Lens Guide

FocusEd Camera™

Table Of Contents

Introduction

Welcome to our Lens Guide, a comprehensive e-book that unlocks the secrets behind camera lenses, unraveling the fascinating world of focal lengths, lens sharpness, the elusive "sweet spot," and all those cryptic lens abbreviations. In the realm of photography, lenses play a pivotal role in capturing stunning visuals and conveying your creative vision. Understanding their intricacies is key to harnessing their full potential and elevating your photographic skills.

This guide is your gateway to unleashing the true potential of lenses and capturing extraordinary images. Learn to navigate the confusing world of lens abbreviations, from focal length notation to common acronyms. There are factors that influence lens sharpness and we explain how to find the optimal aperture setting for maximum clarity and minimal aberrations. Explore how different focal lengths allow us to manipulate perspective, depth, and composition.

Camera Lens Abbreviations

You are standing in the electronics department looking at the end of the camera lens you want to buy and it looks like alphabet soup or maybe a secret code… EF, DX, AF-P, ED, IS, VR, USM. What do all those letters and numbers mean?

Over the years camera manufacturers have changed lens mounts and some newer models will not be compatible with older lenses and vice-versa. Nikon also makes some camera bodies that have built-in focusing motors and some that do not. This article will cover general abbreviations and is not a guide to which lenses will actually work with your camera. Be sure to refer to each manufacturer's site for compatibility information before you purchase.

A short rule of thumb, except for the letters that indicate it is a crop sensor lens, generally speaking, the more letters you see the better quality the lens. I am going to go through a few of the more common abbreviations and explain what they mean. After reading this, you will have a better understanding of those scrambled letters so you can buy camera glass with confidence!

Lens manufacturers build their DSLR and mirrorless camera lenses for basically two categories: crop sensor or full-frame. Full-frame lenses are considered more professional, have a better build quality, and are therefore more expensive. To make things confusing, each lens manufacturer uses a different set of letter codes to signify the “line” of lenses (pro vs. consumer) and the quality of the lens. In this article, I am only going to discuss Canon, Nikon, and Sony, the three most popular brands.

If you want a more complete list of abbreviations for Canon, Nikon, and Sony or third-party manufacturers like Tamron, Sigma, and Tokina, use the chart at the end of this section.

Canon

EF – lenses for EOS full-frame cameras

EF-S – lenses for crop sensor cameras (APS-C sensors); you can use EF lenses on a crop sensor camera, but you cannot use EF-S lenses on a full-frame camera body; EF-S lenses are less expensive and lighter in weight

L – “Luxury” lenses are the cream of the crop and have a red band of color around the barrel; usually a more rugged design and/or weather-sealed

CN-E – specialty cinematography lenses; black and red like the “L” but manual focus only

RF – lenses for the full-frame mirrorless camera bodies; EF lenses can be used with an adapter

EF-M – lenses for the M series mirrorless camera system; EF and EF-S lenses can also be used on EF-M camera mounts with an adapter; EF-M cannot be used on the larger full-frame mirrorless RF mount

Nikon

FX – lenses for full-frame cameras

DX – lenses for crop sensor camera bodies; DX lenses are less expensive and lighter in weight

Z – lenses specifically for the Z6 and Z7 camera systems; FX and DX lenses can be used with an adapter

S-line – lenses for mirrorless cameras; “S” means “Superior”; not to be confused with the older S mount lenses from the 1950s and '60s

Gold ring – if the lens has a gold ring around the barrel, that signifies a higher quality lens

Sony

FE – lenses for full-frame cameras

E – lenses for crop sensor camera bodies; usually less expensive and lighter in weight

Sony has made mirrorless their specialty so you won't find current DSLR cameras. The old models used A mount lenses (SAL part numbers) and DT specified a crop sensor lens. These lenses require an adapter to use on E mount cameras.

G / GM – Gold (old) / Gold Master (new), designation that signifies a higher quality lens

For those who are considering buying lenses for their DSLR crop sensor camera, but eventually want to upgrade to a full-frame body, I would recommend saving up for the more expensive FX (Nikon), FE (Sony) or EF (Canon) lenses. You can use them on your crop sensor camera body for now (with a crop factor) and later when you upgrade to your full-frame DSLR or mirrorless you can continue to use them at their maximum potential.

This can save you from having to re-purchase lenses since the cheaper lenses (E, DX, EF-S) do not have the same quality as full-frame, and for Canon users cannot be used on the full-frame bodies. This is true of third-party lenses made for Canon and Nikon as well. With adapters, these lenses can also be used on the newer mirrorless cameras as well.

Moving on to focal length, all lenses use the same methodology. Focal length is measured in millimeters (mm). This number is the distance between the camera's sensor and the lens' convergence point. The focal length tells us how much of our subject or scene will be captured (angle of view) and the magnification. Short focal lengths have wider angles of view and do not have much magnification, whereas, longer focal lengths have smaller angles of view and a higher level of magnification. Some lenses will have just one number, such as 50mm. This is a fixed focal length which is called a "prime" lens. Prime lenses provide higher image quality and are more compact and lightweight. Additionally, they often have better apertures for low light.

When you see a range of numbers, such as 18-55mm, it means the focal length is variable, or has a "zoom." A zoom lens allows you to switch between subjects and different shooting scenarios without changing lenses as often. For a more in-depth look at focal lengths and the differences between wide-angle, standard, macro, and telephoto lenses, read the next section FocusEd on Focal Lengths.

The next set of letters and numbers is typically the aperture or aperture range indicated by the letter “f” and then some numbers, such as f/2.8. This means the maximum aperture setting is 2.8, and the iris is more open and lets in more light. An aperture of f/22 would mean the iris is less open and would let in less light. Aperture numbers are harder to remember, they don't go in nice even increments of whole numbers like ISO 100, 200, etc. The reason these numbers appear to not follow a pattern is that they are ratios related to the focal length and the diameter of a circle. When we close down an iris we are making the circle that allows light in smaller and smaller. Think of it this way, it is similar to the iris of your eye. If you were in a dark room and there was only one small light bulb, your iris would open to its widest to let in more light. But if that same dark room had 22 light bulbs burning, your iris would become more narrow to let in less light.

You can also think of f-stops as fractions. One-fourth (1/4) is smaller than one-half (1/2); therefore, f/4 is a smaller, narrower aperture than f/2. The full f-stops from wide to narrow are 1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, and 22 (some lenses have f/stops more narrow than f/22, but also typically suffer in image quality).


f/1.4
f/2.0
f/2.8
f/4.0
f/5.6
f/8.0

If the camera lens you are considering for purchase is a prime lens, there will be just one f/. That is the maximum (widest) aperture the lens is capable of using. Lower numbers are better because they allow shallower depth of field and you can get those soft, blurry backgrounds behind your subject in your portraits. If a camera is a zoom, it usually has a range such as f/4-5.6 which means that at the smaller focal length you have f/4 and at the longest focal length you have f/5.6. The more you zoom, the narrower the aperture becomes. Whenever possible, choose a lens that has a low f/ and keeps that throughout the zoom instead of a range. For example, a 24-70mm f/2.8 will be a better lens than something with f/3.5-5.6. In prime lenses, generally speaking, a 50mm f/1.2 is going to be a better lens than a 50mm f/1.8.

