon 600 EX-RT flash with the Canon radio controller to expose the bill. The flash is set to $\frac{1}{4}$ power for the shorter flash duration to eliminate camera shake. Canon does not tell me how long the flash duration is at $\frac{1}{4}$ power, but I suspect it is less than $\frac{1}{3000}$ second and that is now the "effective shutter speed."

10. Since I shoot this test indoors and use flash to expose the \$20 bill, I use ISO 100.

When I once used the sun to expose the target, then I used ISO 400 to obtain a much faster shutter speed. My goal then was to use $\frac{1}{1000}$ second in bright sun.

11. The target should be about 25 to 50 times the focal length of the lens.

How do you figure that distance? A 500mm lens is 500mm. Taking the shorter distance of 25 times the focal length, that equals (500mm x 25 = 12,500mm). There are 25.4 mm in an inch, so 12500/25.4 = 492 inches. 492inches/12 inches per foot = 41 feet. Put the target about 40 feet from the camera.

I do not worry about the exact distance much anymore and I tend to favor shorter distances. For most lenses, I am about 60 feet away – the depth of my garage where I shoot the tests. And when I recently tested my Canon 100-400mm (set to 400mm) and my Canon 1DX Mark III, I used six feet. Why six feet!?! I use that lens/camera combination for hummingbirds, and the hummingbirds are about six feet from me when I photograph them. And I sure get sharp results by doing it this way. Remember: Rules and guidelines are meant to be broken or modified. And the sharpness of my images thanks me for ignoring the guidelines sometimes.

12. Use a two-second delay to fire the camera or a remote release.

Shooting the Test

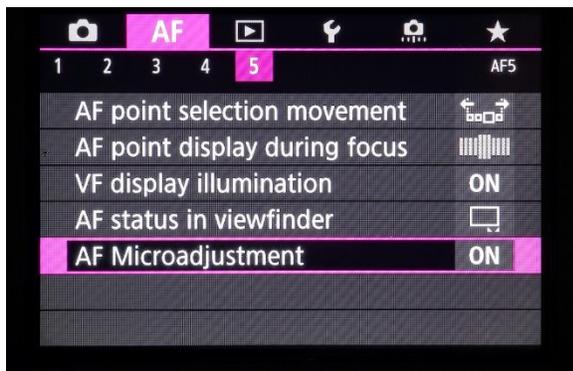


Figure 5 The start of the menu for AF microadjusting my Canon camera.

1. Find the Micro adjustment controls in your camera's menu. On my Canon 1DX Mark III, the control is Under AF and tab #5. Look at the bottom of the list to find AF Microadjustment. Naturally, the location varies with different camera models. And another camera brand may call this something different. Nikon calls this AF Fine-tune for example.
2. My camera gives me two options. These include:
 - a.) All by same amount
 - b.) Adjust by lens

I know my Canon lenses require different adjustments, so I use **Adjust by lens**. And with a zoom lens, two settings can be adjusted. One is for the shorter focal length on the zoom lens, and the other for the telephoto range. My camera can remember the focus adjustment I set for up to twenty Canon lenses! That is handy.

Let me point out that often I do not use autofocus, especially for close-ups (never) and for landscapes. Since I focus manually using a magnified live view image, AF microadjustment is irrelevant when doing focus this way. Plus, with shorter lenses on a tripod, I often use autofocus in live view and once again AF microadjustment does not seem to be necessary since the autofocus sensor is at the sensor plane and not somewhere else.

3. I align the camera's sensor perfectly parallel to the flat \$20 bill target – at least as close as possible. Then I shoot a series of images to find out if the camera/lens combo is front or back focusing. Let us adjust my Canon 100-400mm lens (set to 400mm) with my new Canon 1DX Mark III. My adjustment range provided is +/- 20 increments. These increments are tiny,

and if the autofocus requires more adjustment than this, the manufacturer must adjust the camera's autofocus. But, so far, I have never found a lens/camera combo to be that far off, and I have tested at least 50 of them.

