Canon

# Dual Pixel CMOS AF

*The story of*
*"Technology" and "Passion"*

**Interviews with Developers**

# Dual Pixel CMOS AF will change the basic assumptions about Digital SLRs

This is not just a new technology. It is a revolution that will significantly expand the possibilities of DSLR cameras.

*"The correct way to take photos is by looking through an optical viewfinder and shooting"*

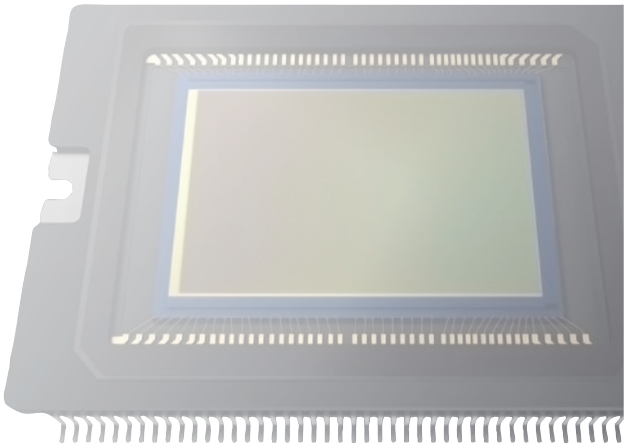
*"Live View is a subsidiary function, inferior to the optical viewfinder"*

*"The DSLR's movie mode is so difficult, as to be usable only by a professional"*

***Dual Pixel CMOS AF*** is a new technology that will cast aside these assumptions. The entire surface of the sensor is lined with pixels composed of two photodiodes each, and the image plane phase-difference detection AF focuses using the phase-difference of the two parallax images.

Even when shooting with Live View, because it is phase-difference detection the AF is fast. Rather than pixels dedicated to AF, the pixels have both AF and imaging functions, all effective pixels can also be used for imaging. Now Live View Shooting will be a shooting method choice that is equal to optical viewfinder shooting.

This innovative technology developed by Canon's elite team will expand shooting possibilities, and change what is possible in Live View and video shooting with digital SLRs.

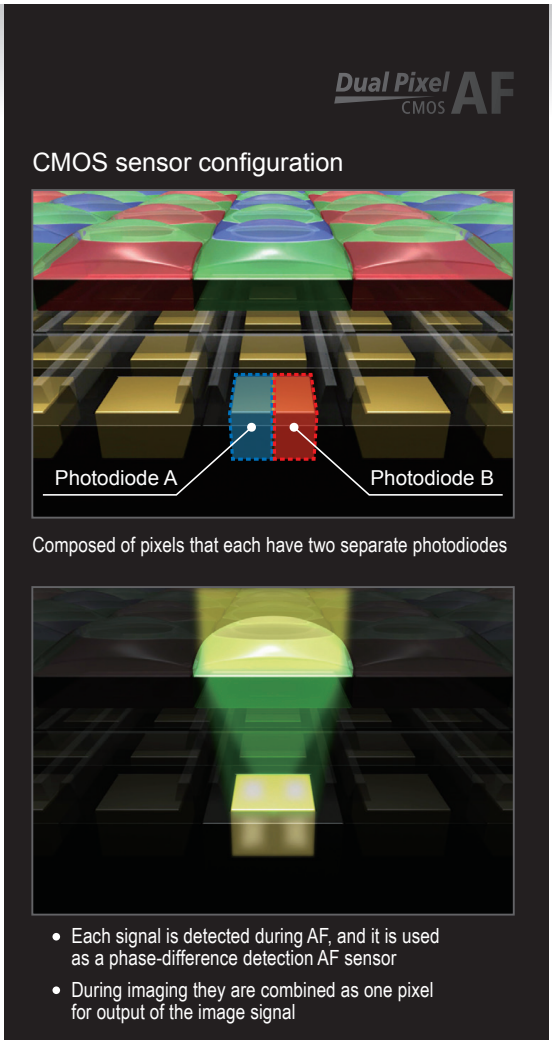


# Even in Live View shooting, achieving "Fast—Comfortable—High Image Quality"

As the mirror is up during Live View shooting, the same phase-difference detection AF used when shooting with the optical viewfinder cannot be used. As a result, contrast AF was used on most cameras up until now; however, compared to phase-difference detection AF which predicts the position the lens is in focus and moves it, contrast AF looks for the sharpest position while moving the lens back and forth, so AF speed ends up being slow. ***Hybrid CMOS AF*** was included from the EOS REBEL T4i, pixels for AF were partially spread out around the sensor, and by integrating image plane phase-difference detection and contrast detection, faster AF was accomplished. In order to accomplish even faster speeds, put simply, increasing the number of AF pixels and improving the precision of phase-difference detection AF should mean contrast AF does not need to be used — however, in combination with imaging, there is a limit to how many AF pixels can be distributed. Dual Pixel CMOS AF solved this problem fundamentally.