A few things to keep in mind, sometimes the f/ is not included, then you might see 1:4-5.6 or 1:4-1:5.6 instead. These are expressing the same range as f/4-5.6.

Additionally, most lenses will shoot at their sharpest when at a medium aperture. So if your lens has a maximum aperture of f/2, your photographs will most likely have fewer aberrations and maximum sharpness at f/4 or even f/5.6.

Some lenses might also have Roman numerals I, II, III to indicate the generation of the lens. A lens with a III is newer and probably has some upgrades compared to the same lens generation II. However, be aware that Tamron, and others, may also use similar markings for other purposes. Tamron lenses marked Di-II indicate a crop sensor lens and Di-III lenses are specifically for mirrorless.

Lenses may have markings for magnification such as 1:1. True macro is considered 1:1 where the lens allows the photographer to focus up close and get a life-sized reproduction on the image sensor. A lens with a 1:2 magnification will reproduce the subject at ½ life-size on the image sensor.

Macro lenses will often say "macro" on the lens, but be cautious. The label "macro" is sometimes used on lenses that do not really produce a 1:1 ratio, so be sure to check the specifications of the lens if that is something you want.

Even with all of those letters and numbers explained, there may still be a mind-boggling amount of remaining letters to decipher. Here are a few of the more common ones for Canon, Nikon, and Sony. Again if you want a more complete list, one is provided at the end of this section.

Canon

IS – Image Stabilization; good for slower shutter speeds because internal mechanisms (gyros) help stabilize camera movement

USM – UltraSonic Motor; faster focus, but quiet

Micro USM - cheaper version of USM for kit and budget lenses and it is not as quiet

STM – Stepper Motor; fast focus, and the most quiet

SC or SCC – Spectra (or Super Spectra) Coating; coating on the lens to decrease reflections and flaring

SWC – SubWavelength Coating; coating to minimize ghosting and flaring; newer version of SC/SCC

DO – Diffractive Optics; lens will have a green ring on the barrel; fewer glass elements so the lens is lighter and smaller with improved optics

Nikon

AF – Auto Focus; allows focusing from the camera; you may also see AF- followed by D, I, P, or S, which stand for Distance, Integrated Motor, Stepper Motor, and Silent Wave Motor respectively, and are all improvements over AF alone (check compatibility carefully some consumer level camera bodies require AF-S lenses for full functionality) SWM – Silent Wave Motor; very quiet, high-speed autofocus

NIC or C (or SIC) – Nikon (or Super) Integrated Coating; to minimize ghosting and flaring

ED – Extra-low Dispersion Glass; used in high-end lenses to reduce aberrations

HRI – High Refractive Index; only used on the very best lenses to reduce aberrations

N – Nano Crystal Coating; labeled in gold; reduces flaring and ghosting

FL – Fluorite – superior lens glass and lighter weight

G – no conventional mechanical aperture ring; aperture set by the camera body

IF – Internal Focusing; focusing is accomplished with internal mechanisms

E – Electronic Aperture; aperture is controlled by electronic signals; not to be confused with the old 1970s E-mount (check compatibility carefully most older bodies and film cameras cannot use E lenses)

Micro – Macro

VR – Vibration Reduction; image stabilization to reduce camera shake

Sony

Zeiss – specially branded lenses created for Sony by Zeiss, or created by Sony and approved by Zeiss, meaning these lenses are held to a higher standard and on par with GM lenses.

SSM – Super Sonic Motor for extremely fast and silent autofocus

OSS – Optical Steady Shot for image stabilization

ED – Extra Low Dispersion glass elements to reduce aberrations

T* – Carl Zeiss T* Coating; reduces the amount of inter-element reflections

PZ - Power Zoom, built-in motor for smooth zoom; great for videography

Okay, so let's put your knowledge to the test by following along. You are considering the following two lenses:

Nikon AF-P DX 70-300mm f/4.5-6.3G ED VR
Nikon AF-P 70-300mm f/4.5-5.6E ED VR

The main differences are the first one is for a crop sensor camera (DX), which has an aperture that lets in less light when zoomed (f/6.3), and no mechanical aperture ring (G). The second lens will be the better quality lens for a full-frame camera with a better f/ range and electronic aperture.

Both lenses have vibration reduction (VR) and extra-low dispersion glass (ED), so neither has any advantage in those areas.

The first lens costs approximately $400, while the second one costs approximately $550. (Note that some camera bodies are not compatible with AF-P and E-type lenses and the link here will take you to some of Nikon's literature regarding lens compatibility).

Let's try another one. You are considering this lens:

Nikon AF-S DX 35mm f/1.8G

This lens will have Auto Focus with a Silent Wave Motor (AF-S). It is for a crop sensor camera (DX). It is a prime lens with a focal length of 35mm. The maximum opening of the aperture, or iris, is 1.8 so you can get some shallow depth of field with blurry backgrounds (f/1.8). You have no manual aperture ring (G) which makes this lens compatible with cameras that allow setting the aperture from the camera body.

Let's try one final example and this one should be easy. You have two lenses to choose from:

Canon EF 85mm f/1.8 USM
Canon EF 85mm f/1.4L IS USM

The one with the "L" for Luxury is the better lens. It has the f/1.4 aperture and the added image stabilization (IS). However, the prices might give you sticker shock - $350 vs. $1500. Whenever possible, it would be my recommendation to save up for better lenses, but sometimes the price is so much higher that the difference in quality might not be the most important determining factor. In this case, the small difference in aperture would probably only be a factor for the most discerning of professionals and if you use a tripod and shutter release the added image stabilization may not add any benefits to your photography.

Buying a lens can be confusing, but by doing your research, checking the specs, and knowing a few key abbreviations, you'll be able to buy camera glass with confidence!

Feel free to print or download the lens abbreviation guides (on the next pages). I have also included a few general recommendations for lenses, but be sure to do your own research and make sure the focal length will be appropriate for how you intend to use it. The next section will cover focal lengths in more detail.