The most AF microadjustment I personally have ever needed with my Canon gear is -9 and that was a Canon 5D Mark V with a Canon 100-400mm lens set to 400mm. Dixie has a Nikon D500 and the new 500mm f/5.6 PF-ED lens that is best at zero correction – one of the few I have tested that did not require any adjustment. But when she used a new Nikon 1.4x teleconverter with it, suddenly, she had to use a +10 AF microadjustment. That means her camera/lens combo was front focusing a little (hitting sharp focus slightly in front of the target) and the +10 correction made her camera/lens combination focus precisely on the target and not a little in front of it.



Figure 6 I saw this green-winged teal swimming toward me as I hid in my floating blind in Canada. I selected a single AF point to place on his head above the center of the image to provide room for its reflection. Since I knew the teal would pass by closely, I also selected the single AF point closer to the right side of the image to avoid cutting off his tail. Sometimes you get lucky!

Since I am talking about adjustment amounts, let me explain them in detail.

If your camera and lens focus in front of the target, then it is front focusing. If your gear focuses past the target, then it is back focusing. Setting a positive AF microadjustment makes the camera/lens focus at a greater distance, and, of course, a negative AF microadjustment makes the lens focus closer. So, a positive adjustment corrects front-focusing and a negative correction corrects back-focusing.

4. I shoot three images at each of these adjustment settings: -20, -15, -10, -5, 0, +5, +10, +15, +20. As there are nine settings, that means a total of 27 images. For each image, I begin out of focus, press the shutter button to initiate ONE Shot autofocus, and then press the shutter button all the way down to start the two-second self-timer, and immediately remove my hands from the camera to avoid vibrations. And don't touch the tripod legs either. (I see a lot of folks do this in workshops.) After two seconds, the camera fires the shot.

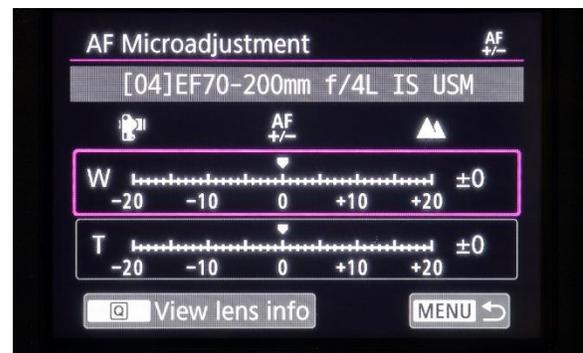


Figure 7 On zoom lenses, Canon lets me set an AF microadjustment for both the short and long end of the zoom range. That is convenient, but I have not done it yet because I rarely use autofocus at the short end of the zoom range. Oh, I use the shorter focal lengths, but seldom for action. Normally I am doing landscapes with the shorter focal lengths, and then I use autofocus or manual focus in live view.



Figure 8 I do not need this option. In every case, my camera/lens combos have required different adjustments. So, I always adjust by lens!

I start the procedure at -20. For the second and third shots at -20, I manually turn the focus ring until the lens is significantly out of focus, then press the shutter button again half way to make the camera refocus on the target and shoot another image. It is important to always start the AF with the target not in focus.

Then I return to the camera's menu and set the AF microadjustment to -15 and shoot three more images.

5. I follow this procedure for all nine focus adjustment values listed above, and then view my test images on my computer using Canon's DPP4 at 100%. Of course, you can use whatever software you normally use. Just view the images at 100%. I like 100% because a sharply focused image looks sharp on the computer monitor. Sometimes I do go to 200% and nothing looks crisp, but I look at relative sharpness and select the images that look sharpest relative to the others.
6. Hopefully, image sharpness is clearly better at one of these settings. I ran my test to find -5 was the best with the Canon 1DX Mark III and 100-400mm

lens set to 400mm. The larger AF adjustments, both positive and negative, such as -10 and 0, were clearly less sharp. That is good news as I know the Canon 1DX Mark III and the 100-400mm lens is close to the factory default of zero, well within the +/- 20 range that I can precisely set.

