

EN

# ON TARGET

AN INTRODUCTION TO  
HIGH-QUALITY HUNTING OPTICS



SEE *THE* UNSEEN



SWAROVSKI  
OPTIK





# INTRODUCTION

The sensation of being intensely close to nature and myself - this is the aspect of hunting that most appeals to me. I see, smell, and feel each season and every kind of weather.

Even with years of experience, hunting is a continuous learning process and there are always a few surprises along the way. Basically, we don't know what lies in store at our next hide or what will happen out in the terrain. This unpredictability creates a certain excitement. It allows me to take time out from my busy daily life and immerse myself entirely in nature. 'When it comes to deer, anything is possible,' an experienced hunter once said to me. In my view, this applies to hunting in general.

Although many things follow an annual cycle, flora and fauna constantly surprise us. They say happiness is in the moment and this is definitely true for hunting. You too have no doubt had some unforgettable experiences in nature. Hunting is one of the most intense and beautiful activities you can engage in. You live, feel, think, and act in harmony with nature. To enjoy these precious moments and make accurate assessments of the situation, you need both time and experience as well as the right equipment and the ability to use it correctly.

Thanks to a happy twist of fate, I'm not only a hunter, but also actually work in the hunting industry every day professionally. I can call on my wealth of experience in my job as product manager at SWAROVSKI OPTIK. Here, in this traditional family business located amid the beautiful Tyrolean Alps, we value the highest level of quality and precision. It is no coincidence that SWAROVSKI OPTIK is among the world's leading manufacturers of high-quality hunting optics, which is something we are very proud of.

The aim at SWAROVSKI OPTIK is not only to develop the best hunting optics for you, but also to share our extensive knowledge. We would therefore like to familiarize those who are interested in the basics of hunting optics. I wish you a great deal of pleasure from reading this, as well as many impressive, unforgettable hunting experiences for the future.

Good hunting!

WOLFGANG SCHWARZ

Keen hunter and product manager at SWAROVSKI OPTIK





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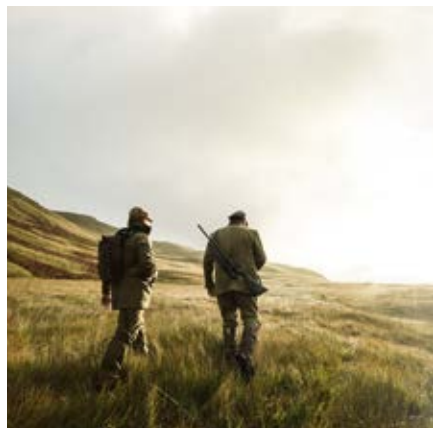
STRUCTURE  
OF AN  
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# STRUCTURE OF AN OPTICAL SYSTEM

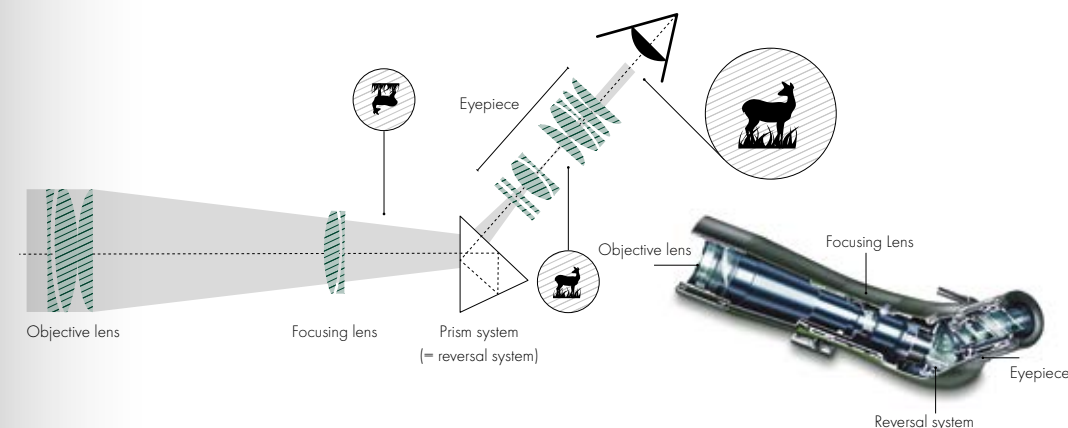


Binoculars, spotting scopes, and rifle scopes are optical systems that allow us to observe what's happening in the distance. They consist of: objective lens, focusing lens, reversal system, and eyepiece. Optronic elements can also be based on a combination of electronic and optical components.

## OBJECTIVE LENS

In the optical system, the objective lens is the front lens group that faces the object. It works like a converging lens. Its job is to display an image that appears at the image plane upside down, laterally transposed, and reduced. This image is subsequently displayed again correctly by the reversal system.

### LENS AND PRISM ARRANGEMENT OF BINOCULARS (INCLUDING OPTICAL PATH)



## FOCUSING LENS

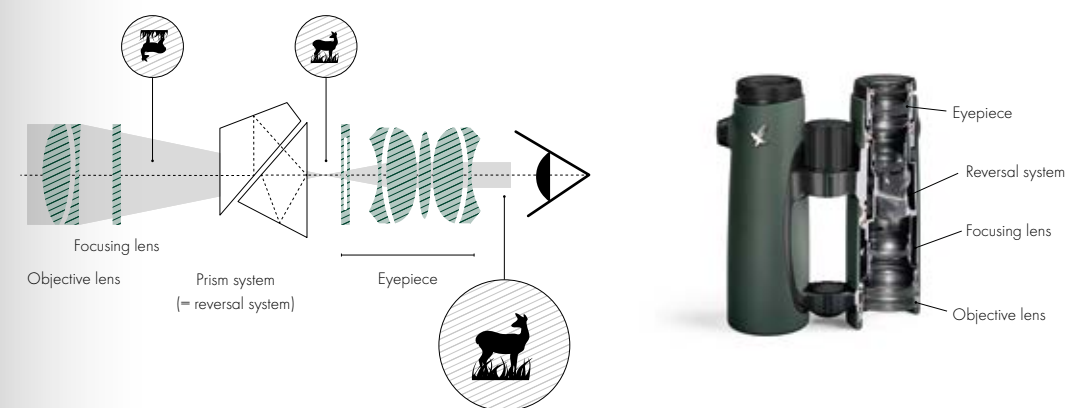
The focusing lens is an adjustable lens inside the optical system for focusing the image at different distances.

- In some binoculars, focusing is controlled via adjustable eyepieces.
- Several optical systems come with a fixed-focus lens, and are usually set in focus at 100 m.
- In the case of rifle scopes, apart from focusing, the focusing lens also facilitates parallax correction.

### FOCUSING RANGE

- for binoculars, between ~ 1.5 m and infinity
- for spotting scopes, typically between ~ 5 m and infinity
- for rifle scopes, typically between ~ 50 m and infinity
- "infinity" corresponds to around 1,000 m and beyond

### LENS AND PRISM ARRANGEMENT OF SPOTTING SCOPES (INCLUDING OPTICAL PATH)



**DIOPTRIC ADJUSTMENT** In order to compensate for various visual impairments (diopters) affecting the eyes, the left side in binoculars is mechanically decoupled from the right side, allowing the image to be focused from right to left.

### MY TIP

The larger the objective lens diameter, the greater the optical system's luminous intensity. However, this luminous intensity can only be utilized if the correct magnification is chosen.

### MY TIP

The diopter adjustment can be made using the focusing button or via the eyepiece. For rifle scopes, the reticle can be focused using the diopter adjustment on the eyepiece, thereby correcting any visual impairment.



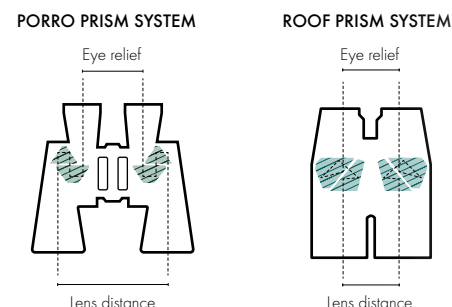
## MY TIP

Binoculars with roof prism systems are generally more ergonomic and compact compared with Porro prism systems.