Name Brands

FocusEd Camera

Guide to Camera Lens Abbreviations

	CANON	NIKON*	SONY
Crop Sensor	EF-S	DX	DT – for older A mount
Full-frame	EF	FX	
Mirrorless	EF-M; RF	Z	E; FE
Professional Lens	L	Gold ring S-line	G (old) or GM (new)
Specialty Coatings, Glass, or Elements	AL – Aspheric Lens ASC – Air Sphere Coating BR – Blue Spectrum Refractive CA – Circular Aperture DO – Diffractive Optics ED – Low Dispersion FL – Fluorite SSC/SC – Super / Spectra Coating SWC – Sub Wavelength Coating Super-UD – Super Ultra-Low Dispersion UD – Ultra-Low Dispersion	AS (ASP) – Aspherical Lens C (NIC) – Integrated Coating ED – Extra-Low Dispersion FL – Fluorite HRI – High Refractive Index N – Nano Crystal Coating PF – Phase Fresnel RD – Rounded Diaphragm SIC – Super Integrated Coating	AA – Advanced Aspherical APD – Apodisation Optics AR – Anti-Reflective ED – Extra-Low Dispersion F or FL – Fluorite Super ED – Super Extra-Low Dispersion T* - Zeiss T* Coating XA – Extreme Aspherical
Auto Focus	AF	AF*	AF
Other Focus Related	FP – Focus Preset FS – Focus Range Selector FT-M – Full Time Manual Focus PT – Power Focus SF – Soft Focus	AF-D – Distance Info* AF-I – Integrated Focus Motor AF-P – Stepper Motor* AF-S – SWM Motor* CRC – Close Range Detection DC – Defocus Control	SAM – Smooth AF Motor STF – Smooth Transition Focus XD LM – Extreme Dynamic Linear AF
Internal or Rear Focus	IR	IF RF	IF
Lens Motor Types	USM – Silent Wave Motor STM – Stepper Motor	SWM (or AF-S) – Silent Wave Motor P (or AF-P)* - Stepper Motor	SSM – Super Sonic Wave Motor DDSSM – Direct Drive SSM RDSSM – Ring Drive SSM STM – Stepper Motor
Image Stabilization	IS	VR	OSS
Macro	Macro	Micro	Macro
Other Lens Types	CN-E – Cinematography Lens KAS S – Cinematography Lens PL – Cinematography Mount TS-E or TS – Tilt-Shift Lens	CX – old Nikon 1 E – old lens mount PC-E – Tilt Shift Lens UW – Underwater Lens	FE C – Cinematography Lens Zeiss Lenses – Distagon, Planar, Sonnar, ZA (Zeiss Alpha)
Other Letters & Old Codes	AFD or MM – Arc Form Drive DC – Direct Connect Motor FD, FL, FLn – old mounts FR – Filter Rotation PZ – Power Zoom	ADR – Aperture Direct Readout AI – Automatic Indexing* D – Distance Info E – Electromagnetic Diaphragm* G – No mechanical aperture ring	PZ – Power Zoom TC – Tele Converter SMO – Smooth Motion Optics (video)

*Check Nikon compatibility carefully; detailed compatibility charts available on their website; certain camera bodies require AF-S lenses for full functionality; E lenses may not be compatible with older bodies; AF-P lenses may not function without firmware updates

Third Party

FocusEd Camera

Guide to Camera Lens Abbreviations

	SIGMA*	TAMRON*	TOKINA
Crop Sensor	DC	Di-II	DX
Full-frame	DG	Di	FX
Mirrorless	DN	Di-III	atm-m; FiRIN
Professional Lens	EX	SP	AT-X Pro
Specialty Coatings, Glass, or Elements	APO – Apochromatic (with ELD or SLD) ASP – Aspherical ELD – Extraordinary Low Dispersion FLD – Low Dispersion SLD – Special Low Dispersion	AD – Anomalous DIspersion ADH-AD and Aspherical ASL – Aspherical eBAND – Extended Bandwidth & Angular Dependency Coat HID – High Index Dispersion LAH – Low Dispersion Aspherical LD – Low Dispersion RD – Rounded Diaphragm XLD – Extra Low Dispersion XR – Extra Refractive Index	AS – Aspherical Optics D – Digitally Optimized Element FF – Flat Field F&R – Advance Aspherical MC – Multi-coating Optics SD – Low Dispersion
Auto Focus	AF	AF	AF
Other Focus Related	DF – Dual Focus	A/M – Auto/Manual AF/MF – Manual Override FTM – Full-time Manual Focus PZD – Piezo Drive Motor	FC – Focus Clutch FE – Floating Elements
Internal or Rear Focus	IF RF	IF	IF IRF
Lens Motor Types	HSM – Hyper Sonic Wave Motor Linear Motor	USD – Ultra Sonic Silent Drive HLD – High/Low Torque Drive RXD – Rapid Extra Silent Stepping Drive VXD – Voice Coil Extreme Torque Drive	IF-S – Internal Focusing, Silent
Image Stabilization	OS	VC	
Macro	Macro	Macro	Macro
Other Lens Types	A – Art Line C – Contemporary; Budget S – Sport Line		atx-i – Interactive AT-X – Advanced Technology Extra AT-X V – Cinematography Lens Opera – Art Lens
Other Letters & Old Codes	TSC – Thermally Stable Composite	FEC – Filter Effect Control BIM – Built-in Motor ZL – Zoom Lock G2 – Second Generation	CF – Constant Aperture

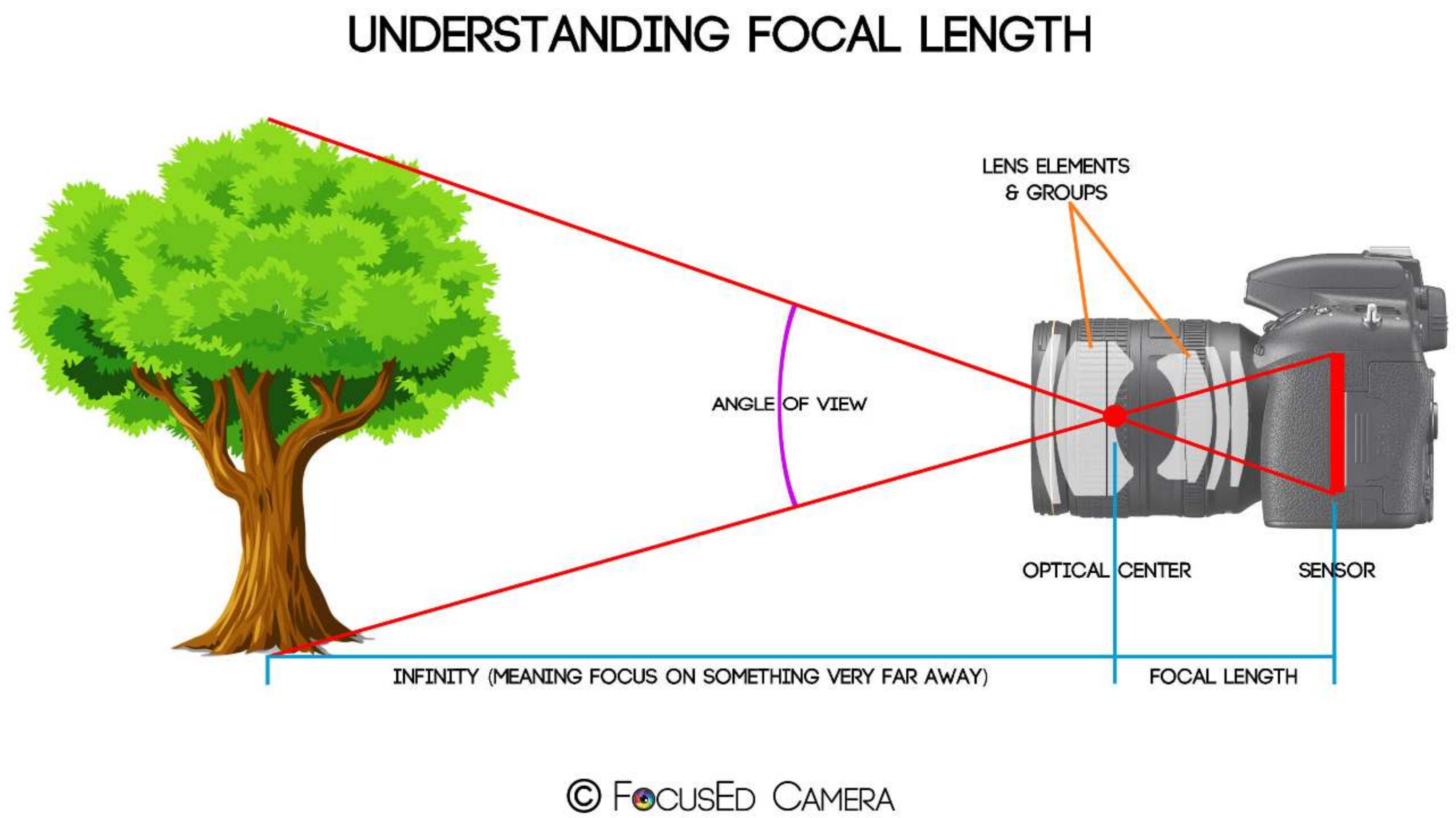
*Detailed compatibility charts available on their website