7. Since -5 is best with my initial test, I need to run one more test covering a small AF microadjustment range. Though -5 produces sharper images than all the other choices, it does not mean -5 is best. Perhaps -3 is slightly better or maybe -6. So, I run a second test to fine-tune my AF. I shoot another series of three images each at -8, -7, -6, -5, -4, -3, and -2. Then I look at the images on my computer monitor with Canon DPP4 and used 100% magnification. All the images look quite similar in sharpness, but by carefully observing Andrew Jackson's hair on the left side of his head on the \$20 bill, I mark the images that are clearly less sharp than others. Eventually I cut the images down to five. Then using the Info button (Control I) in Canon's DPP4 software, I looked at the EXIF data for each image that survives my cut hoping to find an AF microadjustment value that dominates. Here are the values I got from the five remaining images: -6, -4, -4, -3, and -2. Remember that autofocus does vary a little, so that accounts for -6 and -2 to be sharp in one image and my opinion is subjective too. Notice the trend, though. Most of my sharpest images are -4 or close to it. So, I set my AF microadjustment to -4, went outside and photographed some songbirds and got excellent sharpness.
8. From these results, I know two things. First, the camera and lens do need AF

microadjustment to give the sharpest possible image. Second, because the AF microadjustment value selected is -4, I know the lens is back focusing a little. That means the focus is a little beyond where it should be. The -4 setting makes the camera focus slightly closer to me. This is a tiny correction, but it does improve my image sharpness. And you can not assume the -4 correction works for you if you have identical camera gear. You must test your own camera/lens combinations.

9. Though -5 was clearly more in focus than -10 or 0, it was an easy decision to run the AF microadjustment test around -5. But, what should you do if after running the test using increments of five, both -5 and 0 are close in sharpness? Most likely the best AF microadjustment value lies between -5 and 0. Therefore, just to be thorough, I run my second test and shoot three images at -6, -5, -4, -3, -2, -1, 0, and +1. It will be far more difficult to see the difference in sharpness between adjacent values, but hopefully you will be able to arrive at a conclusion. And if -3 is actually the best setting, but you select -2 or -4, that is certainly close enough – even for me and I am picky!!!!



Figure 9 An eared grebe catches a nice juicy leech for lunch! Good bird!!!!

I realize many photographers AF microadjust their camera/lens combo by using tools made for the purpose, such as the highly regarded Lens Align focusing tool. I own this tool, and it does work, and helps you learn if your camera and lens is back focusing or front focusing, but I can easily do that myself without carrying more stuff with me. What if I need to microadjust my camera when I am on the road? I really do not want to carry anything else when I lead my safaris to Kenya or lead my Yellowstone photo tours where I live. By doing it the way I do, I can always set up a flat target with detail, and microadjust my gear quite successfully, and so can you. Some photographers swear by commercial AF microadjustment tools, but then I notice they sell the tools! Mmmmm..... OK, the tool I use is a \$20 bill. I will sell you a \$20 bill for \$50 – any takers? You probably already have a \$20 bill and you get it back when the testing is done! That works for me and I hope you too!!!!

Although I have not encountered it yet, I hear the microadjustment settings for a camera/lens combo can change over time, so watch out for that. And I suspect it is especially important to retest the equipment when shooting temperatures are drastically different. It does seem reasonable that a microadjustment test run in July might not be the best on a cold January morning.

What Lenses to AF Microadjust

Keep in mind that any AF microadjustment setting is good for the camera and lens tested. You cannot assume that adjustment is valid for any other camera or lens, even if the camera or lens is the same model. Think in terms of camera/lens combinations! Many lenses I do not need to AF microadjust because I never use them with autofocus. When I am making landscape images, for example, with my 16-35mm or 24-70mm lenses, I always focus them manually by using the magnified live view image

or use autofocus in live view. Remember, AF microadjustment only matters if you are using autofocus through the viewfinder, not manual focus or autofocus in live view!

This link sends you to an on-line Canon guide for AF microadjusting. It provides “official” guidance. I read this material carefully when I

first ran these tests, and modified things from their good starting point.