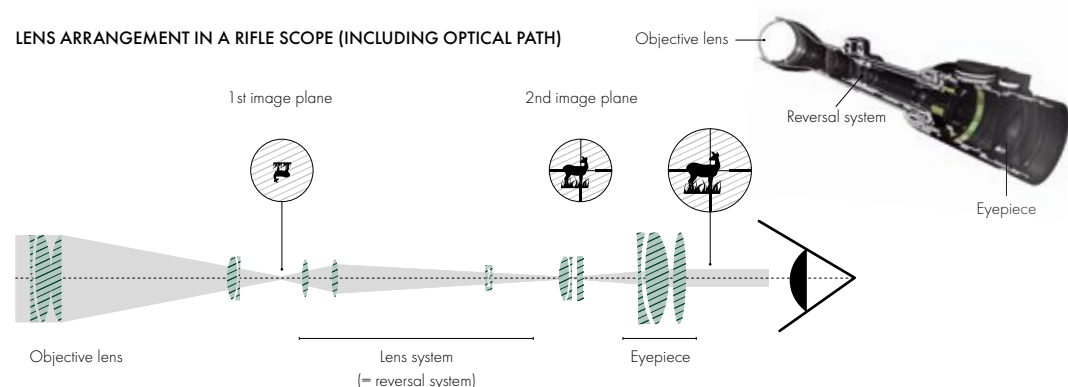
# REVERSAL SYSTEM

The purpose of the reversal system is to reverse the image by means of prisms in binoculars and spotting scopes, and lenses in rifle scopes. Prisms are divided into two different systems: the Porro system and roof system.

- In prism systems, the incident light is totally reflected several times. This produces an upright image.
- Unlike lens systems, prism systems can accommodate a shorter design.
- The lens reversal system is needed in rifle scopes to control the variable magnification and move the exit pupil around 8-9 cm outside (eye relief).



## LENS ARRANGEMENT IN A RIFLE SCOPE (INCLUDING OPTICAL PATH)



# EYEPIECE AND FIELD DIAPHRAGM

The reduced image at the image plane is enlarged by the eyepiece lens using the same principle as a magnifying glass. Within the optical system there are several diaphragms which function as light quantity diaphragms and reduce incident light, or they limit the image produced in the optical system to the useable part. This special diaphragm is called a field diaphragm.

# OPTRONICS

Optronics refers to the combination of optics and electronics. It is used in illuminated reticles and rangefinders.

- Optronic support in high-quality systems is becoming increasingly important. These optronic components can influence the performance of the system's sight optics.
- The challenge for a manufacturer of high-quality optics is to avoid compromising on the optical quality when incorporating a rangefinder.



Illuminated reticle



Rangefinder

# ILLUMINATED RETICLE

Reticles can incorporate an illumination system for lighting up different areas of the target.

Systems are adapted to the hunters' requirements: day/night switch, with adjustment for light intensity, automatic on/off, tilt sensor, durability, luminosity, etc.



Illuminated reticle 4A-I

# RANGEFINDER

Laser rangefinders operate according to the principle of travel time measurement and are available in three different systems: binoculars with an integrated rangefinder, targeting optics with an integrated rangefinder, and pocket rangefinders.

- Measuring travel time involves the emission of short, invisible laser pulses. When they encounter objects, they are reflected there, and the rangefinder then detects these reflected laser pulses. It measures the time elapsed between the emission of the pulses and their detection.
- Rangefinder systems are often integrated with angle measurement systems. The angle is measured via the sensors inside and is used along with the distance for ballistic calculations or aiming point adjustments.
- Class 1 lasers are used in hunting and are able to take accurate measurements up to around 1,400 m. A stronger laser is needed for measurements over longer distances.



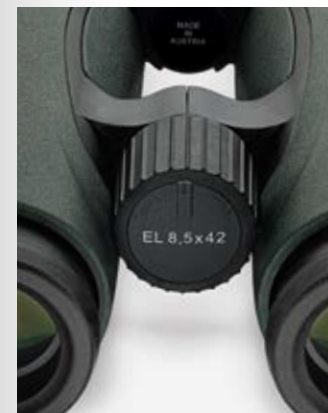
EL RANGE - ground-breaking precision





## PRODUCT SPECIFICATIONS

As a rule, all optical systems indicate **magnification and objective lens diameter**.



**BINOCULARS: 8.5x42**

8.5 = 8.5x magnification  
42 = objective lens diameter in mm



**SPOTTING SCOPE: 25-60x85**

25-60 = variable 25 to 60x magnification  
85 = objective lens diameter in mm

Spotting scopes can usually be connected to eyepieces that offer a fixed or variable magnification.



**RIFLE SCOPE: 2.3-18x56 P**

2.3-18 = variable 2.3 to 18x magnification  
56 = objective lens diameter in mm  
P = Parallax Turret

### MY TIP

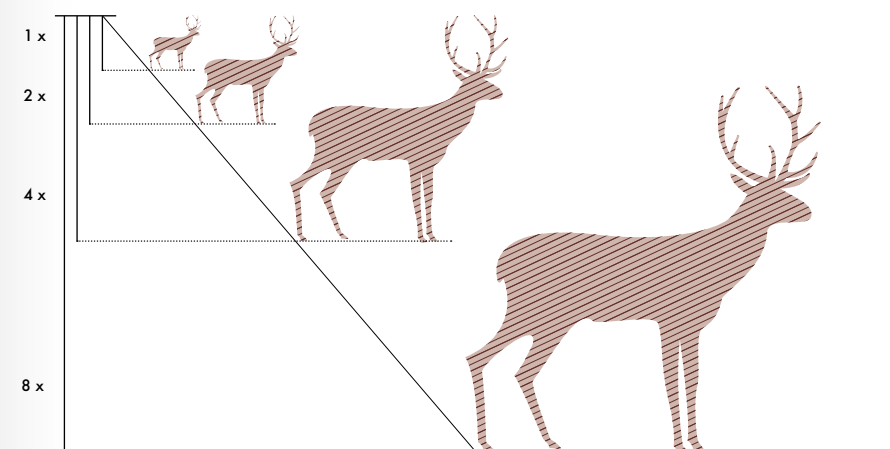
When buying a product, you should not only compare the general parameters. Image and manufacturing quality also play a vital role. Optical calculation and manufacturing, HD optics, coatings, and mechanical consistency are all just as important as the product specification when making your choice.

## MAGNIFICATION

Magnification is generally regarded as the most important dimension, indicating how many times closer an object appears to be. The higher the magnification, the closer the object appears and the smaller the field of view. A differentiation is made between binoculars, which usually have a fixed magnification, and spotting and rifle scopes, which usually have a variable magnification (zoom function).

### EXAMPLE

Binoculars with 8x magnification will optically magnify a deer 100 meters away to make it appear to be 12.5 meters away if viewed with the naked eye.







## OBJECTIVE LENS DIAMETER

The objective lens diameter determines the size of the optical system's effective objective lens and is an essential parameter.

The bigger the objective lens diameter, the more light the system can capture. However, the size of the objective lens does not determine the size of the field of view.



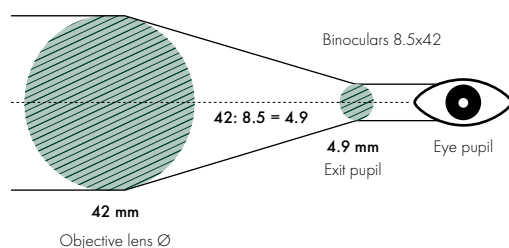
## EXIT PUPIL

The size of the exit pupil depends on the objective lens diameter and magnification.

- If you look at the eyepiece from a distance of around 30 cm, the exit pupil appears as a bright disc.
- If you measure this exit pupil, you can very easily check the basic dimensions (magnification and objective lens diameter).

