

Mastering the Multi-CAM 2000 autofocus system in Nikon DSLRs

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Introduction

I've owned my Nikon D2X for almost two years now. I finally think I'm getting a grip on the autofocus system. When Nikon introduced the Multi-CAM 2000 autofocus module in the D2H, it was the first new AF module since the Multi-CAM 1300 module in the F5. Instead of five AF areas arranged in the center of the frame, Multi-CAM 2000 provides the photographer with eleven sensors to choose from. What's more, the eleven sensors can be set up by the user to operate in four different modes, and some of those modes are further customizable by using the custom menu settings in the camera.

The Multi-CAM 2000 module is so complex that I've refrained from commenting on it on my site until now. When the D2X came out, there was a flurry of activity on various Internet discussion boards that somehow the focus mechanism wasn't accurate. While I certainly won't discount the possibility that certain D2X cameras could have had AF alignment problems, I think that the culprit in 99% of these "focus issues" was a lack of understanding of the CAM 2000 module. I'm saying this because it has taken me almost two years to fully understand (at least I think I do) the AF system on my D2X.

Sensor Layout

As I mentioned, the Multi-CAM 2000 autofocus module has eleven sensors (someone at Nikon must be a *Spinal Tap* fan). Nine of these sensors are the super-sensitive "cross-type", and the two outermost sensors are linear. As you can see in the figure below, the nine cross-type sensors are much larger than the AF bracket designated in the viewfinder. Also note that the sensors practically overlap each other, at least in the vertical axis. This information will be important later when I discuss troubleshooting autofocus issues. Each of the sensors in the CAM 2000 module are capable of sending a stream of focus data to the CPU in your camera for evaluation.

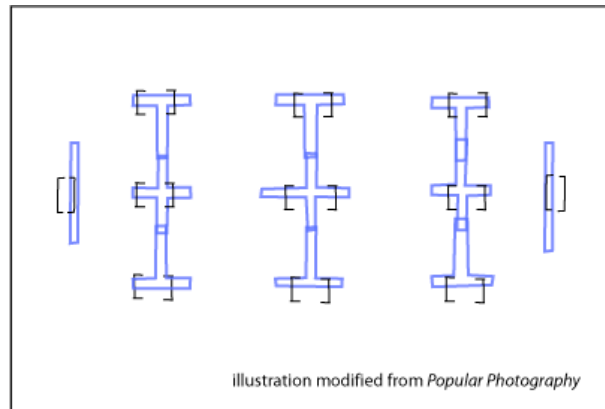


illustration modified from *Popular Photography*

The sensors in the Multi-CAM 2000 AF system are larger than you might think.

Servo Modes

The focus mode selector switch is on the body of your camera. On the D2X and D200, it has three positions: M, S, and C. M is for "manual". Setting the switch to this position disables AF altogether (although the in-focus indicator is still active in the viewfinder) and also puts the camera into release-priority shutter mode (more on this later).



The servo mode selector switch is on the front of the camera, underneath the lens release button.

Setting the focus mode selector switch to "S" puts the camera into single-servo autofocus mode (AF-S). In single-servo mode, autofocus will engage until it achieves a "lock", at which point the AF motors will cease altogether. As long as you are holding down either the shutter release (half-press) the camera will "think" the subject is in focus and the shutter will fire when you press the shutter release all the way down. If your subject moves between the time that focus lock is acquired and the time you release the shutter, your shot will be out of focus. Therefore, single-servo AF is best for stationary subjects, like landscapes or buildings, or for when you want to

focus, recompose, and then shoot.

The last position of the focus mode selector switch is "C", which stands for continuous servo AF. In continuous AF, the camera continually tries to adjust focus on whatever is in the active AF sensor as long as you are activating the system (half-press of shutter release or AF-ON button). By default, Nikon cameras are set to "release" priority when continuous servo AF is chosen. What this means is that the shutter will fire when the shutter release is fully depressed, regardless of whether or not the camera thinks object in the active sensor is "in focus". As I'll explain a little later on, you can change the default release settings for S and C modes if you choose to.