FocusEd on Focal Lengths

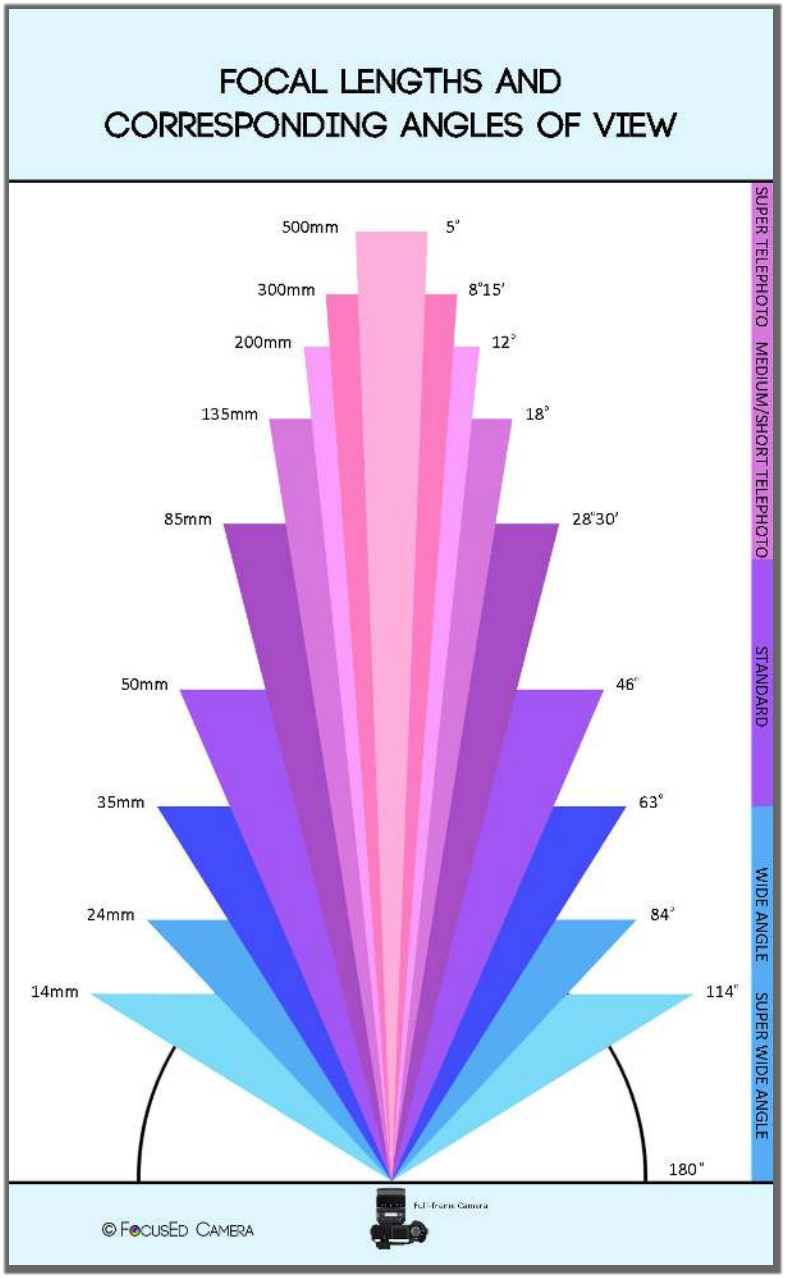
What is focal length?

The focal length of a lens is measured in millimeters. A common misunderstanding is the belief that this lens measurement is the length of the lens from end to end or its overall dimensions. The focal length measurement actually begins at the *optical center*.

A camera lens is made of many pieces of glass and combinations of elements, so as light enters the lens, it converges into “focus” at a point somewhere inside the lens among these elements. This point is the optical center. From the optical center this focused image is then sent to the camera sensor. Therefore to get the focal length, we take the measurement from the focal center to the camera sensor while the camera is focused at infinity (generally means that you are focused on something in the far away distance). The diagram on the next page demonstrates this. Now when you are shopping for a lens and are comparing two different 50mm lenses, you will understand why one of them might be physically longer than the other.


UNDERSTANDING FOCAL LENGTH
LENS ELEMENTS & GROUPS
ANGLE OF VIEW
OPTICAL CENTER
SENSOR
INFINITY (MEANING FOCUS ON SOMETHING VERY FAR AWAY)
FOCAL LENGTH
© FocusEd Camera

This number or how it is calculated isn't something you need to memorize or remember and knowing it isn't going to make you a better photographer. What is important is to understand what focal length affects – which is your angle of view (how wide of a view or how much of your scene will be captured in an image) and magnification (how large subjects will appear). A shorter focal length, like 18mm, will capture a larger width or wider angle of view, and subjects in the frame will appear smaller than they do viewing them with our eyes. Longer focal lengths, like 100mm, or even longer, like 400mm, have much more narrow angles of view. You will capture a much smaller width, but your subject will appear larger.



Angle of view is determined solely by the optics of the lens. It does not change if you place that lens on a different camera. On the other hand, field of view (which is often used interchangeably with angle of view even though they are not the same thing), is determined by the lens *and the sensor of the camera*. What type of camera you have – crop sensor or full-frame – will affect how much of a scene (field of view) ends up in your final image. A crop sensor camera will capture less of the subject or a smaller field of view.

So how does a crop factor work?

Lenses are designed for either full-frame sensors or crop sensors. We touched on this already in the first section and will cover more about it coming up, but for the following examples, we are referring to full-frame designed lenses in all cases.

Let's say I wanted to take a landscape photo with a full-frame Canon camera and a 50mm lens. It would look something like the image on the next page.

If I took that same 50mm lens and put it on a crop sensor Canon camera, the resulting image would look more like the image on the next page.


CANON REBEL
@50mm

The lens' angle of view hasn't changed, but the field of view does because of the size of the sensor. The sensor size is “cropped” or APS-C size. Since the sensor is smaller, it is like trimming off a large border all around the image. Another way to think of it would be similar to using the cropping tool in a photo editing program where the image is cut, not shrunk. The crop factor is different for cameras from each manufacturer. A Canon EF-S camera has a crop factor of 1.6, while the Nikon DX and Sony E models have a factor of 1.5.