**FORMULA**  
Exit pupil =  $\frac{\text{objective lens diameter}}{\text{magnification}}$

**EXAMPLES**  
The larger the exit pupil, the more light that reaches the eye. Therefore, a pair of 8x56 binoculars has an exit pupil of 7 mm. This is compared to 8.5x42 binoculars, where the value is 4.9 mm.



### STANDARD RANGES FOR EXIT PUPILS

BINOCULARS	2.4 to 7 mm	8.5x42 = 4.9 mm
SPOTTING SCOPES	1 to 4.3 mm	20-60x85 at 60x magnification = 1.4 mm
RIFLE SCOPES	1.7 to 13.1 mm	2.5-15x56 at 8x magnification = 7 mm

## FIELD OF VIEW

The field of view is the size of the circular section of the area that can be observed when you look through a long-range optical device. On binoculars and spotting scopes, the field of view is given in meters at a range of 1,000 meters, e.g. 141 m/1,000 m. In the case of rifle scopes, it is specified at a range of 100 meters, e.g. 42.5 m/100 m. As an alternative to meters, the field of view can also be given in degrees (e.g. 6.6°).

- It is always desirable to have the largest possible field of view for long-range optical instruments. But the most technically feasible size for the field of view is essentially determined by the magnification.
- Manufacturers face a major challenge to achieve a combination of the widest possible field of view and an edge-to-edge sharp image.

**The higher the magnification, the smaller the field of view.**

### FIELD OF VIEW



### MY TIP

It is ultimately the purpose for which the long-range optical devices are used that determines the choice of magnification. When rifle scopes are used for driven hunting, a large field of view is crucial for quick target acquisition, so you will need to select a low magnification. For hunting in the mountains, where more time is available for taking the shot, often fired over long distances, a higher magnification is required, meaning the field of view is of secondary importance.





## IMAGE QUALITY

To be able to make the most of the fading light or to hunt over long distances, an investment in high-quality hunting optics is vital. A sign of quality is an ideal balance between absolute image definition, the perfect resolution, no distortion, and producing bright, color-neutral images.

## IMAGE DEFINITION

Image definition is used to mean the overall image achieved. An ideal optical system would reflect an image in such a way that you would not be able to recognize whether there were binoculars in between or not. But this is not fully achievable due to physical restrictions.

- Deviations from the ideal optical representation are called "aberrations." They affect the contrast of the image transferred by the binoculars.
- The aim of high-quality optics is to offset the various aberrations in the appropriate manner.

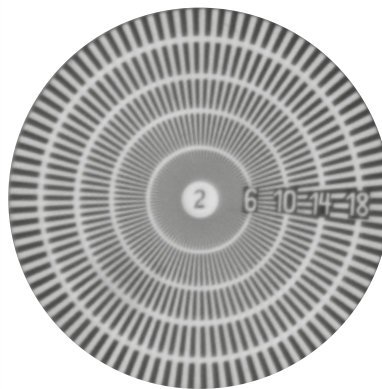
## CONTRAST

Contrast is used to mean the sharp separation of light-dark transitions on an object. Low-contrast images appear dull and flat, but are often only differentiated when compared to high-contrast images. Low-contrast images are the result of strong aberrations, such as color fringing, inadequate coating quality, or strong scattered light.

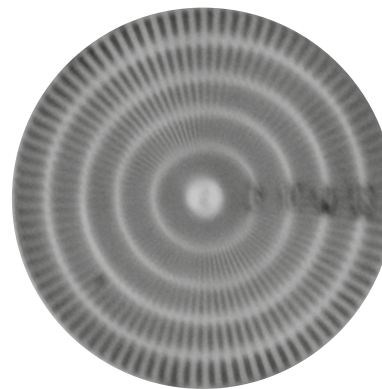
## LIMITING RESOLUTION

Resolution is an optical system's ability to reproduce the smallest details separately from each other. The larger the objective lens diameter, the smaller the objects that can theoretically be identified. In practice, the resolution is usually restricted by the human eye. The optics allow more to be resolved than the eye can perceive or process. The limiting resolution can be checked using the Siemens star.

### EXAMPLES OF LIMITING RESOLUTION



BINOCULARS FROM SWAROVSKI OPTIK  
4.5 arc seconds



STANDARD BINOCULARS  
Approx. 10 arc seconds

## DETAIL RECOGNITION

Being able to recognize fine details on an object is highly dependent on environmental conditions, such as the light conditions and the object's contrast, as well as the size of binoculars chosen.

### MY TIP

In everyday hunting, high-contrast images allow for definite sighting in poor light conditions and over long distances.

### MY TIP

In bright light conditions, the basic rule is that more details usually can be recognized with a higher magnification, but this creates a risk of image vibration. This can be avoided by supporting the binoculars on a flat surface. In twilight and darkness, instruments with a large exit pupil provide the best level of detail recognition. These are long-range optical devices with a large objective lens diameter and generally a smaller magnification. It is also very important that the eye adjustment is long enough. Don't look at a bright cell phone screen!





## EDGE SHARPNESS

The edge sharpness of a pair of binoculars is a good indication of high-quality optics and can also be easily verified. The aim is to achieve the largest possible field of view, without losing the edge sharpness in the process. Good or even perfect edge sharpness permanently reduces the need for readjustment.

Excellent peripheral and image definition is achieved in optical devices with SWAROVISION technology using combinations of lenses (field flattener).

These produce a flattened image and reduce distortion to a minimum. The larger the field of view, the more difficult it is to achieve this.

### EDGE SHARPNESS



**SWAROVISION** Perfect image thanks to SWAROVISION  
**STANDARD** Image using comparable product

### COLOR FRINGING



**USING HD OPTICS** A unique optical system combined with fluoride-containing lenses  
**STANDARD** Without HD lenses, annoying color fringing can occur

## COLOR FRINGING

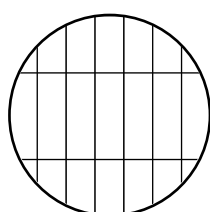
Color fringing, also known as chromatic aberrations, is an image defect caused by optical lenses and occurs particularly at light-dark transitions.

A highly innovative optical design combined with fluoride-containing HD lenses minimizes interfering color fringing. This enables maximum color fidelity and leads to a significant improvement in resolution and contrast.

## DISTORTION

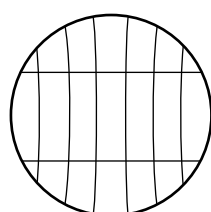
Distortion is used to mean the optical distortion of objects when an image is displayed. There is pincushion distortion, where straight lines curve outward, and barrel distortion, where they curve inward. Binoculars are manufactured with a small desired distortion, with the aim of ensuring the best possible visual impression both for viewing and observation.

### WITHOUT DISTORTION

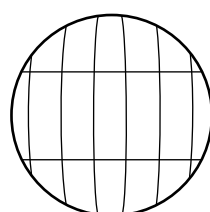


e.g. EL binoculars

### WITH DISTORTION



pincushion

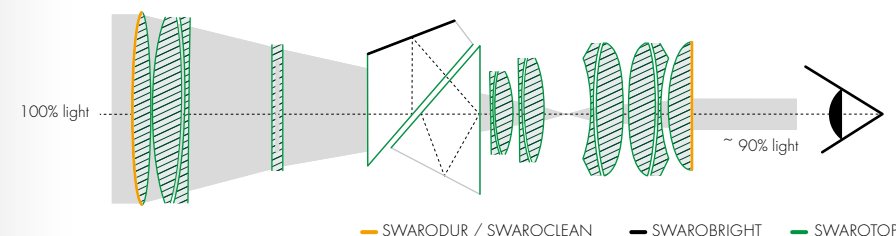


barrel

## TRANSMISSION

This describes the light transmission of an optical system and is expressed as a percentage. For instance, 90% transmission means that 10% of the light is lost while passing through the optical system. This can be caused by absorption in the glass, as well as by reflections at the glass-air boundaries. A higher amount of transmission means a brighter picture, which is important in twilight. Transmission can be influenced positively by various coatings.