***Miyanari:*** *"Ordinary sensors have microlenses distributed to each RGB pixel, and under these, photodiodes that change the light into electronic signals are distributed to each one. However, with a Dual Pixel CMOS AF sensor, two photodiodes are distributed to each microlens. As a result, two parallax images are captured at once. With Dual Pixel CMOS AF, signals from these two images are used to carry out phase-difference detection AF. In addition, by combining two photodiodes, the image signal can be output as one pixel. This is an important point. So, as AF and the imaging function are combined in one pixel, it was possible to expand it to all pixels. Maintaining image quality and increasing the number of AF capable pixels is definitely an advantage. Image quality is absolutely not affected in any way."*

Imaging performance is maintained, and this technology achieves Canon's strong desire to realize high-speed AF even during Live View shooting. Accomplishing this structure brings significant merits.




***Fukuda:*** *"As AF pixels are distributed over the entire sensor surface, a broad area of the Live View screen, final focusing with phase-difference detection AF over approximately 80% (vert.) x 80% (horiz.) is possible. As a result, not only is AF speed improved, but focus precision of points of light in night scenes which was a problem of contrast AF before is now improved. Tracking performance of subjects with movie servo AF is also significantly improved. Also, in comparison with Hybrid CMOS AF which uses contrast AF at the same time, there is no unnatural behavior as the lens searches for the focal position, making even smoother, more natural focus possible.*

*When using supported lenses.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# Innovative breakthroughs opening the way to the future

Dual Pixel CMOS AF achieves a wider range of AF with speeds that approach that of optical viewfinders even during Live View. An elite team that was assembled from all departments within Canon brought about this technology that has the potential to significantly change the way DSLR cameras are used.

By drawing on all of the skills and know-how of each and everyone's respective area of expertise, barriers were overcome. In addition, due to the tight coordination with each department, working together with the same idea gave birth to the new technology. And there were no regrets for the steady efforts that were made. As a camera manufacturer, this breakthrough was accomplished only as a result of the resources from producing almost all of our own equipment for many years.

***Fukuda:*** *"I think separating photodiodes into two while maintaining imaging performance was the big breakthrough this time. Simply inserting a structure between the photodiodes would have an impact on the imaging performance such as the background blurring unique to DSLR cameras. It really was significant that we were able to achieve AF without a loss in image quality. In addition, the performance that is necessary as a pixel for AF is not always same as the performance that is necessary as a pixel for imaging. We thought out the optics design of the pixel to balance two functions in one pixel."*

Development of an IC dedicated to AF for processing information was carried out.

***Miyanari:*** *"With the AF signal of Dual Pixel CMOS AF, there was twice the amount of information as the number of effective pixels that lined the sensor. This process could be performed with just the imaging processor; however, we believed it would be too much to ask, so a dedicated IC was developed. By establishing an IC for the role of preparation so the imaging processor could process one after the other, high-speed, optimized processing was made possible."*

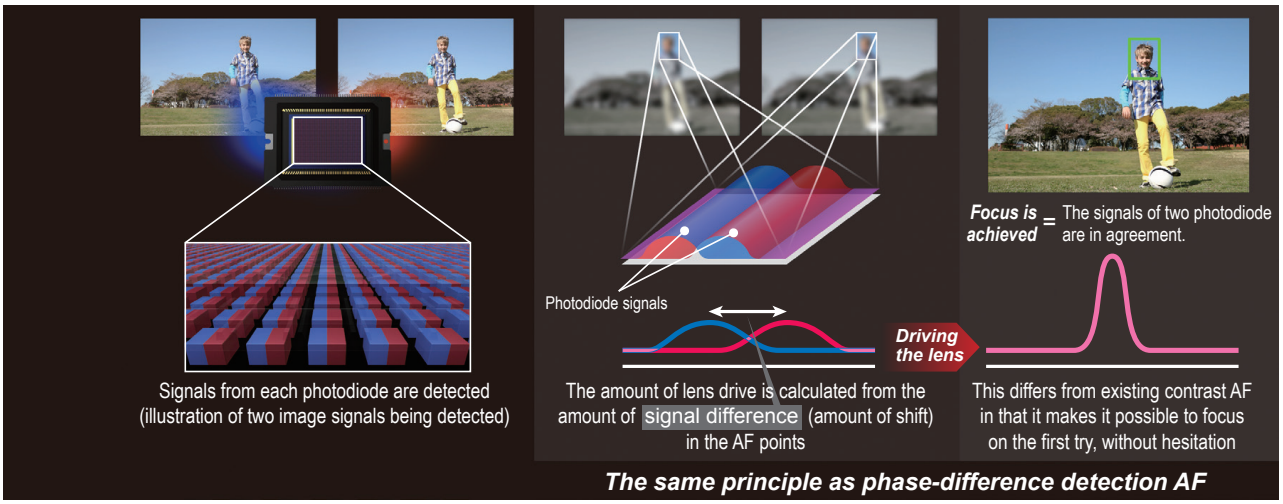
In order to accomplish Dual Pixel CMOS AF with its completely new structure, a major redesign of the algorithm was carried out.