Focus Modes

The Multi-CAM 2000 AF module offers four distinct ways of activating the eleven autofocus sensors. You can toggle between these modes with the four-position switch located on the back of the camera. The four modes are, in order of increasing complexity:

Single-Area AF
Single Area Dynamic AF
Group Dynamic AF
Dynamic AF with closest-subject priority



The Autofocus mode selector switch is on the back of the D2 series cameras

Single-Area AF: Pure Speed

In Single-Area AF mode, only one of the eleven autofocus sensors is active at a given time. You can toggle between active sensors by using the directional thumb pad on the back of the camera. With only one active sensor sending a data stream to the camera CPU for evaluation, Single-Area AF is by far the fastest AF mode available. If your intention is to capture fast-moving subjects, and you are able to keep the AF point on your subject, then this is absolutely the best mode to use in combination with continuous servo.

Dynamic AF: less is more

Sometimes, however, it is a challenge to keep the AF point on your subject. For those times, Nikon offers "dynamic" autofocus modes. In the dynamic modes, the camera reads the AF data stream from multiple AF sensors, and then chooses which one has the "best" data stream. The sensor with the "best" stream is then tied to driving the lens into focus. The problem with dynamic autofocus is two-fold. First, autofocus systems don't know what object the photographer wants in focus, they just try to find the data stream with the best contrast information. Sometimes, the AF sensor that is chosen by the camera isn't the subject as you intended. Second, as you increase the number of active sensors, the camera's CPU has more and more data to evaluate to determine the best stream. This additional workload will slow down AF performance compared to Single-Area mode. In order for dynamic autofocus to work, the photographer needs to give the camera two input parameters: the initial focus point and the number of active sensors for the camera's CPU to evaluate.

Nikon offers three different dynamic AF modes. In Single-Area Dynamic AF, you set the initial AF point, but you allow the camera to read the data streams from all eleven sensors. As with all the dynamic focus modes, the camera will switch to a different AF point if it starts getting "better" data from another point. In other words, you are setting some input parameters (initial focus point) but then you put your trust into the camera. As you can guess by now, Single-Area Dynamic AF sounds great on paper but has the potential to cause incredible headaches in practice. The combination of letting the camera choose between any of the eleven AF areas and the workload of having eleven data streams to evaluate can cause serious issues in performance and focus if Single-Area Dynamic AF is not implemented judiciously. Single-Area Dynamic AF works very well when you have a plain, low-contrast background, like an empty sky. If your scene has trees in the distance, or rippling waves, you are setting yourself up for focus trouble.

Group Dynamic AF sounds more complex than Single-Area Dynamic mode, but actually it is somewhat simpler. Instead of activating all eleven sensors, the photographer selects a subset of active sensors. Because the camera is restricted to reading the AF data streams from only the sensors in the active group, Group Dynamic AF is the second-fastest AF mode on the CAM 2000 system. The photographer can further refine the behavior of the Group Dynamic AF mode by choosing from one of two patterns (custom setting a3 on the D2X). Unlike Single-Area Dynamic AF, you also have the option of specifying the initial focus point. You can choose to use the center point in the group, or you can let the camera evaluate the focus data to find the subject that is closest to the camera. As you can probably guess by now, choosing closest-subject priority also taxes the camera's CPU and slows down AF performance.

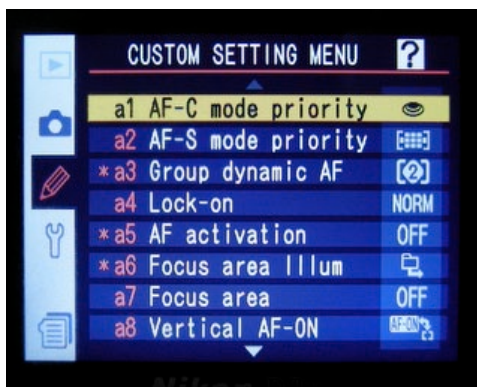
The last of the dynamic modes is Dynamic Area AF with Closest Subject Priority, or "hanging out at the pub mode". In this mode, all eleven AF sensors are active and the camera evaluates all of them and picks the closest subject. Because the camera is being asked to not only choose the initial AF point but also evaluate every sensor's data stream, Dynamic Area AF with Closest Subject Priority is the slowest of the CAM 2000 AF modes. Of course, when you are just taking family snapshots (or group shots at the pub) it is really convenient to use this mode.