### EXAMPLE OF TRANSMISSION IN EL BINOCULARS

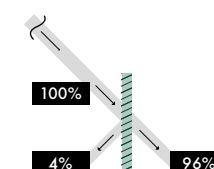


## COATINGS

Different coatings are used to optimize long-range optical devices for the relevant applications.

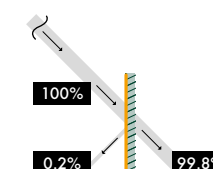
- High-quality coatings provide a high rate of transmission, which is associated with a bright, lifelike image.
- You can avoid interference from reflections (anti-reflection coating).
- The coating process involves ultra-thin layers (in the order of nanometers, i.e. 250 times thinner than a human hair) being steamed onto the surface of the glass.
- The glass in high-quality systems has up to 120 of these layers.
- This produces a transmission in excess of 90%.
- A high transmission rate (over 90%) may entail a loss in terms of lifelike color reproduction. Both these parameters can be adapted to each other in the current coating process. While a difference of 2% in transmission can hardly be noticed by the naked eye, a level in color fidelity definitely can.

Transmission loss of approx. 4% per glass-air interface  
**WITHOUT COATINGS**



Transmission loss of approx. 0.2% per glass-air interface  
**WITH COATINGS**

Layer



## SCATTERED LIGHT

Scattered light mainly occurs as a result of reflections from intense light (moon, sun etc.) on housing walls, diaphragms, screws, and lens mounts and edges or due to lower-value coatings, as well as for many other reasons. This must be skillfully reduced using baffling, lacquer, and shades. Scattered light appears as a dull, nebulous haze.

### WITH SCATTERED LIGHT



### WITHOUT SCATTERED LIGHT



### MY TIP

When cleaning the lenses, you must be very careful not to cause any damage to their surface. You should always resist the temptation to clean a dirty binocular lens with your own clothing, you should use good-quality cleaning cloths or cleaning sets.





BINOCULARS

Binoculars are an indispensable tool for hunters when scanning the hunting ground. Especially important is image quality at twilight or at night. You can see considerably more when observing through binoculars, i.e. using both eyes, than you can through a rifle scope with the same specifications.

HIGH-QUALITY BINOCULARS HAVE THE FOLLOWING OUTSTANDING FEATURES:

- perfectly fine-tuned optics
- a precise focusing mechanism with an easy-to-use focusing wheel
- an ergonomic design with adjustable eyecups
- rubber armoring with specially developed materials providing perfect feel and balance to keep stable
- high-quality, suitable accessories such as objective lens and eyepiece covers, bino guard, carrying strap, and bag

THE IDEAL MODEL FOR EVERY HUNTING SITUATION:

- When hunting in the mountains or stalking, a small, compact pair of binoculars (e.g. 10x32) or binoculars with a rangefinder are recommended (EL Range 10x42).
- For hunting in a hide in twilight, twilight performance is particularly important (e.g. 8x56).
- The 8x42 model is recommended for universal use as it has a very large field of view, but also offers a suitable magnification and twilight performance.



MOUNTAINS/STALKING		HIDE	
NL Pure 8x32	EL 10x50	SLC 8x56	
NL Pure 10x32	EL 12x50	SLC 15x56	SLC 10x56
ALL-ROUND			
NL Pure 12x42	NL Pure 10x42	NL Pure 8x42	
	EL 10x42	EL 8.5x42	
	EL Range 10x42	EL Range 8x42	

☀ DAY/LARGE DISTANCES NIGHT 🌙



MY TIP

Depending on your habits and personal preference, binoculars with a higher magnification are good to pick out more details. It is important to remember that higher magnification can impair image stability. Try out different models and find which one suits you best.

MY TIP

It is important to set up the binoculars correctly in order to get the best possible results.

- Eye relief: adjust both halves of the binoculars until you see a single round image and no disturbing vignetting
- Diopter adjustment: to ensure optimum image quality, adjust the focus to compensate for any differences between your left and right eye.
- Eyecups: used with or without glasses, you can turn the eyecups to adjust them.





## LONG-RANGE OPTICS WITH INTEGRATED RANGEFINDER AND ANGLE MEASUREMENT

Firearms, ammunition, and also optical devices have become far more precise in recent years. Nevertheless, shots across long distances remain a significant challenge and you are responsible to decide, between what is technically possible and what constitutes good hunting practice. Making an accurate long-range shot you need to take into account external influencing factors as well as many years of experience and practice. You not only need to trust your own skills and abilities, you must also be able to rely on your equipment. High-precision rangefinders and angle measurement provide support.

### MY TIP

To avoid misses, it is absolutely essential to calculate the exact distance. Since it is easy to misjudge distances in open land or in the mountains, the wrong aiming point is often chosen.



- Rangefinders are available as binoculars, rifle scopes, and pocket rangefinders.
- The solution you opt for depends on your individual hunting requirements.
- A rangefinder integrated as part of a pair of all-round binoculars is always to hand and can be used immediately.
- Traditional rifle scopes allow you to transfer the information directly and adapt the aiming point to the distance.
- The smart dS rifle scope measures the exact distance and the precise aiming point at the touch of a button. It factors in the magnification setting, air pressure, temperature, and angle. You do not need to make any other manual adjustments to the rifle scope before taking your shot.
- The pocket rangefinder can be used separately if required, but takes up additional space in your rucksack.

## SHOOTING AT AN ANGLE

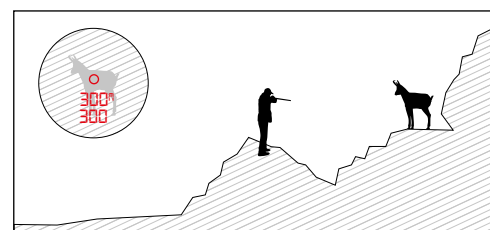
When you shoot at an angle, the gravitational pull does not have such a strong impact on the shot's flight path as in the case of shooting horizontally. This means that the aiming point for the game changes when shooting uphill or downhill (high shot). Shooting at an angle happens quite frequently, not only when hunting in the mountains, but also in hilly terrain.

- The crucial factor is the combination of the angle and the target distance measured.
- This allows you to calculate the adjustment and choose the correct aiming point.

- Modern rangefinders come with this angle function and show the aiming point adjustment or the adjusted shooting distance.