Going back to my example, both images were taken with a 50mm lens. To figure out how much “loss” of the field of view we would get on the Canon crop sensor, we would multiply the 50mm x 1.6 to get 80mm. Therefore, the amount of image we get on the crop sensor camera with the 50mm is equivalent to 80mm if it had been on the full-frame we started with instead.

On the next page is the same landscape again. This image was taken with the full-frame camera using a zoom lens set to 80mm. Notice how the field of view is basically the same as the 50mm on the crop sensor camera pictured above.


CANON 5D
@80mm

We can also work this equation in reverse. Let's say I want to get the wider field of view of the full-frame camera, as we did with the 50mm, but by using my crop sensor camera instead. I would take 50mm and divide by 1.6 which would result in approximately 31mm. Therefore, if I put a 30mm lens on my crop sensor camera, it should "see" almost the same thing as the full-frame camera with the original 50mm. You can witness this effect in the images below.

Should you learn how to do all these calculations?

No, there are apps and online charts that have these calculations already completed for you! Online you can use mmcalc.com, which is also available as both iOS and Android apps.

So what is the takeaway then for a beginning photographer?

First, know that if you have a crop sensor camera then you will not be able to get the same field of view as a full-frame camera unless you go down to smaller focal lengths (in effect, zooming out). Second, understand that the focal length, as it gets larger, has the inverse effect on your field of view which gets smaller and smaller and brings the subject closer (in effect, zooming in). Third, know the basic classifications of lens focal lengths and their main uses so that you will have a basic idea of what lenses to use for different shooting situations (and make adjustments as necessary if you are shooting with a crop sensor camera). We are going to discuss these next.

Lenses basically fall into five types of focal lengths; super wide-angle, wide-angle, standard, telephoto (zoom), and super telephoto. In each of the descriptions below I am speaking in terms of using a full-frame camera.

Ultra wide-angle lenses have a 24mm or less focal length which allows them to capture a very wide scene. They can be useful for home interiors (real estate photography).

Below 24mm, and especially with super-wide fisheye lenses, images can become distorted and present an exaggerated perspective that can be artistic and fun to play around with. The curve of the horizon in this image demonstrates this effect.

Wide-angle lenses have a focal length range from 24mm up to 35mm. These lenses are also good for confined spaces, such as home interiors, or capturing the whole table of guests at a family holiday or celebration. In addition, these lenses are good for large group photos, cityscapes, landscapes, and architectural photography. These lenses have a larger depth of field (shorter focal lengths can create a deeper depth of field and long focal lengths can create a shallower depth of field), so both far away and near objects can have tack sharp focus and there will be visible distance between your subject and the background when taking portraits.

Standard lenses have a focal length range of between 35mm to 70mm. These lenses "see" the world in much the same range and way our own eyes see it. There is little distortion of the subject so they make flattering portrait lenses. The shallower depth of field these focal lengths create will allow the photographer to separate the subject from the background as well.

These lenses are excellent, not only for portraits, but for nature, "on the street" shots, and low light conditions (or when you do not want to use a flash or only want natural light). The 50mm lens is in the standard lens range, and is such a popular lens choice, that it has earned the nickname – The Nifty Fifty.

Telephoto lenses are focal lengths of 70mm up to 300mm. These lenses are very popular for wildlife/nature photographers because they allow shooting from a distance without encroaching on the subject (which might be skittish). These lenses bring the subject closer. A lens that is 70-135 is considered a short telephoto and one that is 135-300 is a medium telephoto. Telephoto lenses have a shallower depth of field so crisp focus on the subject is a must. In addition to wildlife, these lenses are also used for any activity or subject where distance is required or unavoidable, such as shooting from the sidelines during a sporting event.

Super telephoto lenses are much like telephoto lenses, except their focal lengths go beyond 300mm. They provide a telescope-type magnification which brings the subject and the background closer. Objects behind your subject will look much closer than in a similarly framed shot using a smaller focal length lens.

These lenses are very heavy and can't be used for handheld shooting. A sturdy tripod is needed to support these lenses. Some even include additional support brackets built into the lens. Any type of photography where you don't want to fight through a crowd for a position or you are limited on how close you can get benefits from this type of lens: birding, wildlife, sports, astrophotography, moon photography (or any other small distant objects), air and boat shows, car races, and more.

Macro lenses are not a type of focal length. They are specialty lenses that come in various focal lengths. They are used for photography of small objects, flowers, products, and insects in amazing detail. Macro lenses create 1:1 or life-size reproductions on the camera sensor.

Macro is considered a specialty genre of photography, so in addition to special lenses or gear, you also need to have some additional knowledge. If you have an interest in Macro, we have some resources on our website that can help you.

Your camera may have come with a “kit” lens. An 18-55mm is a common "kit" lens. This lens gives the photographer the whole range of lens focal lengths from 18mm to 55mm, or from a wide angle up to a standard angle. An 18-135mm lens would give a photographer the range of focal lengths from a wide angle all the way up through a short telephoto.

A lens with a focal length that can change is called a zoom lens. Zoom lenses like these can be great lenses because you don’t have to change your lenses as often and they cover a wide variety of photographic situations.

Prime lenses on the other hand have one fixed focal length, like a 50mm. In order to change the angle or field of view, or to "zoom" in or out, you have to change to a different lens.

Below is a series of images from a local garden showing the range you can achieve with a zoom lens. In this particular instance, the lens used was the Tamron 18-400mm f/3.5-6.3 Di II VC HLD for Canon APS-C cameras. In the first image, it is obvious that I took the photo of the purple flowers from a distance. By the last image, it looks like I was standing next to the flower, but I was not. I was still standing at a distance, just zoomed in with the lens. This is the effect of longer focal lengths.

From left to right and top to bottom, these images were taken at 18mm, 35mm, 70mm, 200mm and 400mm using a Tamron 18-400mm f/3.5-6.3 Di II VC HLD lens on a Canon Rebel using a tripod in a stationary position.

What is the advantage of a zoom vs. a prime lens?

The main advantage, as demonstrated in the photos above, is versatility. With one zoom lens in your bag, you reduce the weight of your gear and you can shoot everything from wide scenery shots to close-ups, people, or details without changing lenses.

Additionally, when shooting sports or other fast action, you can re-frame your subject without having to move closer or farther away. Finally, fewer lens changes mean you save time and protect the camera sensor from dust and moisture exposure!

One disadvantage of a zoom lens is that they often have narrower maximum apertures than prime lenses and/or variable apertures which means less and less light makes its way to your image sensor as you zoom in. A prime lens can open up wider and let in more light, as well as achieve a shallower depth of field.

Another disadvantage of a zoom lens is its size and weight. Zooms are usually larger and heavier than a prime; however, if one zoom can replace three or four primes in your bag you will still come out ahead with the zoom. Lastly, zooms are usually not as pristine when it comes to image quality, but that should not stop you from purchasing a zoom if it fits your needs. The next section covers lens sharpness.

