VORTEX
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ALL ABOUT OPTICS

YOUR GUIDE TO UNDERSTANDING THE BASICS OF OPTICS

RIFLESCOPES | BINOCULARS | SPOTTING SCOPES

THE BASICS OF OPTICS

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For hundreds of years, people have used optics to enhance vision, as well as optimize effectiveness of shooting equipment. Whether glassing up that big buck, taking aim, or simply observing the natural world, great optics make great experiences. Optics can be very task-specific. For that reason, we want to make sure you're armed with enough information to choose the right tool for the job. So come on in and let's talk optics.

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DETERMINING QUALITY

OPTICAL GLASS

Quality optics use dense optical glass that is painstakingly designed, shaped, and polished to eliminate flaws. When a product features more sophisticated optical design techniques and glass, the results are better images. The quality of the optical glass will make a difference in how bright, sharp, and colorful a view will be.

Standard glass provides good image quality.

Extra-low Dispersion Glass achieves the highest possible image resolution, contrast, and color fidelity—exact properties vary among manufacturers. Some of the common names for this type of glass include: HD (High Density or High Definition), ED (Extra-low Dispersion) and XD (Extra-low Dispersion).

CONSTRUCTION

You may pay more for products using higher quality materials, more sophisticated designs and stricter tolerances, but this adds up to greater reliability in the field.

Waterproof / Fogproof binoculars are sealed with o-rings to inhibit moisture, dust, and debris. The inside of the binocular is then purged of atmospheric air and filled with an inert gas that has no moisture content. This will prevent internal fogging from high humidity or altitude changes.

>> Nitrogen gas purging delivers fogproof, waterproof performance.

>> Argon gas purging guarantees superior fogproof and waterproof performance.

☑**TIP** Keep in mind that an investment in better optics may cost more. However, investing in higher quality optics not only yields better optical gain, but greater reliability when it counts.

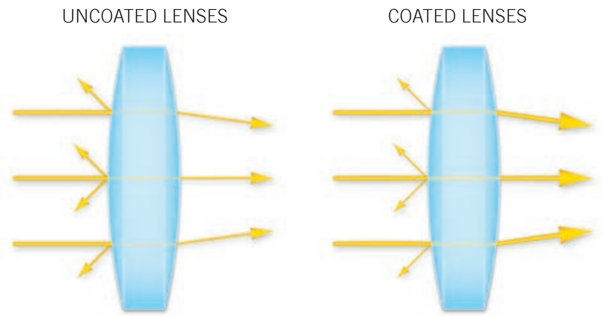
ANTI-REFLECTIVE LENS COATINGS

Metallic compounds, such as magnesium fluoride, are vaporized and applied to the optical glass in extremely thin layers to reduce internal reflections, light scattering and glare. The result of adding more layers of an anti-reflective lens coating to a greater number of glass surfaces is an improvement in image brightness, sharpness and contrast in low light.

Why anti-reflective coatings are needed.

Anti-reflective coatings increase the amount of light that passes through the optical system so more light gets to your eye. The type and number of coatings applied to the lenses in a binocular or spotting scope make a significant difference in how brilliant and crisp the views will be.

Each time light strikes an uncoated glass surface about 4–5 percent of the light is reflected. Without lens coatings, almost 50 percent of the light could be lost as it passes through the multiple air-to-glass surfaces of a standard binocular or spotting scope.



☑**TIP** The application of more coatings results in an increase of light transmission, resolution, contrast, and color fidelity.

Levels of anti-reflective coatings

Fully multi-coated optics have all air-to-glass surfaces coated with multiple anti-reflective coating films, and offer the highest image quality.

Fully-coated optics have all air-to-glass surfaces coated with an anti-reflective coating film.

Multi-coated optics have one or more surfaces coated with multiple anti-reflective coating films.

Coated optics have one or more surfaces coated with one or more anti-reflective coating films.

SPECIFICATIONS

Knowing what features matter to your use of optics is important. What follows is an explanation of basic features and specifications to understand so you select optics that will perform to the level you need when out in the field.

EYE RELIEF

The term eye relief refers to the distance between the ocular lens and where the image comes to focus and the entire field of view can be viewed. Proper eye relief is important for safe, comfortable viewing.

> **Riflescopes:** A minimum distance of three inches or more provides safe eye relief when viewing.
>
> **Binoculars** and **Spotting Scopes**: Proper eye relief is important to people who must wear eyeglasses or sunglasses while looking through optics. However, anyone planning to view for long stretches of time will also benefit from optics with longer eye relief.