***Sakaguchi:*** *"Although it is the same phase-difference detection method as viewfinder AF, because the sensor and optics differ, it was necessary to design a new algorithm. However, as just designing was not enough, it was necessary to make tests one at a time. We had in particular a hard time to overcome the scenes affected by light saturation such as sunshine filtering through foliage as well as reflecting off car hoods, and points of light in dark scenes. By repeating low-profile work such as sitting in the hot sun and continuously shooting bright subjects for three hours every day on a hot summer day, and running tests, the algorithm was improved and we were finally able to reach a successful victory."*

Dual Pixel CMOS AF which made a great leap forward from existing technology possible is a technology with great potential for the future.

Development of Canon's new technologies will not be stopping any time soon.

## *Dual Pixel CMOS AF structure*



# 103 EF lenses are supported

* Including models with limited, local distribution

At present, Dual Pixel CMOS AF supports 103 EF lenses (this includes EF-S lenses). Of course currently sold lenses, as well as many EF lenses sold in the past are supported.

***Nakagawa:*** *"Lenses can be changed on DSLR cameras, and as they are a very important system, this is a great merit. Just because a lens has been discontinued, this does not mean that we will no longer support it. This is something that surely needs to be confirmed one at a time."*

Dual Pixel CMOS AF is not an upgrade of existing technology, it is a completely new technology. As there is no past accumulated data, dedicated testing of all lenses was necessary.

***Nakagawa:*** *"First we started by shooting a predetermined subject, then testing the focus shift. This work was to confirm that it conformed to Canon's established standards. Of course we confirmed through simulations that focus was achieved with Dual Pixel CMOS AF, however, there were some cases where it did not go that way during actual testing. With old lenses in particular, as this was technology that was not envisioned at the time, disagreements with the simulations were more apt to occur. So, it was necessary to check them all. With the labor of checking the zoom positions for 30 minutes to an hour for each lens, when checking 50 lenses for example, if a problem occurred with the 50th lens and the algorithm needed to be revised, there were cases where all 50 of the lenses would need to checked all over again. From the start of testing, it took about half a year to finish 103 lenses."*

With the testing finished, Dual Pixel CMOS AF was finally completed. The result that all common EF lenses are supported is an extremely big deal.

***Miyanari:*** *"Even new EF lenses equipped with USM and STM that had fast AF drive already, it could be proven that they were even faster, and amongst the lenses that supported Dual Pixel CMOS AF, in particular lenses developed awhile ago, and low priced lenses, you will find that the effect of Dual Pixel CMOS AF is quite significant."*

The ability to choose lenses from an abundant lineup freely is a big merit of the "EOS system". It may be natural to expect new technologies always support for old lenses. But it is often very difficult in fact.

Steady testing is continued every day to have all users realize evolution of "EOS".

## Supported lenses

| | | Supported lenses | Non-supported lenses, or with an extender attached |
|---|---|---|---|
| Still image | One-shot AF | A | B |
| Movie | Movie servo AF | A (low-speed drive) | A (low-speed drive) |
| | One-shot AF | A | B |

**A:** Dual Pixel CMOS AF

**B:** After Dual Pixel CMOS AF detects the direction of the focus lens, contrast AF is used

*With Live View continuous AF as well, Dual Pixel CMOS AF is possible with all lenses.

*Compared to One-shot AF, movie servo AF is driven more slowly.

*Contrast AF is used during Magnification or Movie Digital Zoom.

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# EOS MOVIE for everyone

Up until now, the basic assumption was “DSLR = a camera for shooting still images”. Movie shooting was a function that was included, but it was only a secondary function. EOS MOVIE is certainly proving to be extremely popular as a new form of video expression, however, as the AF performance is not sufficient, where it is used a lot in the professional world, it cannot be handled easily like it is on video cameras.

However, as Dual Pixel CMOS AF achieves high performance AF during Live View shooting, this will break down these assumptions. Movie expression that takes advantage of background blurring, and lens interchangeability that is inherent to DSLR will become available to everyone.

***Miyanari:*** *“I believe that it will pave the way for a new form of shooting that differs from video cameras. Ordinary users will shoot while changing lenses, and they will be able to shoot movies with ambience.”*

With Dual Pixel CMOS AF, in order to ensure that it works extremely effectively when shooting movies, special tuning is being carried out.