To summarize, here are the Multi-CAM 2000 autofocus modes listed again, but this time in order of decreasing performance:

- Single-Area AF (fastest)
- Group Dynamic AF with center area priority
- Group Dynamic AF with closest-subject priority
- Single Area Dynamic AF
- Dynamic AF with closest-subject priority (slowest)

AF Custom Options

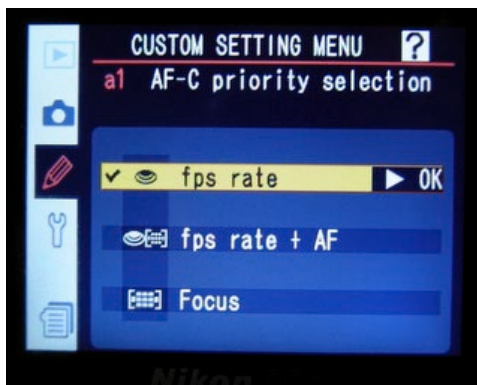
In the D2x custom menus, the user can choose to modify the autofocus parameters. For the D2 bodies, autofocus custom settings are in the "a" group, and there are eight customizable settings (a1-a8).



Release options

The first two custom options (a1 and a2) allow you to change the default shutter release options for single servo (AF-S) and continuous servo (AF-C) focus modes.

The default setting for AF-C (setting a1) is called "fps rate", which stands for "frames per second rate". This is also commonly referred to as "release priority". The camera will fire the shutter no matter if the subject is in focus or not. You can also select "focus priority" or "fps rate +AF", which acts as a hybrid between release and focus priority. I set my D2x to use "fps rate" when I'm using AF-C mode.



The default for AF-S (setting a2) is "focus priority". In focus priority mode, the camera will only allow the shutter to release if focus is "locked". In AF-S mode, you achieve focus lock by waiting for the camera to acquire focus while keeping the shutter button half-pressed. Once focus is locked, you can recompose and shoot, even if the subject moves out of the AF indicator bracket. If you want, you can change this setting to "release" priority.

Which setting should you use? I recommend using the default settings for both AF-S and AF-C servo modes. I have seen other articles recommending the use of focus priority for AF-C mode, and I have tried it, but I eventually went back to release (fps rate) priority. I'll explain why later on when I discuss the AF-ON focus technique.

Group Dynamic options

Custom setting a3 allows you to set up Group Dynamic AF. Recall that the camera needs to know two pieces of information when dynamic focus is enabled: the number of active sensors and which sensor to choose as the initial "subject" point. Custom setting a3

allows you to choose between two different grouping patterns, and for each pattern, you can specify either the center point as the starting point or allow the camera to use closest-subject priority. Pattern 1 creates a group of either four or five sensors in a cross shape, while Pattern 2 enables a center pattern of three AF sensors, and peripheral patterns of four sensors. When Pattern 2 is selected, pressing the center button of the D-pad will toggle the center group between a vertical and horizontal grouping. Because Pattern 2 uses fewer active sensors, autofocus performance will be theoretically faster than Pattern 1. I usually set custom setting a3 to Pattern 2 with center-area priority.



Lock-on

Custom setting a4 is probably the most contentious and controversial of all the AF options, based on the sheer number of discussions surrounding it on the Internet. Setting a4 is a feature called "Lock-on". In the original D2X firmware, you could either turn a4 ON or OFF. Since the introduction of the D2Xs, the D2X firmware was updated to include four different lock-on settings: Long, Normal, Short, and Off.



To understand how to set up the lock-on parameters in your camera, you need to understand what "lock-on" is actually doing. If an object comes between you and your intended subject, the AF data stream for the active sensor will suddenly indicate an out of focus image. The question is: "is this new object your subject?" If you are at a football game and the referee runs between you and the player with the ball, the answer is probably "no". That's why Nikon developed "lock-on". What the lock-on settings do is create a latent period during which the AF will not try to reacquire focus should the perceived distance to subject change rapidly. In other words, using lock-on initiates a DELAY in your AF system. This is a very good feature if you are tracking subjects whose distance to you is not changing quickly. However, if you are targeting animals or athletes running towards you or away from you rapidly, the lock-on feature can cause loss of focus. Based on my completely unscientific method (counting out loud), I have concluded that the delay for the various lock-on settings is as follows:

Custom Setting a4	Delay before AF reacquires target
Off	<0.3s
Short	0.5s
Norm	1s
Long	1.5-2s

What this means is that lock-on is great when you are panning with your subject, but it can cause serious problems if your subject is running towards you quickly. Since I do a lot of wildlife work, my default setting is Short, but I'll turn a4 off if I'm tracking flying birds.