TWIST-STYLE EYECUPS

FOLD-STYLE EYECUPS

Adjustable eyecups allow for the best viewing if you wear eyeglasses. Eyecups that twist up-and-down or fold back are common styles that are easily adjusted to accomodate eyeglasses or sunglasses.

CLOSE FOCUS

This is the minimum distance to which you can focus an optic on your subject. Close focus is more important for some applications than others. For example, many binoculars will focus down to ten feet or less—a feature that is especially important for watching butterflies, insects and birds.

FIELD OF VIEW

Another important number to understand is the field of view. When looking through an optic, you'll see the field of view as the area between the left and right edges of the image. The field of view can be measured either in linear feet or in angular degrees. (One degree equals 52.5 feet).

- **Riflescopes:** measured in feet @ 100 yards
- **Binoculars:** measured in feet @ 1,000 yards
- **Spotting Scopes**: measured in feet @ 1,000 yards

FIELD OF VIEW

A wide field of view has advantages when following fast-moving action or scanning dense habitats. When comparing optics with the same size objective lenses, higher magnifications will generally have a narrower field of view.

EXIT PUPIL

This is the beam of light that exits each eyepiece and enters the user's eyes. You'll want to have an exit pupil that is adequate for the lighting situation in which you'll be viewing. A person's eye pupil can dilate from roughly 2 mm to 8 mm, depending on the person's age and the lighting situation:

- **In bright light** the pupil will dilate to about 2–3 mm.
- **At dawn or dusk** the pupil will dilate to about 4–5 mm.
- **In dark light** the pupil will dilate to about 7–8 mm.

A larger exit pupil will deliver brighter images—especially under low light conditions.

EXIT PUPIL

Look for the exit pupil by holding the optics a short distance from your face—seen as clear circles in the center of the eyepiece.

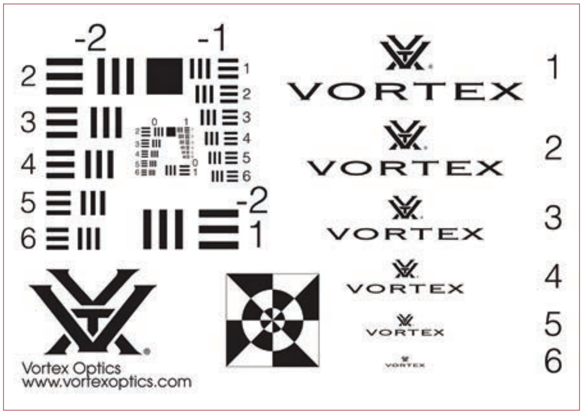
☑**TIP** Calculate the exit pupil by dividing the objective lens by the magnification.

Example: 10x50 Binocular
50 ÷ 10 = 5.0 mm

RESOLUTION

Resolution refers to the ability of an optic to distinguish details. A resolution chart contains groups of lines set in a series with progressively smaller spacing—a design used to ascertain the limiting number of lines per millimeter that optics can resolve.

RESOLUTION CHART



☑**TIP** Use a resolution chart to determine how well a binocular, spotting scope, or riflescope can resolve fine details.

WARRANTY

A manufacturer's warranty ought to be considered a feature of the binocular—especially if you use the optics outdoors where anything can happen. Most warranties offer a warranty limited only to initial defects with no protection from accidental damage or regular wear and tear. Progressive warranties cover optics in any situation, no matter what happens or who is at fault.

☑**TIP** The Vortex VIP warranty is an unconditional, unlimited warranty that offers the ultimate in customer service and protection for your optics.

TRADE-OFFS TO CONSIDER

Yes, there are trade-offs and, no, there are no perfect optics. So, consider the following trade-offs when selecting optics.

OBJECTIVE LENS SIZE

Objective lens size is the main trade-off to consider. A larger objective lens will deliver brighter images, especially under low light conditions, but it will be heavier and bulkier than a smaller lens. Think about how much you want to carry!

OPTICAL GLASS QUALITY

Optical glass changes in weight as the quality increases. Vortex offsets the extra weight of the high-quality glass components by using rugged, yet lightweight, housing materials.

MAGNIFICATION

Choosing the higher magnification option has benefits, but it may not always be the best choice for observation.