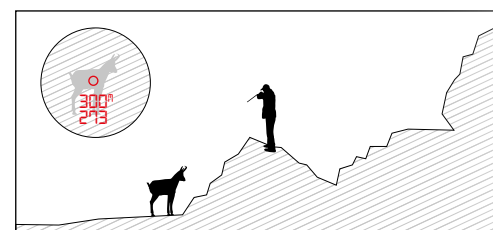
### HORIZONTAL SHOT

300 m = distance, 300 m = shooting distance



### SHOOTING AT AN ANGLE

300 m = distance, 273 m = adjusted shooting distance

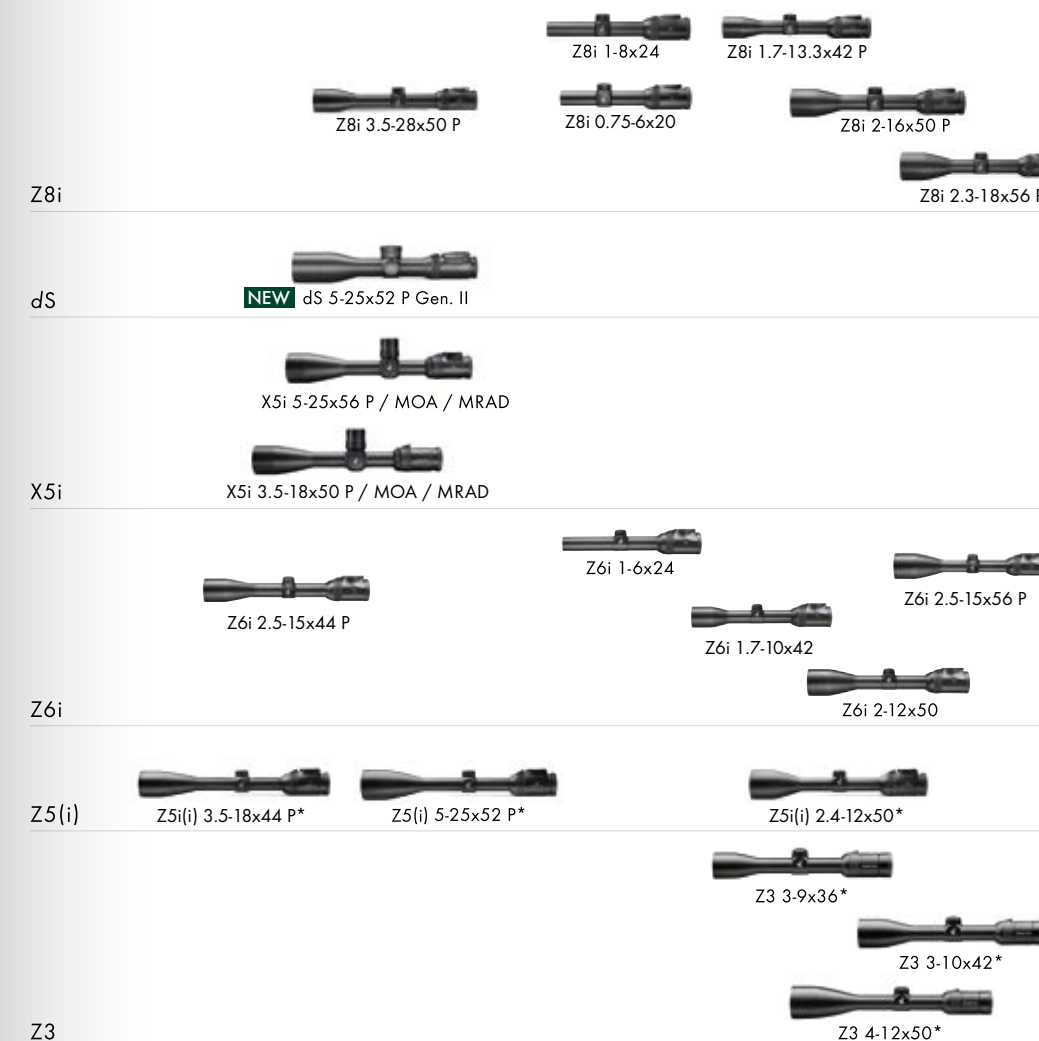
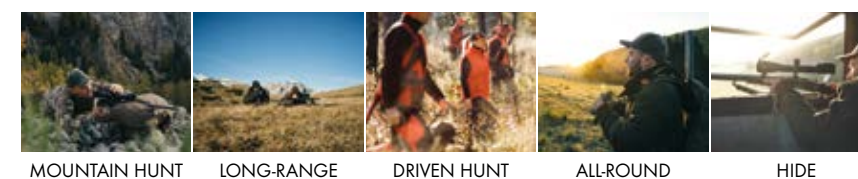


Modern rangefinders, such as the EL Range TA, not only show the angle-corrected distance, but also the number of clicks needed to adjust the reticle.

## RIFLE SCOPES

Rifle scopes are standard equipment for hunting firearms and allow you to take a precise shot. The reticle built into the rifle scope replaces the back and front sights and, together with the magnification, enables controlled firing. The reticle is a series of fine lines used as an aid to locate an object.

- Rifle scopes are available with fixed or variable magnification. Variable models offer greater versatility.
- Certain rifle scopes are suitable for use in twilight as well as quick shooting on driven hunts or precision shooting at great distances.
- However, rifle scopes cannot turn night into day. The high magnification performance of a 2.5-15x56 rifle scope, for instance, can be fully utilized during the day. At night, on the other hand, at a magnification above 8x the rifle scope image becomes increasingly dark. This is because at a higher magnification the exit pupil becomes smaller and, therefore, the incident light is reduced.
- The highest possible magnification is not always the panacea either for targeting, particularly as the field of view for observation becomes considerably smaller. With a 15x magnification it is only approx. 2.7 m at 100 m.



\* only available in the U.S., Canada, and other selected countries

### MY TIP

A high magnification does not mean that you can "see more" in twilight, because the lower the magnification, the brighter the image will be. Therefore, you must choose the correct magnification for the particular hunting situation.

### MY TIP

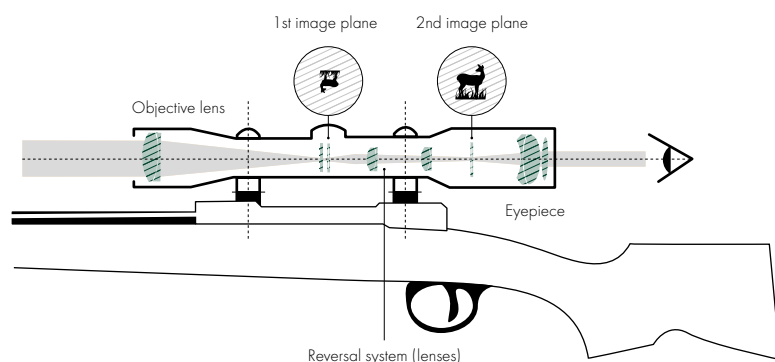
When observing at night, it is important to avoid bright light sources (e.g. cell phone display) because the eye needs about half an hour to adjust to the dark. In the hide in twilight, it is recommended to position and focus the binocular at a fixed point and to use focusing as little as possible.





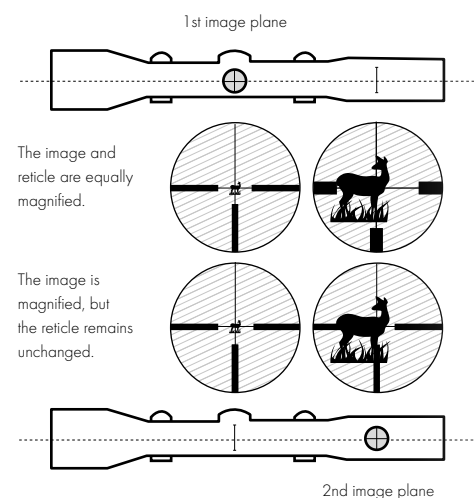
## IMAGE PLANES

- The design principle used in rifle scopes (use of lenses as a reversal system) results in two image planes.
- Behind the objective lens the image appears upside down and laterally transposed at the 1st image plane (objective lens image plane).
- This is then magnified by the reversal system and displayed as an upright image at the 2nd image plane.
- The eyepiece takes this image and projects it, like a magnifying glass, onto the eye.



## VARIABLE OR FIXED MAGNIFICATION

- The magnification value in variable rifle scopes can be adjusted progressively.
- In fixed rifle scopes, the magnification value cannot be changed. These rifle scopes are not so common now because the image quality offered by variable rifle scopes has been significantly improved and their scope of application expanded, thanks to the higher zoom factors.
- Nowadays, more rifle scopes are used with the reticle at the 2nd image plane. In this instance, less of the target is covered, especially at a high magnification and over long distances. The image is magnified but the actual reticle remains the same size.



## ZOOM FACTOR

The zoom factor describes the adjustable magnification range in optical instruments. The higher this factor, the larger the magnification range. The lowest magnification is characterized by a large field of view, while the highest magnification enables identification of the target object in sharp detail.



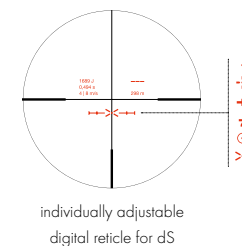
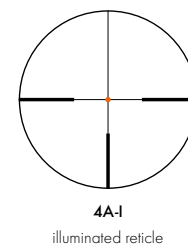
### MY TIP

The 8x zoom allows you to enjoy a larger field of view at a lower magnification and better detail recognition at higher magnifications. This makes rifle scopes with a higher zoom factor much more versatile. For example, hunters on a driven hunt using the Z8i 0.75-6x20 at 0.75x magnification have a field of view of 56 m and can pick up moving targets at lightning speed. At the same time, they can shoot with precision over longer distances using the same rifle scope at 6x magnification.