So, now that you know a bit about focal length and which lenses are best for different photographic scenarios, you can buy gear that will serve your needs best! The list below contains some suggestions for high-scoring lenses for Nikon, Canon, and Sony. If a lens is not on this list that does not mean it is a bad lens. Use online research sites that test lenses and cameras and give them scores (not the blogs that just list a bunch of lenses for Amazon clicks) and in-depth reviews. Sites like DXO Mark, Camera Decision, and Ken Rockwell are good ones to bookmark. Also, check the reviews and photos submitted by other users. New lenses are added frequently by both brand manufacturers and third-party manufacturers. Sometimes a lens has been revised and there are second or even third generations of the same lens, and lenses are discontinued as well. So keep that in mind and know this is not a complete list.

Prime, Nifty 50:

Canon EF 50mm f/1.4

Canon RF 50mm f/1.2L USM

Nikon AF-S 50mm f/1.8G

Nikon Z 50mm f/1.8S

Sony FE Carl Zeiss Sonnar T* 55mm f/1.8 ZA

Mid-Range Zoom:

Canon EF 24-70mm f/2.8L II USM

Canon RF 24-70mm f/2L USM

Nikon Z 24-70mm f/2.8 S

Sigma 24-70mm f/2.8 DG OS HSM Art

Sony FE 24-70mm f/2.8 GM II

Tamron SP 24-70mm f/2.8 Di VC USD

Tokina AT-X 24-70mm f/2.8 PRO FX

Telephoto Zoom:

Canon EF 70-200mm f/2.8L IS II USM

Nikon AF-S 70-200mm f/2.8G ED VR II

Nikon Z 70-200mm f/2.8 VR S

Tamron SP 70-200mm f/2.8 Di VC USD

Sony FE 70-200mm f/2.8 GM OSS II

Sigma 120-300mm f/2.8 DG OS HSM Sport

Mega Telephoto Zoom:

Canon EF 200-400mm f/4L IS USM Extender 1.4x

Nikon AF-S 200-500mm f/5.6E ED VR

Before buying, be sure to check the compatibility of a lens using the resources on each manufacturer's website.

Lens Sharpness: Your Lens Has a "Sweet Spot"

In discussion groups and photography groups you see questions about lenses from shoppers and the number one thing they want to know is if a lens is “sharp.” What many beginning photographers don’t understand is that lenses are not sharp at every aperture value and at every possible distance (especially with zoom lenses).

Therefore the responses one gets on these forums will likely be very subjective and based upon that photographer’s experience and how they use that lens. If a person reports a lens is "not sharp" they may not be giving you accurate information. Every lens has a “sweet spot” and sharpness is often confused with depth of field. This article will help clear up that confusion and help you figure out what your lens' "sweet spot" is and how to find it.

First, some background information; no lens is ever perfectly sharp. Lenses are designed for maximum performance based on what manufacturers believe the main function of that lens will be. For example, if you purchase a zoom 70-200mm lens, the manufacturer might assume that the main use of that lens will be at the 200mm end of the range and they will maximize its performance for that focal length. A lens that is a macro lens will be maximized for close-up shooting distances. Never purchase a lens and expect perfect sharpness at every distance, aperture, and zoom level. Know what you will be using the lens for and buy a lens designed for maximum performance for that purpose.

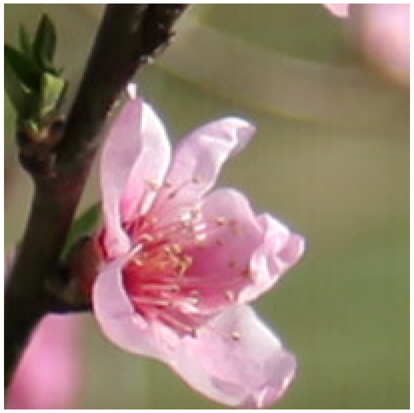
Another common point of confusion for beginning photographers is understanding the difference between sharpness and focus (or depth of field). Sharpness is related to resolution and depth of field is related to how much of the image is in focus from foreground to background. When you are first learning photography you will probably hear the advice that if you want more of your image in focus use a narrow aperture (larger f/# like f/11 or even f/16). While generally this is true, greater depth of field (or focus) does not always mean more overall sharpness.

I took three photos of a flowering tree using f/4, f/5.6, and f/22. The top photo at f/4 has the most shallow depth of field (blue line) where only some of the flowers are in the plane of focus. The bottom photo taken at f/22 has the deepest depth of field (blue line) where the tree, flowers, and the grass and trees across the pond are all in the plane of focus. The f/5.6 image (not shown) would be somewhere in between. While there is more in focus (greater depth of field) in the photo taken at f/22, it is probably not as sharp compared to the in-focus parts of the same picture taken at f/5.6.

A quick side note: Using smaller apertures will increase the depth of field, but the depth does not increase equally in front of and behind the subject. Instead when you stop down your lens, the increase in the depth of field behind your subject will be almost twice as much as in front. In other words, if the overall depth of field increases to 20 total feet, about 1/3 (~7 ft) of this will be in front of the subject (focus point) and the remaining 2/3rds (~13 ft) behind the subject. (If you need an introduction to depth of field check out our e-book on our website).

We can examine the sharpness of our two images by "pixel peeping" and looking at only the areas that were in the zone of focus. We should find that the image is sharper at f/5.6 and less sharp at f/4 and f/22. The image taken at f/5.6 will appear “sharper” even though more of the area of the scene (depth of field) is in focus at f/22.

Now let's actually take a look at those images on the next page. The series of shots was taken from the same location and only the aperture was changed. These are parts of the same photos shown above that demonstrated depth of field taken at f/4 and f/22 (plus the additional shot at f/5.6). Note that the original images were already cropped and then I further cropped in on just one flower that was inside the depth of field (in the area of focus).



At f/4 the overall flower looks a bit fuzzy. In the uncropped image shown previously only the flowers were in the plane of focus at f/4.

At f/5.6 the flower looks sharper (even though at this level of pixel peeping it doesn't look "good" we can see clearly it is better than the other two).

At f/22 the image is very fuzzy, even though this same image when uncropped (shown previously) demonstrates an overall greater depth of field.

At this "pixel peeping" level we can compare the sharpness. Remember that when not cropped to show detail, each of these photos "looked" sharp and in focus in this area of the image. The focus and focus point were not changed in between shots so any differences you see are not because of a focusing issue. We can see that none of the images are perfectly sharp, but the one in the middle is the best. The issue/difference between these images occurs because of the internal workings of the lens. All those glass elements have to align and at different apertures, the quality differs.

Lenses are “softer” at both extremes of aperture – wide open and mostly closed. The details in an image won’t be as crisp or “sharp” when shooting at the maximum apertures like f/1.4 (or in the case above with my lens at f/4), or at minimum apertures like f/22. Both extremes are equally deficient when it comes to sharpness. As a general rule the maximum sharpness, or “sweet spot” of a lens is 2 to 3 stops from the maximum aperture of that lens. So for example, if the maximum aperture of a lens is f/2, then the “sweet spot” would be between f/4 and f/5.6.

The lens used for the photos above has a maximum aperture of f/4. Therefore the "sweet spot" should be between f/5.6 and f/8. The image at f/5.6 gave good results, but with further testing, I believe this lens would probably be sharpest around f/6.7 or f/7.1 which is about one and 1/2 stops above the maximum.