<https://cdn.static-bl.com/images/manual/Canon-AF-Micro-Adjust-Guide.pdf>

AF microadjusting has made a world of difference to the sharpness of my images. I cannot imagine not doing it. Good luck and may the sharpness of your images improve!!

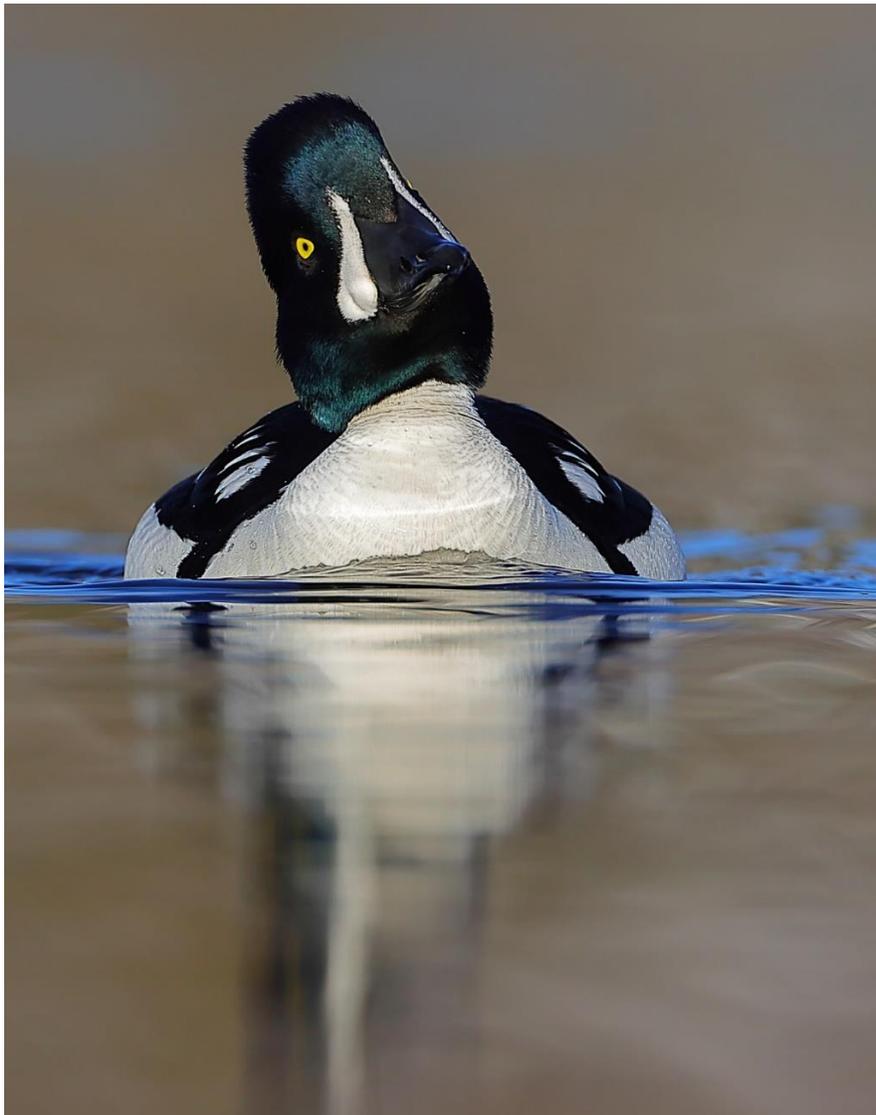


Figure 10 When one of your dream birds is slowly swimming right at you, sharp focus must be easy to do! Here is my first chance to photograph a drake Barrow's goldeneye on 99% frozen Henry's Lake where I live in Idaho. I selected a single AF point that corresponds to the forehead of the duck. Also, my Canon 1DX Mark III, Canon 600mm lens with 1.4x teleconverter is attached to a Wimberley Gimbal Head that is itself screwed onto the frame of a Mr. JanGear floating blind. Since things move in the water a little, I have image-stabilization on in Mode 2 so I can pan with moving subjects.