## RETICLES

The reticle is the target aid in the rifle scope. There are various forms of reticles, mostly consisting of a crosshair, line, dot, or circle, or any combination of these. Reticles are available in two designs: non-illuminated or illuminated. The reticles are illuminated by an LED, which is directed at the parts of the reticle to be illuminated. Both horizontal and vertical parts of the reticle can be lit.

Rifle scopes with illumination units have emerged because they provide a greater contrast for game, thereby ensuring more certainty when taking aim.



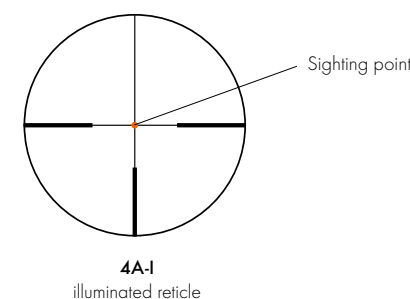
## RETICLE ADJUSTMENT

When using open sights both back and front sights must be lined up with the aiming point in order to hit the target. The aiming point is understood to mean the point on the target object at which you are aiming. With a rifle scope the back and front sights are, as it were, brought together into a single point on the reticle, the sighting point.

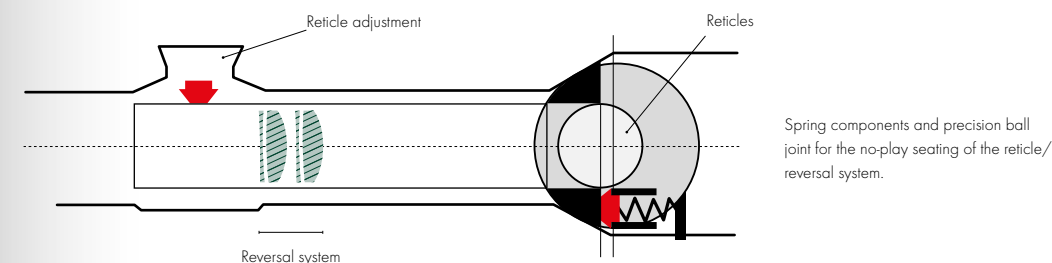
- When aiming with a rifle scope, hunters need to line up two different points, the sighting point and the aiming point on the target.
- The reticle must not be displaced by external forces such as recoil, otherwise the impact point of a sighted-in firearm will vary uncontrollably.
- However, in order to sight in the firearm it must be possible to move and adjust the reticle inside the rifle scope.
- The reticle adjustment in the turrets on the rifle scope is operated using the click settings. The relevant direction is indicated by the label on the turrets.
- Each click changes the impact point at 100 m, e.g. by 1 cm.
- The click adjustment can vary from one manufacturer to another.
- The displacements of the reticle this produces in the reversal system are in the thousandths of a millimeter.

### EXAMPLE

The acceleration forces when firing a .460 Weatherby Magnum cartridge (if you ignore the duration of the acceleration effect) can be illustrated as follows: the firearm including the rifle scope accelerates about 770 times faster than a Formula 1 racing car. In practice, this means that the resulting recoil corresponds roughly to a steel ball measuring 10 cm in diameter and a mass weighing 4.5 kg falling to the ground from a height of 2.5 m.



### SEATING OF THE REVERSAL SYSTEM/RETICLE IN SWAROVSKI OPTIK RIFLE SCOPES



### MY TIP

Especially when hunting at twilight, it is advisable to keep the reticle brightness as low as possible. This provides you with the best possible contrast. Some rifle scopes provide the option of storing specific brightness levels. Use the memory to store useful settings.





## PARALLAX

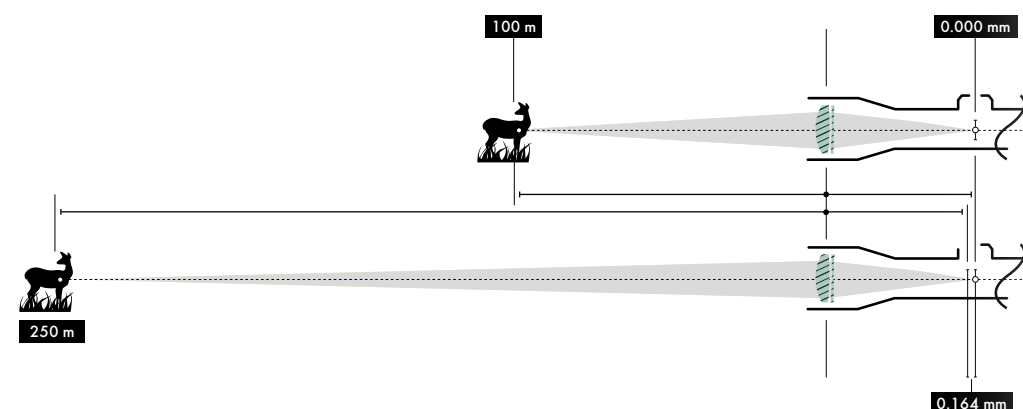
The parallax is the error that occurs when shooting long- or short-range shots without looking through the center of the rifle scope. It results in a displacement between the target and the reticle. The parallax only occurs when the eye is positioned outside of the optical axis, e.g. when looking into the eyepiece at an oblique angle.

Nowadays, with a few exceptions, hunting firearms are fired at 100 m. Rifle scope manufacturers also abide by this rule and factory-set the rifle scopes so that the image of the object is exactly in the plane of the reticle at this range. At this distance, the object's image and reticle is still covered, even if the hunter looks through the rifle scope at an oblique angle. In this case, the rifle scope is set to be parallax-free at 100 m.

### EXAMPLE

For distances that are greater or smaller than the set parallax-free range, the object image in the scope is a few hundredths of a millimeter in front of or behind the reticle. As long as the hunter continues to look straight

through the center of the rifle scope, the correct impact point is maintained. **But if the marksman looks through the scope at an angle, the aiming point appears slightly offset compared to the reticle.** If the target is 250 m away, for example, the object image in the rifle scope moves a tiny 0.164 mm in front of the reticle. This is roughly the same thickness as two sheets of paper and produces a maximum display error (parallax error) of 3.7 cm at a target distance of 250 m.



### MY TIP

The choice of the correct mounting depends primarily on the firearm but also on the existing rifle scope. In order to avoid surprises it is recommended to contact the gunsmith to ensure the ideal configuration of firearm, optics, and assembly.

## ASSEMBLY

- A host of rifle scope mountings are available, which you can select according to the firearm and optics.
- There is generally a difference made between ring and rail mountings.
- SWAROVSKI OPTIK offers its own innovative mounting rail. This guarantees absolute shock resistance and offers a quick, simple mounting option without needing to get involved in gluing and drilling.
- In any case, it is recommended that you have the scope mounted only by a qualified expert.

## SIGHTING IN A FIREARM

It is vital for a firearm to be sighted in properly using the appropriate optics. Since hunting also involves shooting at ever greater distances, the firearm has to provide perfect shot grouping at 100 m. Whether via a ballistic turret, long-range reticle, table, or dS, it is vital to measure muzzle velocity in order to accurately determine the aiming point or the clicks.



## SHOOTING OVER LONG DISTANCES

As a result of technical developments in the combinations of firearms, optics, and ammunition, long-range shots have become possible in recent years even using standard firearms. However, the requirements are strict and, apart from the precise distance calculation, there is also a demand for solutions that allow the exact aiming point to be determined, and therefore a targeted long-range shot.

### THE FOLLOWING CRITERIA MUST BE TAKEN INTO ACCOUNT IN THIS CASE:

- First of all, the marksman must feel confident in firing a shot over long distances.
- Appropriate equipment should be available (optics, firearm, ammunition).
- The distance must be familiar through using a rangefinder or from personal experience.
- The wind strength should be known or at least considered to be a source of error.