> **Binoculars:** As the magnification increases, you'll see a shallower depth of field, a diminished field of view, and you may experience a greater chance of image shake when viewing.
>
> **Spotting Scopes**: As the magnification increases, you'll see a reduction in image brightness.

CLOSE FOCUS AND DEPTH OF FIELD

In general, optics with a close focus will generally have a shallow depth of field.

MORE OPTICS TERMS

Alignment or Collimation – All elements (lenses or prisms) are in line along the optical axis. The misalignment of elements results in diminished performance and can cause eye strain and fatigue.

Astigmatism – Because the lenses in a binocular or spotting scope usually have a curved shape, the light rays passing through the lens will not all converge on the same focal plane. If this physical reality isn't remedied in the overall optical design, images will either be in focus in the center area or at the edge—but not in both areas at the same time. Astigmatism cannot be eliminated completely, but it can be kept to a minimum. Avoid optics that exhibit too much astigmatism.

Chromatic Aberrations – Diminished resolution and color fidelity display as green or purple fringing. This is the result of a physical reality of color. Different colors move at slightly different wavelengths and will have slightly different focal lengths when passing through optical glass. The XD and ED glass types reduce or eliminate this inherent problem of chromatic aberrations.

Contrast – This refers to differences in brightness between the light and dark areas of an image. Because we see much of the color spectrum, contrast also refers to differences in the dimensions of hue, saturation, brightness, or lightness. Optics with superior contrast transmit colors that appear very dense and well-saturated.

Distortion – This is the inability of an optical system to deliver an image that is a true-to-scale reproduction of an object. There are two types of distortion. In either case, the distortion is due to a poor or compromised optical design. Any binocular or scope that exhibits distortion should be avoided.

Barrel distortion – Image bows outward and looks bulged.

Pincushion distortion – Image bends inward.

Light Transmission – This is the percentage of light that passes through the binocular, spotting scope, or riflescope to reach the user's eyes. Light transmission will be higher through more expensive optics than through modestly priced optics due to better optical designs, glass quality, and improved optical coatings.

Resolution – Essentially the same as image sharpness, resolution is the ability of the binocular to separate and distinguish thin lines with clarity.

RIFLESCOPES

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Ready. Aim. Fire! Riflescopes and their features are as varied as the firearms they can sit atop. The firearm, as well as its intended application will dictate which riflescope will be the best fit. Understanding the basics will make the right choice clear.

UNDERSTANDING THE CONTROLS

Windage, oculars and parallax—oh my! Riflescopes generally have several adjustable features. When broken down to the basics, many are commonly shared and relatively simple. Once basic feature terminology and their functions are understood, you'll be able to select the right riflescope with pinpoint accuracy.

TUBE DIAMETER

Riflescope main tubes come in several diameters, including 1 inch, 30 mm, 34 mm and 35 mm. Larger diameter tubes can provide increased travel ranges for windage and elevation adjustments as well as greater strengths. Being aware of tube diameter is also very important when selecting rings to mount the scope.

☑**Tip** A common misconception about greater tube diameter is that it always provides a brighter image; this is usually not the case.

OCULAR FOCUS

Use the ocular focus to tune the reticle image for maximum sharpness. This adjustment will be slightly different for every shooter, and only needs to be set one time. To adjust, begin by backing the focus out until the reticle is clearly fuzzy. While taking short, quick looks through the scope, turn the focus in until reticle image is sharp and crisp to the eye immediately upon viewing. Do NOT use this focus to adjust the target image.

ADJUST THE RETICLE FOCUS

MAGNIFICATION ADJUSTMENT

Use the magnification adjustment to change the "power" level of the riflescope— adjusting from low to high magnification depending on the shooter's preference.

> **Lower** magnifications will provide brighter images and wider fields of view which can be helpful in low light and/or close-range shooting and with moving targets.
>
> **Higher** magnifications will have narrower fields of view and dimmer images, but will offer better ability to shoot smaller targets at longer ranges.

ADJUST THE MAGNIFICATION

ELEVATION AND WINDAGE TURRETS

Turrets are used to adjust the bullet's point of impact down range, and will be marked in either MOA or MRAD scales. Turrets come in several styles, depending on user preferences.