1/3	1.0	1.1	1.3	1.4	1.6	1.8	2.0	2.2	2.5	2.8	3.2	3.5	4.0	4.5	5.0	5.6	6.3	7.1	8.0	9.0	10	11	12	14	16	18	20	22	25	29	32
1/2 stops	1.0	1.2	1.4	1.7	2.0	2.4	2.8	3.3	4.0	4.8	5.6	6.7	8.0	9.5	11	13	16	19	22	27	32										
whole stops	1.0	1.4	2.0	2.8	4.0	5.6	8.0	11	16	22	32																				

Once you know the range of where the “sweet spot” should be, it is easy to conduct a test to find it with more precision. To conduct the test you will need to use Aperture Priority Mode. In Aperture Priority mode we can set and test the aperture and the camera will set the ISO and shutter speed.

If you are unsure of how to switch to Aperture Priority and how to change the aperture settings in that mode, you may need to consult your camera manual (we have most manufacturers' links here). If your camera allows you to use one-half or one-third stops, make sure that is selected in your settings.

To perform a test to find the "sweet" spot of your lens, first find the maximum aperture of the lens and add one half or one full stop to that number to use as your starting point. If your lens has a maximum aperture of f/3.5 (many kit lenses), then start at f/4.8 or f/5. If your lens has a maximum aperture of f/2, then start at f/2.4 or f/2.8.

Go outside in good sunlight. Use a tripod or something to stabilize the camera and to keep it in position between shots. You will need to take photos of something that is about 10 feet away (like my sample images of the flowering tree) and make sure your focus point is on that object. You will not recompose or refocus in between shots (after getting your focus point you can change over to manual focus to make sure your focus point stays set or use focus lock/back button focus if you have this option.

Start by taking a photo with the aperture at your starting point (from above). Then turn the aperture dial 2 or 3 clicks narrower (bigger f/#) and take another photo. Then turn the dial a few more clicks and take another photo. Take test shots from your starting point up to about f/11.

By taking a test shot every 2-3 clicks you will be sampling a range of f/stops that include some half and third stops. The “sweet spot” may not be at a full stop like f/5.6. If your camera only has full f/stops, then take sample test shots at each full stop.

Now it is time to "pixel peep." Upload your photos and zoom in on each one. Examine the area of the photo that contains the object you focused on (that was about 10 feet away) and examine that same area in every photo. You should be able to tell which aperture gave you the sharpest image.

You can then repeat the test using the range of apertures in 1/2 and third stops around that aperture to further narrow it down. In my test above f/5.6 was the sharpest, but to really narrow it down I would test again starting at f/4.8 using every increment up to about f/7.1 (I already had an image at f/8 that was not as sharp so I know I can stop before that point).

Once you know the "sweet spot" make a note of that aperture for that lens. Repeat for different lenses. Each one will have a different “sweet spot” but typically the maximum sharpness will be about 2 stops above the maximum aperture, somewhere in the range of f/4 – f/10 on many lenses.

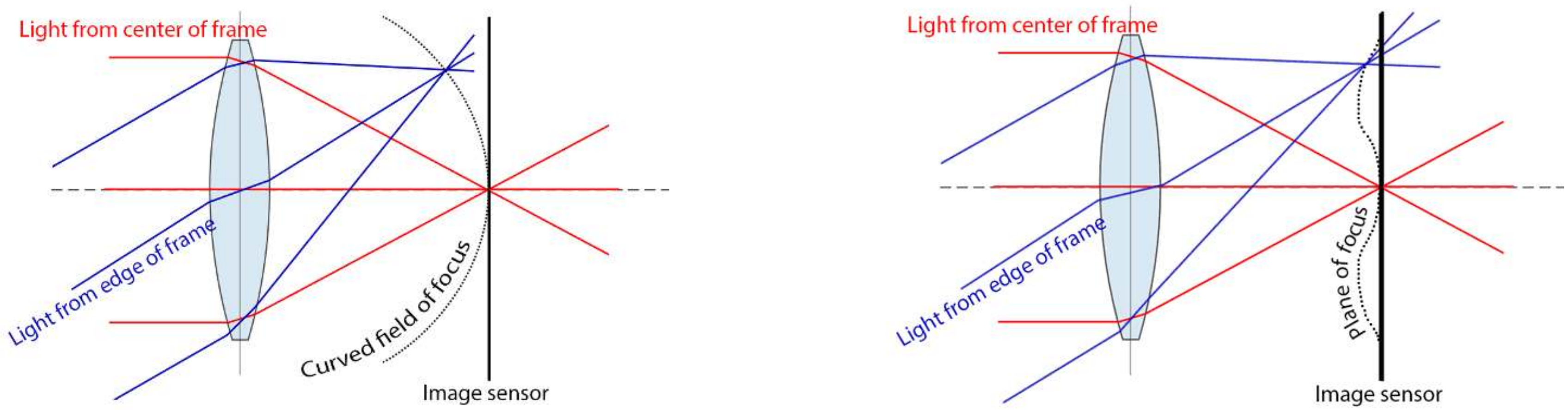
If your lens is a zoom lens the sharpness and “sweet spot” may not be identical throughout the zoom. For example, I have a Tamron 18-400mm and the maximum sharpness at 18mm may not be the same aperture setting when shooting at 400mm. You can test your zoom lens in the same way as above at each zoom level such as 18mm, 50mm, 100mm, 200mm, and 400mm. You may find one particular aperture setting that is better for all of them, but more likely it will differ depending on the amount of zoom.

We could not ever hope to detail all the possible parameters for every lens in the marketplace in a short e-book like this, but we can offer a little general advice. If you are ever out and about and need a sharp image and you are not sure what the “sweet spot” of a particular lens is, then use Aperture Priority Mode and take a series of photos from f/4 through f/11 and you will have all your bases covered!

Another often overlooked way to help improve image quality and sharpness is to use a tripod and a shutter remote. These reduce camera shake.

Keep in mind that prime lenses are often sharper than zoom lenses. If you have a 24-70mm lens and a 50mm lens and need to shoot at 50mm then select the prime lens, not the zoom. Additionally, even the best zoom lens won't have perfect sharpness at all levels of zoom. As mentioned before, the manufacturers will optimize the lens for certain focal lengths. Often the two extremes of the zoom are the least sharp.

And finally, understand that most lenses have curved glass elements. This means that you may have more sharpness in the center and less sharpness along the edges. This can result in a bowl-shaped field curvature. Since lens manufacturers try to correct this issue by using multiple glass elements, the resulting lens may be corrected in some areas but not others. This can create a doughnut-shaped field curvature or wavy curvature. The diagrams below refer to these curvature issues. Using a narrow aperture may reduce this effect. To test your lens for curvature take a photo of a flat subject (such as a brick wall; use a tripod) where you are completely parallel and examine the areas of the photo for differences (edges vs. center).



Bowl and Wavy field curvatures by BenFrantzDale, Wikimedia Commons, licensed CC-BY-SA

Or you can embrace this effect. Some specialty lenses use curvature for their dreamy feel, like the example below using a Lensbaby Spark 2.0 with Sweet 50 optic.