### FAST RETICLE ADJUSTMENT

Ballistic turrets (BT, BTF) and personalized ballistic cams and rings (PBR, PBC, PXC) make it possible to stay on target at various distances. The required distance is set on the rifle scope by clicking.

- You can assemble the ballistic turret in a few steps and adjust it to exactly match any firearm.
- You can change the distances selected.
- There are other distance settings available in addition to those marked.
- A specifically developed ballistics program (see p. 27) calculates the values that you need (number of clicks) for the desired distances.
- You can secure the ballistic turret using the locking ring to avoid unintentional readjustment.
- It is possible to have a ring or cam individually engraved with your personal ballistics.

Register with the SWAROVSKI OPTIK ballistics program (see p. 27) and select your rifle scope or ammunition. It is particularly important to measure the muzzle velocity of your firearm/ammunition combination. If you have decided to have a PBR, PXC, or PBC engraved, you should also buy a larger amount of the corresponding ammunition because the ballistic data can vary with different lot numbers. The corresponding distances are then engraved directly on the turret in 100-, 50-, or 25-m increments.



PERSONALIZED BALLISTIC CAM (PBC)



BALLISTIC TURRET FLEX (BTF)

### MY TIP

Long-range shooting is the pinnacle of hunting. Be aware of your personal limits and prepare thoroughly to make responsible and ethical decisions.

### MY TIP

Unlike the long-range reticle, the ballistic turret operates independently of magnification because the same aiming point is always used. This means, for instance, that you can sight in at a higher magnification without any problem, but it is also possible to take a long-range shot at a lower magnification without adjusting the aiming point.

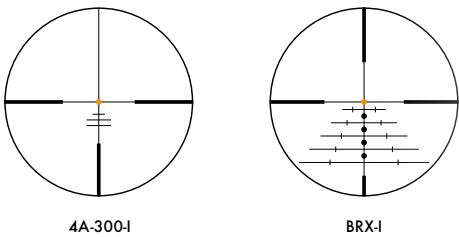




LONG-RANGE RETICLES

The long-range reticle allows you to have a precise aiming point even for long-range shots, and offers you a simple aid to adjust your aiming, if necessary, to achieve an accurate shot at distant targets. You do not need to make adjustments to the rifle scope for this.

With a long-range reticle, you must take into account that when changing magnification, the ratio of the target marks in the reticle to the game changes. The ballistic program can calculate the desired magnification, which is usually the rifle scope's maximum magnification.



In general, there are two types of rifle scopes for long-range shooting: manually adjustable and digital models.

With manually adjustable rifle scopes (e.g. XSi), the necessary adjustments are made manually by means of high-precision, mechanical turning devices.

Digital rifle scopes (e.g. dS) automatically calculate the aiming point from all relevant influencing factors, such as shooting distance, angle of fire, temperature, and air pressure, and use these parameters in combination with the individual ballistics data. The automatically corrected aiming point is displayed in the reticle, allowing the marksman to concentrate on the essentials.



APPS

BALLISTIC PROGRAM

SWAROVSKI OPTIK offers software which is tailored to individual hunting requirements. The ballistic program supports hunters in identifying the relevant endpoints for long-range reticles. You can also identify the required correction values for the downrange distances you want for the ballistic turret. Available for smartphones and tablets (Android and iOS).

[BALLISTICPROGRAMS.SWAROVSKIOPTIK.COM](https://www.swarovski-optik.com/ballistic-programs)

SUBTENSION DIMENSION PROGRAM

The SWAROVSKI OPTIK subtension dimension program helps you to work out the particular subtension dimensions of your reticle with regard to configurable magnification and different distances. You can select from a number of SWAROVSKI OPTIK rifle scopes or the STR spotting scope. All standard subtension dimensions are displayed.

[SUBTENSIONS.SWAROVSKIOPTIK.COM](https://www.swarovski-optik.com/subtensions)

EL RANGE CONFIGURATOR APP

It's easy to customize your EL Range with Tracking Assistant. Transfer your personal ballistics data directly via the app, and you can even use it on your smartphone.

[SWAROVS.KI/vg~D](https://www.swarovski-optik.com/el-range-configurator)

LEAD DISTANCE APP

SWAROVSKI OPTIK has developed a lead distance app to help you prepare for the challenges of driven hunting. Excellent shooting skills are a vital ingredient of a successful hunting trip. This means that your technique must be instinctive, as hitting a moving target is a much greater challenge than hitting a stationary one. This app helps you to gain a better feel for lead distances with moving targets. Available for smartphones and tablets (Android).

DS CONFIGURATOR APP

Easy and smart configuration of your digital rifle scope from SWAROVSKI OPTIK. The dS projects relevant information in the display in real time without any distraction, and automatically displays the correct aiming point. The aiming point is calculated on the basis of the individual ballistic data for the firearm/ammunition combination that is entered using the dS Configurator app.

[SWAROVS.KI/Yg~D](https://www.swarovski-optik.com/ds-configurator)





## MY TIP

For everyday hunting you can choose between extendable and observation spotting scopes. The first type will impress you with its compact, lightweight design. The extended length improves handling and facilitates rapid target acquisition. On the other hand, observation scopes stand out for their waterproof qualities and are ideal for digiscoping.

# SPOTTING SCOPES

If binoculars are unable to provide the necessary magnification, a spotting scope is required. Its higher magnification and correspondingly larger objective lens diameter make it easier to sight in the animal you are observing. Even at long range, it is possible to make out the key details.

- Spotting scopes are available in straight or angled versions; the choice depends on the type of hunt.

## ADVANTAGES OF A STRAIGHT VIEW:

Familiarity because it is similar to binoculars in use; fast target acquisition.

## ADVANTAGES OF AN ANGLED VIEW:

This is especially suitable for raised hides or steep terrain; it is more comfortable for tripod use because the position of the head reduces fatigue.

- Typical scope sizes in hunting are from 65 mm objective lens diameter or larger with wide-angle eyepiece in the 25-60x magnification range.
- Modern spotting scopes have HD lenses, which are an advantage when combined with digital photography.
- These HD lenses reduce color fringing, especially during light-dark transitions.
- The contrast of the image is increased and the detail resolution improved, even in poor light conditions.



EXTENDABLE SPOTTING SCOPE



SPOTTING SCOPE

# DIGISCOPING

Digiscoping is digital photography using an optical system via an adapter.

- You combine a digital camera or smartphone with a spotting scope or binoculars. This allows you to achieve long focal lengths.
- You can take pictures of images which would normally remain uncaptured.



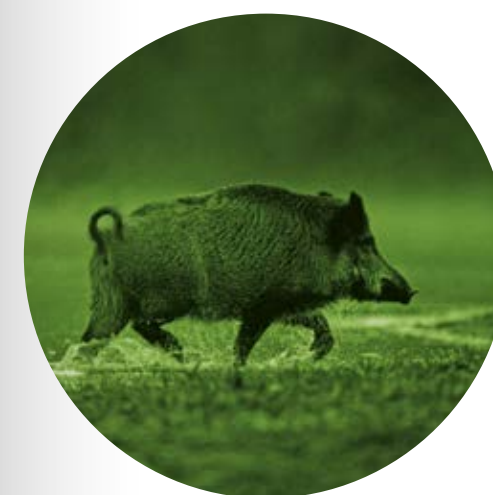
SWAROVSKI OPTIK NL Pure and smartphone with VPA (variable phone adapter).

# THERMAL IMAGING AND NIGHT VISION OPTICS

The development of digital technologies has taken huge strides in recent years. Technical innovations are increasingly aiding hunters. In particular at low visibility, when game is difficult to see, the hunter can now draw on a wide variety of additional technologies.

## NIGHT VISION WITH IMAGE INTENSIFIER TUBES

Classic night vision devices work according to the image intensification principle. In other words, they gather residual light (such as stray light from cities or moonlight) and intensify it. Light photons are converted to electrons, intensified, and displayed as visible light on a phosphorous surface. The result is the greenish image displayed to the user.