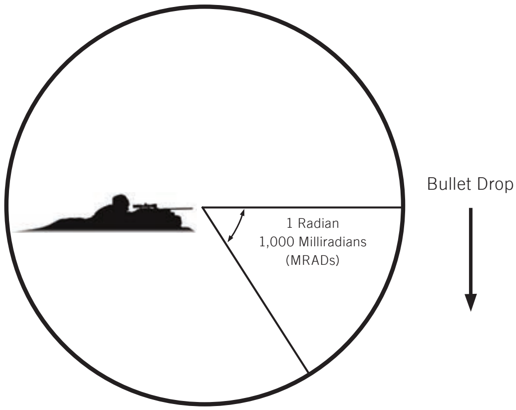
Exposed target-style turrets are used by long range shooters who routinely "dial" elevation corrections for bullet drop at long range.

Capped style turrets are often used by shorter range shooters and hunters, who may prefer the security and lower profile of this type.

Arc Measurements

MRAD (Milliradian) arc measurements are based on the concept of the radian. A radian is the angle subtended at the center of a circle by an arc that is equal in length to the radius of the circle. There are 6.283 radians in all circles. Since there are 1,000 milliradians in a radian, there are 6,283 milliradians (MRADs) in a circle. An MRAD will always subtend 3.6 inches for each 100 yards distance.

Most riflescopes using MRAD turrets will use 1/10 mrad mechanical *clicks* which subtend .36 inches for each 100 yards of distance.



MOA (Minute of Angle) arc measurements are based on the concept of degrees and minutes in a circle. There are 360 degrees in a circle, 60 minutes in a degree for a total of 21,600 minutes in a circle. An MOA will always subtend 1.05 inches for each 100 yards distance. Most riflescopes using MOA turrets will use ¼ minute mechanical "clicks" on the turret which subtend .26 inches for each 100 yards distance.

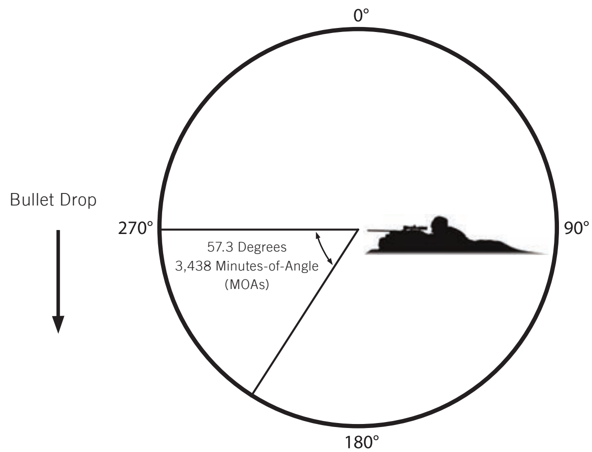


IMAGE SHARPNESS

Some riflescope models feature an adjustment that allows you to tune the target image for maximum sharpness. This adjustment may be on the objective lens or near the turrets on the side of the riflescope.

Adjustable Objective Lens Focus – This adjustment dial is marked with approximate yardages to aid in initial setting, and should be matched to the targets distance. Final focus setting should be checked by moving shooters head back and forth slightly, watching for any shift of the reticle on the target (parallax). If shift is observed, the dial should be adjusted slightly until shift is removed. Once this focus is correctly set, shooting errors due to parallax will be eliminated.

Adjustable Objective Lens Focus

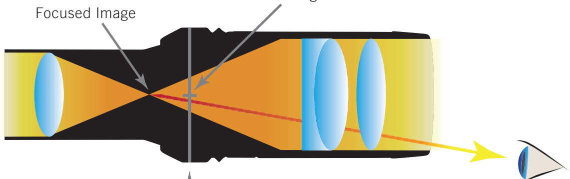
Side Focus Adjustment – This adjustment serves the exact same purpose as an adjustable objective, but is more conveniently located on the left side of the riflescope. The adjustment dial is marked with approximate yardages to aid in initial setting, and should be matched to the targets distance. Final focus setting should be checked by moving shooters head back and forth slightly, watching for any shift of the reticle on the target (parallax). If shift is observed, the dial should be adjusted slightly until shift is removed. Once this focus is correctly set, shooting errors due to parallax will be eliminated.

Adjustable Side Focus

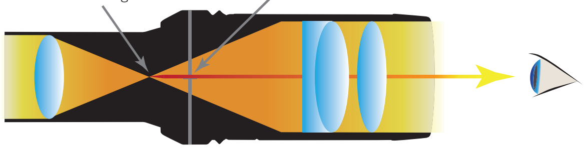
What is parallax?