Custom setting a5 allows you to disable AF activation when pressing the shutter release (AF-ON Only). If you do this, only the AF-ON button on your camera can be used to activate the AF servos. In my D2x, custom setting a5 is set up to do just that. I'll explain why I do this in the section about technique.



Other options

The last three custom settings in the "a" bank are really personal preferences. In setting a6, you can specify how long an AF indicator bracket lights up in the viewfinder, and whether to light up the points in manual focus mode. In setting a7, you can change the behavior of the D-pad to either "wrap-around" when selecting the AF points, or to stop when it gets to the edge of the viewfinder frame. Custom setting a8 allows you to change the behavior of the vertical AF-ON button on the D2X.

Focus technique: Using the AF-ON button instead of the shutter release

I've been mentioning specifics about the way I've set up the AF system on my D2x. Most of my choices have to do with the technique I use for focusing the camera. I learned this technique from a Nikon Professional representative, and I think it works really well. Essentially, I can keep my D2x set to continuous servo mode all the time but still have the same functionality of AF-S mode if I want.

Let's start with the basic ideas first. In AF-S mode, the advantage is being able to lock focus, recompose and then release the shutter. This technique is great for when you are trying to compose a shot and your point of interest does not fall directly on a focus point in the viewfinder. In AF-C mode, you get the benefit of continual AF drive. Let's face it, lots of things don't stand still long enough to lock focus and then recompose. But what about those times when you are tracking a moving subject and then it stops long enough for you to actually compose a nice shot? If you are in AF-C mode and you have the AF activation linked to the shutter, if you recompose the shot the AF system will engage and reacquire focus on whatever is in the bracket. Not good. You'd have to switch to AF-S mode, and then hope your subject doesn't start moving again. Well, if you set custom setting a5 to OFF (AF-ON only), and you have AF-C set to release priority (fps rate), then you can get the best of both worlds!

- 1) Follow your subject continuously by pressing the AF-ON button.
- 2) When your subject stops, focus on the point of interest and then RELEASE the AF-ON button.
- 3) Recompose and shoot.

This technique only works when you have custom setting a1 set to (fps rate or fps rate+AF), and you have custom setting a5 set to OFF. If a5 is ON, then the camera will try to refocus the image when you press the shutter release. If a1 is set to "Focus", then the camera will think the image is out of focus when you recompose and it won't fire the shutter.

The major disadvantages of using the AF-ON technique are:

- Using the AF-assist lamp on an SB-800 requires AF-S mode
- Difficult to use in portrait orientation on cameras without a vertical grip (D200)
- Can be tricky if you are a PJ and you are shooting one-handed over a crowd

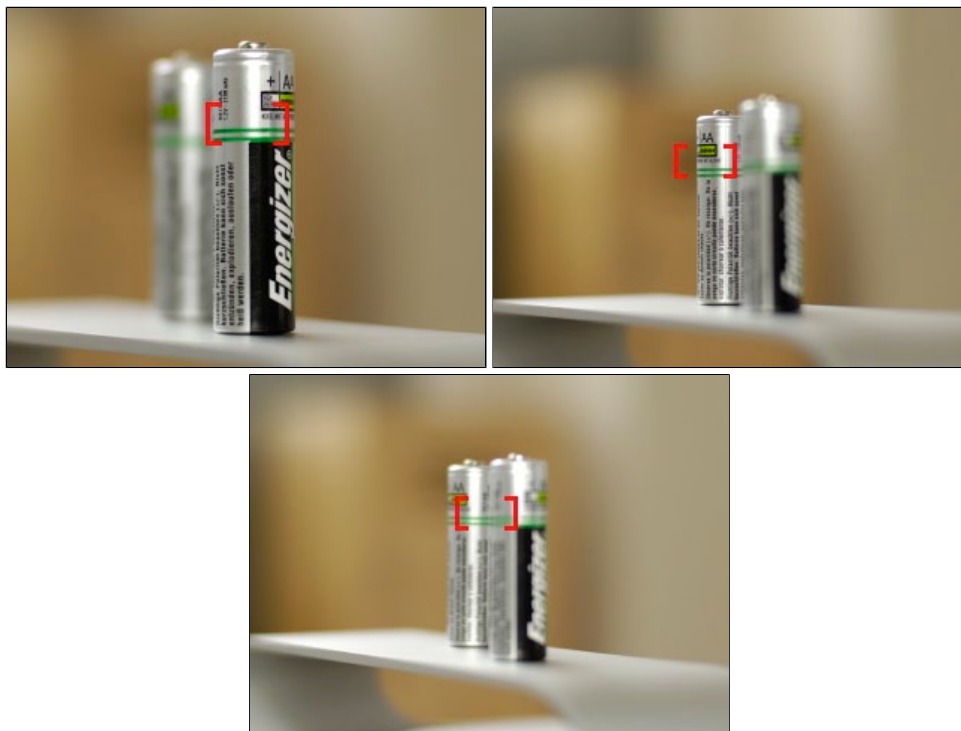
Otherwise, I really think this technique is great; you get the speed of AF-C and the ability to lock focus at any time by simply releasing the AF-ON button.