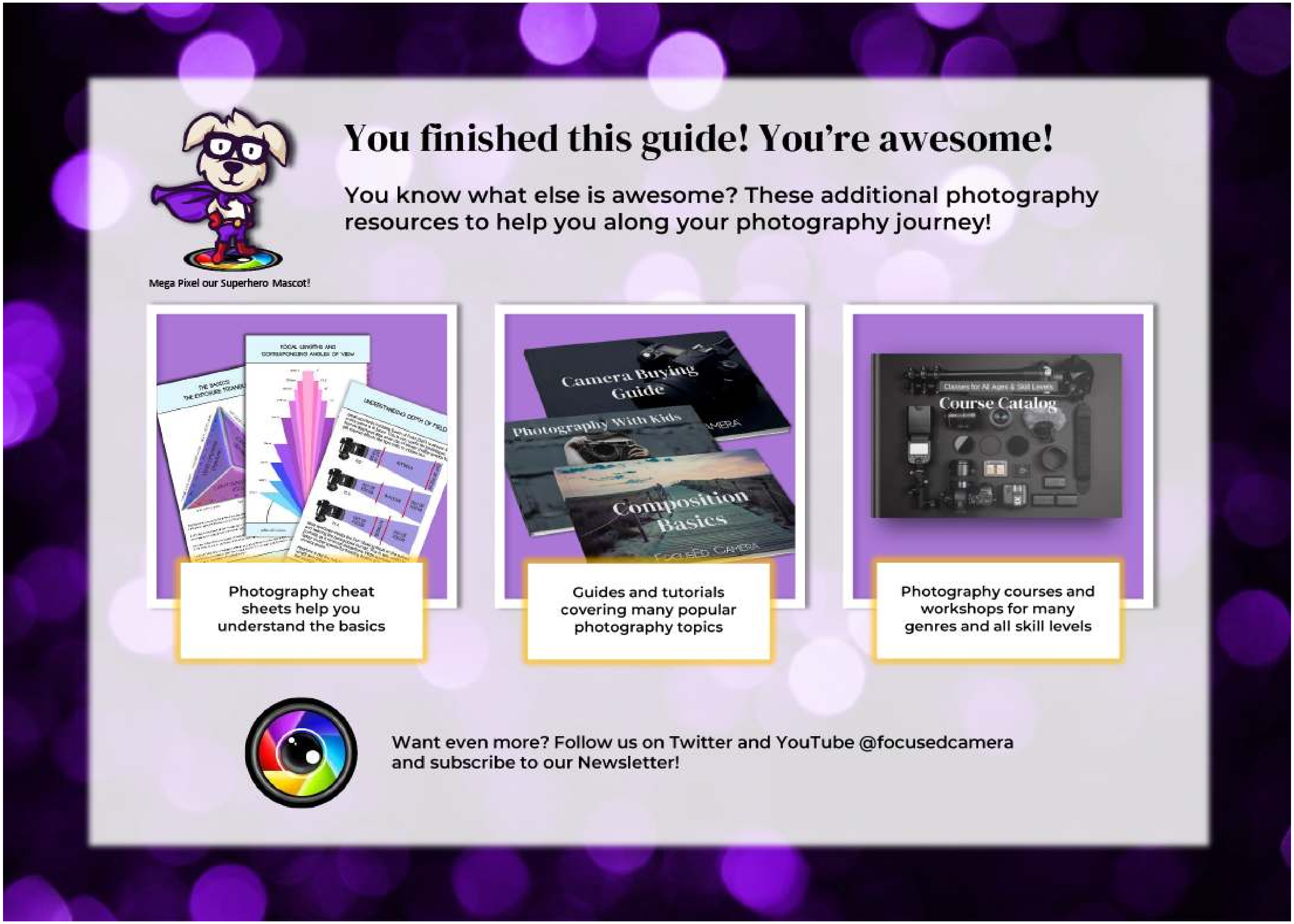
So in summary, shooting with wide-open apertures may result in reduced sharpness in your images and will show lens curvature issues more readily. Additionally, at wide apertures, the shallow depth of field can be difficult to work with. At very wide apertures this depth can be less than an inch and can cause one part of a face, like the eyes, to be in focus and the nose out of focus. In the example below the issue is a depth of field issue, not a lens issue.

When examining your images to troubleshoot a “non-sharp” image, consider both the depth of field (focus) and sharpness (resolution) as separate factors even though both are related to the aperture. Decide if the lack of “sharpness” you see is due to missing your focus point while using a very narrow depth of field, or if it is an overall resolution issue due to shooting at the extremes of the lens’ aperture range.

Knowing that your lens has a “sweet spot” and how to find it can help improve your images overall, but much about photography comes down to compromise. Just because your lens has a “sweet spot” doesn’t mean you should always use that aperture. When out in the field you may have to decide which is more important; maximum resolution (sharpness) or depth of field. It may be that you want a wider depth of field for a landscape shot and to get that you may have to sacrifice some level of sharpness. Also, remember, that to see the difference in sharpness you may have to “pixel peep.” The actual difference in sharpness between two images in normal print sizes may not even be that noticeable to the naked eye (even though they are there). “Pixel peeping” can become a dangerous obsession. Don’t let the search for optimal sharpness interfere with your creativity and the fun and joy that photography can provide.

Congratulations on completing our Lens Guide! Throughout this guide, we've demystified the jargon and provided you with practical insights. You now possess the knowledge to confidently navigate the confusing world of lens abbreviations, understand the factors influencing lens sharpness, and discover the optimal aperture setting for maximum clarity and minimal aberrations. By exploring different focal lengths, you've unlocked the ability to manipulate perspective, depth, and composition, allowing you to create extraordinary images that tell your story in a truly captivating way.

We hope that this journey will not only help you the next time you purchase a lens, but also expand your photographic skills and ignite a passion for the artistry of lenses. As you continue to explore and experiment, may your lens mastery grow, and may each click of the shutter bring you one step closer to capturing the world through your unique lens. Happy capturing!



You finished this guide! You're awesome!
You know what else is awesome? These additional photography resources to help you along your photography journey!
Mega Pixel our Superhero Mascot!
Camera Buying Guide
Photography With Kids
Composition Basics
Course Catalog
Photography cheat sheets help you understand the basics
Guides and tutorials covering many popular photography topics
Photography courses and workshops for many genres and all skill levels
Want even more? Follow us on Twitter and YouTube @focusedcamera and subscribe to our Newsletter!

About the Author

Cheryl Ritzel, founder of FocusEd Camera, is an esteemed instructional coach. Her exceptional talents have garnered recognition and accolades throughout her career. Cheryl's company and her remarkable work have been featured in prestigious publications such as ICM Magazine, Business Insider, Dogster, Spectrum News, and Yahoo News, and on the social media channels of Lensbaby, Canon, and Adaptalux.

Understand Your Camera Lens...

Our camera Lens Guide unravels the secrets of focal lengths, lens sharpness, the elusive "sweet spot," and lens abbreviations. This guide is your gateway to unleashing the true potential of lenses and capturing extraordinary images. Learn to navigate the confusing world of lens abbreviations, from focal length notation to common acronyms. There are factors that influence lens sharpness and we explain how to find the optimal aperture setting for maximum clarity and minimal aberrations. Explore how different focal lengths allow us to manipulate perspective, depth, and composition.