Parallax is a phenomenon that results when the target image does not quite fall on the same optical plane as the reticle within the scope. This can cause an apparent movement of the reticle in relation to the target if the shooter's eye is off-centered.

» When the target image is ***not focused*** on the reticle plane and your eye is ***off-center*** behind the scope, parallax occurs. This is because the line of sight from the eye to the focused target image ***does not coincide*** with the reticle aiming point.

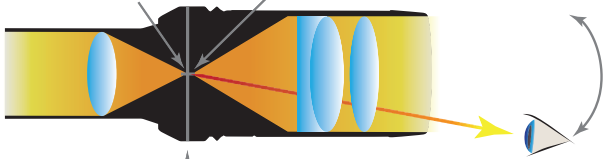


» When the target image is ***not focused*** on the reticle plane and your eye is ***centered directly*** behind the scope, no parallax occurs. This is because the line of sight from the eye to the focused target image ***coincides*** with the reticle aiming point.



☑**Tip** Correctly focus the target image so it falls on the same optical plane as the reticle within the riflescope.

» When the target image ***is focused*** on the reticle plane, parallax cannot occur—even if your eye is ***not centered*** behind the scope. This is because the line of sight from the eye to the focused target image ***always coincides*** with the reticle aiming point no matter where you position your eye.



RETICLE ILLUMINATION ADJUSTMENT

Use the reticle illumination adjustment to “light up” all or a portion of the reticle within a riflescope—allowing the reticle to be more easily seen against a dark background. The intensity level can usually be adjusted and is commonly placed on the ocular or left side of the scope, though it can be located in other positions. Illumination is normally powered by a small watch type battery.

Illumination Adjustment Knob

ZERO STOP ADJUSTMENT

Use the zero stop adjustment to prevent the elevation turret from being rotated downward past the point of original zero. It is most useful for shooters who routinely adjust the elevation turret “up” for long range shots, allowing them to always easily and accurately return “down” to their original zero setting. Zero stops are usually seen on higher quality long range or tactical riflescopes.

Adjusting the zero point.

UNDERSTANDING THE NUMBERS

THE RIFLESCOPE CONFIGURATION

Magnification is indicated by the first set of numbers in the example of a 4–16x50 riflescope—the magnification ranges from 4x up to 16x. Some riflescopes do not have a zoom eyepiece and use a single number to indicate a fixed magnification, as in a 2x20 scope.

Magnification Scale

Objective Lens Size is indicated by the last number in the 4–16x50 example—referring to the diameter of the objective lens in millimeters. If all other things are equal, larger objectives can yield brighter images at high magnifications. This is an advantage for hunting at dusk and dawn when animals are most active.

Objective Lens

EYE RELIEF

With proper eye relief, there will be a space cushion that protects the eye from recoil of the firearm. Keep in mind that eye relief typically decreases as magnification increases.

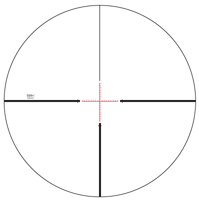
UNDERSTANDING RETICLES

From the simple Plex crosshair to first focal plane hashmark-based, mrad reticles with wind dot references—every reticle shines under certain conditions and when paired with an appropriate firearm.

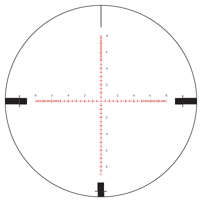
FIRST AND SECOND FOCAL PLANE RETICLES

All reticles will be termed either first (FFP) or second (SFP) focal plane, depending on their internal location within the riflescope.

> **FFP** – This style of reticle will grow and shrink as magnification is changed. The main advantage to this style reticle is that the reticle subtensions used for ranging, bullet drop compensation and wind drift corrections are always accurate at any magnification.

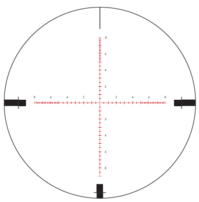


Low Magnification

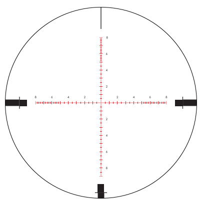


High Magnification

> **SFP** – This style of reticle does not change size when magnification is changed. The advantage to this style of reticle is that it always maintains the same ideal visual appearance and will not appear “too fine” at low magnification or “too heavy” at high magnifications.