Troubleshooting autofocus issues

Despite all the advances in autofocus technology, it is important to remember that the camera is a machine and it cannot read your mind. The human eye still focuses much faster than the best AF systems. With this in mind, let's examine some of the subjects that are really tough for even the best AF systems.

Small subjects

As a general rule, if your subject is smaller than the AF indicator in the viewfinder, you are going to have a hard time getting precise focus. Also recall that the actual sensors are MUCH larger than the AF indicator brackets. If there is another object that is not in the AF bracket but still in the AF sensor coverage area, you could mis-focus. Here's a test: Set up two small objects, one behind another about three inches apart, but so that they overlap in the viewfinder. Place the focus point on the area of overlap, lock focus (or try to), and take the picture. Chances are, the AF system will "split the difference" between the two objects and result in an image where neither object is sharp!



These shots illustrate what happens when multiple objects overlap a single sensor in the D2X. These screen shots are from Nikon Capture NX, where I was able to superimpose the position of the AF bracket on the screen. In the bottom image, the focus bracket straddles two objects, resulting in the camera "locking on" to a point in between the front and back object.

Fast-moving subjects

The Multi-CAM 2000 system is very fast, but it still has its limits. If you are tracking a subject that is moving very fast, I suggest setting custom setting a4 to OFF.

Low-contrast subjects

Autofocus systems judge focus based on image contrast. As a result, some subjects are easier than others to focus on. Athletes with brightly colored jerseys with numbers and letters are an easy target. Monochromatic animals in dim conditions are a challenge. When you have a small, low-contrast subject that is moving against a high-contrast (busy) background, like a duck in rippling water, you've set yourself up for focus problems! Set the camera to single area AF and avoid using dynamic AF in these situations. Probably the biggest culprit for "backfocus" issues is using Single Area Dynamic AF in a situation where the subject is low-contrast, small in the viewfinder, and against a high-contrast background.

Wide-angle lenses

Super-wide lenses, like the Nikkor 12-24 DX lens, have tremendous depth of field, even when used wide open. As a result, objects can "overlap" in the viewfinder over a single AF point, as discussed in "small subjects" above. With these lenses, it is often better to use hyperfocal technique or focus manually, unless your subject really fills the frame.

"Slow" lenses

Slow lenses (f/4 and slower) let less light into the camera, and the AF acquisition will sometimes be slower as a result. Slow lenses also have greater depth of field, which can make critical focus more challenging. Using f/2.8 lenses (or faster) is a great way to improve AF performance, if you have the money for these expensive lenses.

Conclusions

The Multi-CAM 2000 autofocus system in the Nikon D2 series and F6 cameras is a complex system that is capable of outstanding performance. It is, however, far more complicated than the Nikon AF systems that preceded it. As such, focus problems can occur because the camera and photographer choose the subject of interest differently. Subject size, contrast and placement of the AF

sensors can all contribute to focus "problems" if not properly understood. My personal conclusion is that after nearly two years with the D2X, I'm finally beginning to master this complex technology. At the same time, it is important to remember that no autofocus system is as precise as the human eye when it comes to subject acquisition and tracking.

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