***Sakaguchi:*** *“Some lenses are made to move smoothly when shooting movies; however, as most EF lenses were originally made for shooting still images, they move extremely fast. However, when shooting movies it is necessary to move it slowly intentionally. The ability to focus instantly for still images is controlled so movement is gradual, and as a result this achieves smooth focus which is suited for movies. By tuning for movies in this manner, movie servo AF will support all lenses with Dual Pixel CMOS AF.”*

In addition, AF tracking performance which movies cannot be without has been dramatically improved. Smooth movie servo AF like that of video cameras is now possible.

***Miyanari:*** *“Tracking performance is extremely high. Faces are tracked reliably. It works extremely well in particular with lenses equipped with STM of the lead screw type. You could say that they are the best match, as they focus with gratifyingly smooth movement, and drive sound is quiet so it does not affect audio.”*

This is a shooting device that makes it possible to shoot high image quality photos and highly expressive movies on the same unit. A high dimension of expression with the new format distinguishes it from video cameras and compact digital cameras. You can capture moments with photos, or express the passage of time with movies. As a result of Live View equipped with high performance AF, we will be able to freely choose the recording method according to the objective at that time. We have accomplished another step up to a new level of DSLR cameras.

## *Merits of the Dual Pixel CMOS AF in movie shooting*

As movie servo AF tracking performance is even better, it is possible to shoot movies while more continuously focusing on moving subjects.

As contrast AF is not used at the same time, there is no unnatural behavior as the lens searches for the focal position, making even smoother, more natural focus possible.

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**Hiroshi Matsushima**

# New forms of photographic expression that spread out from Live View shooting

With Dual Pixel CMOS AF, it will no longer be possible to make the generalization that viewfinder shooting is a superior method to Live View shooting. Users will be able to differentiate the merits and demerits of the two "viewfinders" and use according to the scene. As the range of shooting styles will expand, we will be able to shoot photos that we could not capture until now.

***Matsushima:*** *"Dual Pixel CMOS AF has merits that you will not find with viewfinder AF. The area capable of AF is expansive, and intuitive selection of AF points is possible with the touch panel. This is not a case of which focus method is better, but as they both have areas they excel at, having both on the same camera means that it will rapidly expand the world of shooting which is very important."*

It is a fact that some photos cannot be taken by just looking through the viewfinder.

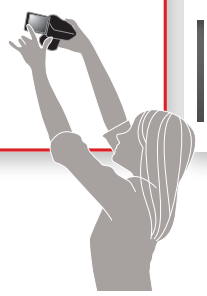
***Matsushima:*** *"By combining Live View shooting with a vari-angle LCD and Touch Shutter function, the world you could not shoot with the viewfinder can now be portrayed. Shooting flowers from below against a blue sky, or conversely shooting from overhead is also possible. These photos would be impossible to shoot with the style of pressing the shutter button while looking through the viewfinder. With Dual Pixel CMOS AF, as Live View shooting AF speed has increased, it is now even easier than ever to shoot when handheld, from any orientation. And, by taking advantage of the EOS Remote application to link with a smart-phone, you will be able to shoot even more interesting photos. You will be able to shoot a pet from a distance as it eats, or a child that is peering into a refrigerator from inside the refrigerator for example."*

As technology advances, at Canon, we want to offer new experiences to our users.

***Ishida:*** *"What Canon is pursuing in terms of product development, is to be able to offer the customer as many shooting experiences as possible. We will attempt to answer the shooting demands of various customers around the world, for example regarding improved AF performance results, I would like to appeal what kind of shooting is possible. With Canon cameras, customers will encounter scenes that they have not seen before, and they will be impressed no matter what kind the new experience is. At Canon, we refer to this as "expansion of shooting possibilities", and all of us here at Canon carry out product development with this in mind. We will continue to advance EOS with the intention of "expansion of shooting possibilities". In that sense, Dual Pixel CMOS AF is nothing more than a milestone."*

## *Merits of Live View shooting and Viewfinder shooting*

| Dual Pixel CMOS AF advanced points | Merits of Live View shooting | Merits of Viewfinder shooting |
|---|---|---|
| Improved AF speed over the entire area: ***Approx. 80%*** of the shooting area horizontally and vertically. | Wider potential AF area compared to the viewfinder | Fast AF speed |
| Improved tracking performance of continuous AF and movie servo AF | Intuitive AF point selection is possible with the Touch Shutter | AF tracking is possible during still image continuous shooting |
| Even smoother AF operation during movie shooting (No back and forth movement like that of contrast AF) | Exposure simulation and Creative Filter effects can be visualized | The cross AF points are effective at capturing, regardless of the subject pattern |
| | Subjects have good visibility even when poorly lit | The visibility only from an optical viewfinder, and great image response |
| | Movie shooting is possible | Peering through the viewfinder it is possible to shoot with a stable pose |
| | Various shooting angles are possible with the vari-angle monitor | |



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