Low Magnification



High Magnification

HOW TO RANGE WITH MRAD AND MOA RETICLES

Using simple formulas, both MOA and mrad hashmarked reticles can be used to estimate distance. This is a useful skill—and provides a good back-up should your laser rangefinder fail or lose battery power.

To range with a reticle formula, you can use either the vertical or horizontal scale. Place the reticle on a target of known width or height and read the number of mrads or MOAs spanned. You will obtain maximum accuracy in ranging by calculating as exact a measurement as possible—down to fractions of an mrad or MOA. Accurate measuring will depend on a very steady hold. The rifle should be solidly braced using a rest, bipod or sling when measuring the size of the target or nearby object. Once you have an accurate reading, use a formula to calculate the distance.

Mrad Ranging Formulas

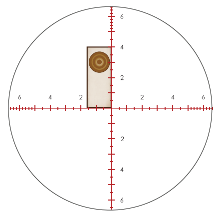
$$\frac{\text{Known Width or Height of Target (Yards) x 1000}}{\text{Target Width or Height (Measured on Reticle in MRADS)}} = \text{Range (Yards)}$$

$$\frac{\text{Known Width or Height of Target (Meters) x 1000}}{\text{Target Width or Height (Measured on Reticle in MRADS)}} = \text{Range (Meters)}$$

$$\frac{\text{Known Width or Height of Target (Inches) x 27.8}}{\text{Target Width or Height (Measured on Reticle in MRADS)}} = \text{Range (Yards)}$$

MRAD EXAMPLE – Ranging a 6-foot target stand (2 yards) at 4 mrads to get 500 yards.

$$\frac{\text{2 x 1000}}{\text{4 mrads}} = \text{500 Yards}$$

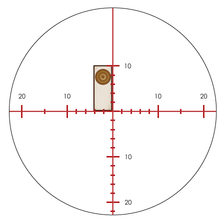


MOA Ranging Formula

$$\frac{\text{Known Width or Height of Target (Inches) x 95.5}}{\text{Target Width or Height (Measured on Reticle in MOAs)}} = \text{Range (Yards)}$$

MOA EXAMPLE – Ranging a 6-foot target stand (72 inches) at 10 MOA to get 688 yards.

$$\frac{\text{72 x 95.5}}{\text{10 MOA}} = \text{688 Yards}$$



☑**TIP** You can substitute 100 for 95.5 for faster calculating, but this will produce a five percent over-estimation error of the yardage distance.

BINOCULARS

What binocular should I get? The answer to this question is generally found by asking another. What do you plan on using it for? A person scouring a vast western landscape will have different needs from another who finds themself immersed in a stand of Midwest hardwoods. Read ahead about the various features of different binoculars and you'll SEE what we're talking about.

BINOCULAR DESIGN

There are three main binocular designs: the roof prism, Porro prism, and reverse Porro prism. These designs come in a variety of weights and sizes. The greatest factor in determining the weight of a binocular is the size of the objective lens: the larger the lens, the heavier the binocular.

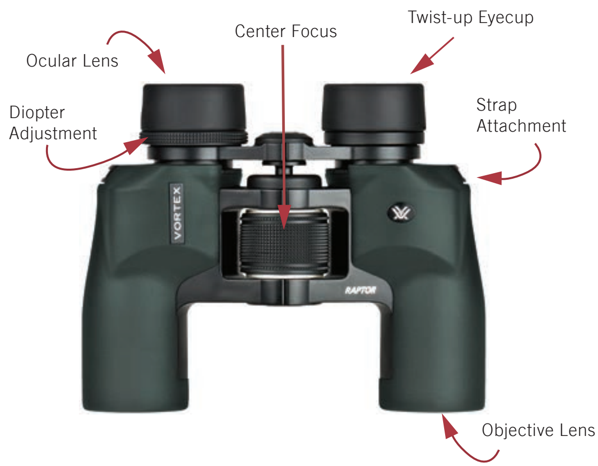
> **Compact** binoculars generally have objective lenses of 28 mm or less and can weigh from a few ounces to under a pound.
>
> **Mid-size** binoculars include models with objective lenses between 30 mm and 35 mm.
>
> **Full-size** binoculars generally have objective lenses over 35 mm and can weigh from twenty ounces to around two pounds.