## BENEFITS

- High detail perception
- Long battery life

## DISADVANTAGES

- An infrared illuminator is required for optimum use
- Not suitable for use in daylight
- Limited lifespan of the image intensifier tubes
- In expansive terrain or in forests, game often blends with its surroundings

## DIGITAL NIGHT VISION DEVICES WITH IMAGE SENSORS

In the same way as with a digital camera, the incident light is collected by an objective lens and projected onto a sensor. The image sensor converts the light into digital data. Image processing software uses this data to create a digital image which is presented on a display. The quality of the image depends on various factors, including:

- Quality and performance of the optical-mechanical system (objective lens, zoom, eyepiece, etc.)
- Size and resolution of the sensor
- Image processing software
- Size and resolution of the display

## BENEFITS

- Can also be used during the day (color images)
- Additional functions (photo/video)

## DISADVANTAGES

- From a specific level of darkness, additional illumination (infrared) is required
- When using additional infrared light, you can potentially be dazzled by nearby objects. Animals can also sometimes perceive the infrared light and be scared off
- In expansive terrain or in forests, game often blends with its surroundings



### MY TIP

It is difficult to judge distances on the display of a thermal imaging or night vision device. It is useful to memorize certain distances in the terrain. Otherwise, it could be possible to confuse an adult boar at 300 m with a yearling at 100 m.

## THERMAL IMAGING TECHNOLOGY

*Thermal images are generated by heat energy rather than visible light. The thermal radiation is captured by a thermal imaging detector and then displayed on a screen. The technology is based on the principle that all bodies emit thermal radiation. The greater the heat difference between a body and its surroundings, the better it is captured and displayed. The resulting thermal image shows areas with the same thermal radiation (e.g. a meadow) with an equal level of brightness. Bodies with more thermal radiation (e.g. a fawn) or less thermal radiation (e.g. a stone in the shade) are displayed brighter or darker. These optics quickly detect strong heat sources. Thermal energy can be generated by a wide variety of sources. As well as animals and people, engines or even rocks in sunny locations, for example, also emit heat. Thermal imaging devices can be used both day and night. No additional infrared illuminator is required.*



Thermal image display in two modes:  
left white-hot (white heat sources),  
right black-hot (black heat sources)

### BENEFITS

- Very fast detection of game, even when it is partially concealed
- Can also be used during the day
- Additional applications, for example, searching (fresh sweat is warmer than the surrounding area and therefore shows up clearly in the thermal image)
- No additional devices required for illumination
- Penetrates even fog

### DISADVANTAGES

- The screen shows a false color image that appears unnatural to the viewer
- Precise sighting of game is sometimes difficult since, for example, color differences in the coats of furred game are not shown
- Sparse shrubs or twigs may not appear in the thermal image but could potentially influence the trajectory of a shot
- Distances and the quality of the shot are sometimes more difficult to estimate
- Does not work through a windowpane
- High energy consumption

## TYPES OF DEVICE

Before making a purchase, it is important to clarify a few points: **Statutory regulations come first: What type of device is permitted for this kind of hunting?**

It is also important to decide how you intend to use the device:

- |   |   |
|---|---|
| - To detect, observe, sight or shoot?                   | - Will I use it to hunt in twilight, at night, or during the day too? |
| - Will I use it for stalking or only in the stand/hide? | - And how far do I want to shoot with it?                             |

*The new device should, of course, contribute toward giving you the best possible complete system. This should support your own personal hunting procedures and help you experience the moment with all your senses.*

### HAND-HELD THERMAL IMAGING DEVICES

As with classic binoculars, night vision and thermal imaging devices help you to both find and identify game – in other words, sighting. A distinction is made between monocular and binocular devices.

Bright displays have a particularly strong effect on the human eye at night and cause the pupils to contract. Therefore, when using a monocular observation device, we recommend observing with the eye that is not needed for aiming (if you are using a classic rifle scope without a thermal imaging clip-on device). The pupil of the aiming eye therefore stays adjusted to the darkness. It also helps if the brightness of the display can be adjusted very precisely.

### THERMAL IMAGING CLIP-ON AND REAR ADD-ON DEVICES

Both types of device are often described as 'clip-ons.' Thermal imaging clip-on devices are mounted on the objective lens of a classic rifle scope. Thermal imaging rear add-on devices are mounted on the eyepiece. These devices are usually mounted using a special adapter tailored to the diameter of the objective lens/eyepiece. Some thermal imaging clip-on and rear add-on devices can only be used in combination with a rifle scope. Some can also be used as hand-held observation devices, without a rifle scope. It is important to ensure that the firearm still shoots on the same spot after the device is mounted. This is determined by the complete system of rifle scope, adapter, and clip-on. In high-quality complete systems, no impact point correction is required after mounting a clip-on.

To cover the widest possible hunting spectrum with a clip-on, we recommend a rifle scope with a low starting magnification and smaller objective lens diameter. For example, the Z8i 1.7-13.3x42 for driven hunts (large field of view with 1.7x magnification) and for long-range shots (with 13.3x magnification). The slim 42 objective lens saves weight and in combination with a thermal imaging clip-on device can tackle any level of darkness.



The tM 35 is a thermal imaging hand-held and clip-on device with modern thermal imaging technology in one, which allows easy and intuitive use in the dark. Together with SWAROVSKI OPTIK rifle scopes, the tM 35 creates an intelligent, high-performance combination that guarantees 100% reliable point of impact. There is no need for sighting in.

### AIMING DEVICES

Aiming devices are often used on special 'night hunting firearms.' This means the hunter knows from the outset that he or she will use this firearm almost exclusively at night. The aim is to ensure the firearm is as easy as possible to handle in the dark. With an aiming device, the user is always looking at a digital image and is therefore dependent on an external energy source. An aiming device – in comparison to a clip-on/add-on – is therefore more ergonomic to handle and generally smaller and lighter.

## CONCLUSION

*New technologies and optical devices are creating advantages for hunters. They help hunting enthusiasts assess the situation as accurately as possible and make the right decision. However, they can never replace essential hunting knowledge. Responsible behavior is crucial to ensure the sustainability of hunting. It is up to the hunter to reap the benefits of technology for his or her own use and for nature!*

### MY TIP

It is important to note that thermal imaging rear add-on devices reduce eye relief. This increases the risk of injury from the firearm's recoil!

### MY TIP

Digital night vision and thermal imaging devices often provide the option of taking a photo or recording a video. The pictures are not generally the same quality as a digital camera or smartphone. However, the image quality is often sufficient for documentation purposes.



## ALWAYS THERE FOR YOU



As head of Customer Management at SWAROVSKI OPTIK, I am delighted to share our wealth of knowledge with you. Our aim is to provide you with clear and easily understandable product information. This will enable us to provide our partners and customers with the best possible training.

Together with colleagues from the technical, sales, and marketing departments, we have prepared a clear and concise summary of key information on optical products in this brochure for hunters. We offer many more opportunities for anyone interested in finding out more about the world of long-range optics. You can try our products at events all over the world or in our showroom in Absam. A list of scheduled events and opening hours of the showroom can be found online:

**SWAROVSKIOPTIK.COM/INT/EN/  
HUNTING/EVENTS-OVERVIEW**

We are delighted to be able to bring you closer to the beauty of nature and wish you clear views at all times and many unforgettable hunting experiences.

Good hunting!

DANIEL MÜHLMANN  
Head of Customer Management  
at SWAROVSKI OPTIK

*This is a schematic diagram of the reticle. For more details including correct subtension dimensions, please visit:*  
**SUBTENSIONS.SWAROVSKIOPTIK.COM**

*You can find further information about the extensive range of SWAROVSKI OPTIK products at:*  
**SWAROVSKIOPTIK.COM**



### MY TIP

Visit us on My Service and find practical tips for adjusting, operating, registering, and maintaining our products.

**MYSERVICE.**  
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