ROOF PRISM

Named for the roof-like appearance of the prisms, the roof prism binocular has objective lenses and eyepieces positioned in a straight line and is appreciated for a streamlined, durable chassis. Phase correction coatings on the prism glass keeps the light in correct color phases—enhancing the resolution, contrast and color fidelity. Fine quality in this complex prism design is possible as a result of care in engineering and design.

PORRO PRISM

Many people will recognize the traditional binocular shape of a Porro prism by its offset barrels. Named after the Italian optical designer, Ignazio Porro, Porro prism binoculars have objective lenses that are spaced wider apart than the eyepieces. This design offers a rich depth of field, wide field of view, a three-dimensional image, and delivers good quality at a reasonable cost.



REVERSE PORRO PRISM

The reverse Porro prism is a compact version of the full-size Porro prism binocular with the eyepieces spaced wider apart than the objective lenses.

THE NUMBERS

IDENTIFYING THE CONFIGURATION

When you look at your binocular, you'll notice numbers like **10x50** (read as "ten by fifty") printed on the binocular.

10 x 50 Model

The first number (10x) refers to the magnification provided by the binocular (or how many times larger an object will appear than when viewed without magnification). Binoculars vary in magnification, but 8x and 10x are most common.

☑**TIP** *As magnification increases, it may be more difficult to hold the binocular steady so the image may appear to shake. In addition, an increase in magnification generally causes a decrease in image brightness. 7x or 8x magnification is considered adequate for woodland settings, while 10x is preferred for viewing at greater distances.*

The second number (50) refers to the diameter of the objective lens in millimeters. Objective lenses vary in size from 15 mm to 50 mm and beyond. The size of the objective lens determines how much light the binoculars can receive and how bright the resulting images will be. The size of the objective lens also affects the size of a binocular.

Exit pupil is especially important for viewing in low light conditions. If your primary time for viewing is during the bright light of day, then a binocular with a smaller objective lens of 26 mm or less will do just fine. If you want the brightest possible image during near-dark conditions, you'll want to choose a binocular with an objective lens in the 33 mm to 56 mm range.

Wide field of view has advantages when following fast-moving action and scanning dense habitats. The field of view is measured in feet at 1,000 yards or degrees:

Example: 388 feet @ 1000 yards
6.0 degrees

Close-focus binocular will focus down to ten feet or less. This feature is especially important for watching birds, insects and butterflies.

BASIC ADJUSTMENTS

ADJUST THE INTERPUPILLARY DISTANCE

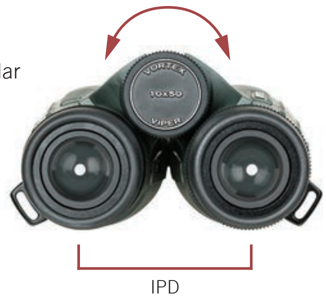
The interpupillary distance (IPD) is a measurement of the distance between the centers of a person's left and right eye pupils. A binocular also has an IPD measurement that can be adjusted.

The hinged design of a binocular allows you to match the IPD of your eyes to that of the binocular so that you see a single image that is free of shading. If the IPD is not correctly adjusted, you may see shading over part of the image. With correctly adjusted binoculars, you will see a single image without the shading.

The IPD corresponds to the spacing between a person's eyes.

To adjust the IPD of your binocular, simply rotate the binocular barrels inward or outward to line up the ocular lenses with your eyes.

Adjust the IPD of your binocular for the best viewing possible.



ADJUST THE EYECUPS

Adjusting the eyecups up or down allows the user to see a full field of view. This is important for people who must use eyeglasses or sunglasses. The two main styles of eyecup design are:

Retractable eyecups that twist up and down. Multi-position eyecups let you choose the most comfortable position.

Flexible eyecups that fold back for maximum eye relief with eyeglasses.

TWIST EYECUPS

FOLD BACK EYECUPS

With Glasses – If you wear eyeglasses or sunglasses, rest the eyecups of the binocular against your glasses with the eyecups folded back or twisted down. If the eyecups stay fully extended when wearing eyeglasses, images will appear as if you are looking at them through a tunnel.

Retract the eyecups when viewing with eyeglasses or sunglasses.

Without Glasses – If you do not wear eyeglasses or sunglasses, extend the eyecups to provide the proper distance for seeing the full field of view. If the eyecups do not stay fully extended, you may see black crescents in the field of view.

Extend the eyecups when viewing without eyeglasses or sunglasses.

PROPERLY FOCUS THE BINOCULAR

For the best views, follow this two-step process to properly adjust the center focus and diopter. Choose an object that is about 20 yards away from you and stay in the same spot until you have adjusted the binocular for your eyes.

1. **Adjust the center focus** – Start by closing your right eye or covering the right objective lens with your hand. Focus your left eye on the object and adjust the center focus wheel until the image is in focus. Leave the center focus in this position as you adjust the diopter.

Adjust the center focus.

2. **Adjust the diopter** – Start by closing your left eye or covering the left objective lens with your hand. Look through your right eye and adjust the diopter ring (generally found on the right eyepiece) until the object is in focus. Make note of this diopter setting in case you need to set it again. From this point on, you will only need to use the center focus wheel.

Adjust the diopter setting.

☑**TIP** **Locking Diopters** – Some models feature a diopter that locks the settings. If the diopter locks, lift the diopter ring (or follow manufacturer instructions) to unlock. Then, looking through your right eye, adjust the diopter so that the object is in focus. Make note of this diopter setting in case you need to set it again. Push the diopter ring down to lock—from this point on, you will only need to use the center focus wheel.

SPOTTING SCOPES

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When true long-distance spotting and subject evaluation are the name of the game, it's time to break out a spotting scope. As with other optics, spotting scopes have specific features you'll want to be familiar with. Zoom in on the facts to ensure all your spotting needs are met.

SPOTTING SCOPE DESIGN

Spotting scopes provide higher magnification than available through most binoculars and are designed for viewing wildlife and landscapes at longer distances. In many cases, manufacturers make a spotting scope design available with both an angled and a straight body style. Though one design is not better than the other, each offers distinct advantages.

The angled body features an eyepiece that is set at a 45-degree angle. This style lets people of different heights share without adjusting the tripod. Because angled scopes can sit lower on a tripod, users will benefit from the added stability.

The straight body features an eyepiece in line with the objective lens. This natural line of sight works well with a car window mount.

THE NUMBERS

IDENTIFYING THE CONFIGURATION

The name of a spotting scope frequently includes a group of numbers such as **20–60x85**. This range of numbers is called the configuration and indicates the magnification and the size of the objective lens.

The first set of numbers (20–60x) indicates the magnification range. Since spotting scopes feature high magnifications for long-distance viewing and large objective lenses, these optics must be mounted on a tripod.

☑**TIP** Some eyepieces vary in magnification and allow you to "zoom" from low to high power; other eyepieces are fixed at a single power. In some cases, the same eyepiece may be used with models of varying objective lens sizes with the result that the magnification will be 18x in a 65 mm model and 23x in an 85 mm model.

The last number (85) indicates the size of the objective lens in millimeters. This size directly affects the overall size of the spotting scope resulting in anything from extremely compact to full-size models.

☑**TIP** Spotting scopes with an objective lens of 50 mm to 65mm are fairly portable and compact—offering performance at a lower price than the same model with a larger objective lens. Spotting scopes with an objective lens of 80 mm and larger will be brighter than more compact models, but are generally heavier and bulkier.

BASIC ADJUSTMENTS

ADJUST THE EYECUP

Spotting scopes typically feature an adjustable eyecup in one of two styles: twist or fold. Adjusting the eyecup up or down allows you to see a full field of view whether or not you wear eyeglasses. Even if you wear sunglasses, making this adjustment will enhance your viewing experience.

TWIST EYECUP

Adjust by twisting the eyecup.

FOLD EYECUP

Adjust by folding the eyecup.

ADJUST THE MAGNIFICATION

Change the magnification of your spotting scope by simply turning the magnification adjustment ring in a clockwise or counter-clockwise direction.

ADJUST THE FOCUS

Some spotting scopes provide both fast and fine focus dials. After setting the magnification, some refocusing is usually required.

1. Slowly turn the fast focus dial until the subject is nearly in focus.

2. Turn the fine focus dial to pick out the finest details.

ADJUST THE VIEWING ANGLE

Some spotting scopes provide a rotating tripod collar that allows you to rotate the spotting scope body for greater viewing flexibility.

Rotate the spotting scope body for the most comfortable viewing.

ADJUST THE SUNSHADE

Some spotting scopes provide a built-in sunshade that extends to effectively block out disturbing stray light. The sunshade also shields the objective lens from mechanical damage and guards against soiling by fingerprints and precipitation.

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