Carl Zeiss Sports Optics · Optics for Hunting and Nature Observation

Optics for Hunting and Nature Observation

Nominal charge: € 19,95
Foreword

Carl Zeiss is a globally leading group of companies in the optical and optoelectronic industry which sets the standards of visual observation in many fields. Scientific applications, semiconductor technology, and medicine — even the emotional experience of nature are the focus of optical innovations. In particular, this applies to the Carl Zeiss Sports Optics GmbH which has committed itself to the development and manufacture of binoculars, spotting scopes, and riflescopes for hunting and nature observation. As part of a successful optical concern with a long tradition, the company utilizes all the possibilities and opportunities of the latest technology to demonstrate its innovation leadership repeatedly.

The company’s origins go back more than 160 years. The Carl Zeiss company was founded in Jena in 1846 and began to produce prism binoculars in 1894. Spotting scopes were introduced only two years later offering magnification adjustable to the respective situation from the beginning. The first ZEISS riflescope appeared in 1904. Initially deemed „un-hunter-like“, over the years they revolutionized the need for and possibility of a clean shot thus ensuring that front and rear sights came into play at short distances on driven hunts only.

Furthermore, by 1928 Carl Zeiss had acquired Wetzlar-based Moritz Hensoldt & Sons which has been a member of the Group ever since. Founded in 1852 and headquartered in Wetzlar since 1865, “Hensoldt” was also well-known by hunters and nature lovers for its outstanding targeting optics and binoculars such as the legendary Dialyt.

Science and innovative technologies but primarily the close contact to enthusiastic nature observers and passionate hunters who see their “ZEISS” as a reliable companion even under the toughest conditions lead to pioneering developments over and over again. The historical invention of anti-reflective coatings by Professor Smakula at the Carl Zeiss Works is just a single event — an event that launched an entirely new epoch in the field of optics. Image brightness, twilight performance, and brilliance were redefined by the T* coating and are still an outstanding feature of all ZEISS products. Designed to withstand the forces of nature in extreme hunting and outdoor conditions, these high-performance optics also provide robustness and reliability expected by demanding users the world over. Electronics and additional innovative functions increasingly create new ways of experiencing nature and passion than never before.

With this book we are proud to provide you with a few basics about optics and practical advice to help you select the optics that best suit your requirements. If you have any questions or suggestions regarding optics for hunting and nature observation, please do not hesitate to contact us.

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1. The Most Important Optical Parameters

1.1 Magnification (M)

The first digit in the type designation indicates the magnification factor. With 10 x 56 binoculars, the observed object appears 10x larger than with the naked eye. To put it into simpler terms, the distance to the object shrinks by the magnification factor, i.e. a deer 400 m away looks like it is only 40 m away when you look through 10x binoculars.

Two different interpretations:

1. The object appears e.g. 10 x larger
2. The distance appears e.g. 10 x smaller. The object appears 40 m instead of 400 meters.

For anyone interested in precise mathematical descriptions: the magnification is defined as the ratio between the tangent of the angle at which the object appears with binoculars to the tangent of the angle at which the object appears without binoculars. In other words:

\[ M = \frac{\tan \text{ (viewing angle with binoculars)}}{\tan \text{ (viewing angle without binoculars)}} \]
Unfortunately, on lower-quality binoculars the effective aperture, i.e. the effective entrance pupil, is occasionally much smaller than given despite the large lens diameter. For example, this is due to the small dimensions of the prisms, lens elements, or other components that obstruct the flow of light inside the binoculars. For example, if only 3 mm of the incidental light is cut all around the outer edge on an 8 x 56 model, the effective entrance pupil is 50 mm only. These “8 x 50” binoculars, therefore, have about a 20% smaller light transmission than expected and 20% less light reaches the eye.

This is not easy for amateurs to test – and it is also not necessary for ZEISS products. The given lens diameter is fully utilized to ensure maximum light transmission and brightest images.

1.3 Exit pupil

In addition to the lens aperture, the magnification plays a key role in image brightness. The larger the image on the retina, i.e. the larger the area on which available light is distributed the darker the image.
The key factor is the exit pupil which takes these two effects into consideration. It creates the “window” or the “light exit opening” from which light exits the binoculars or riflescope. The larger it is the more light that can reach the eye and, therefore, the brighter the image.

The diameter of this exit pupil is calculated on the basis of the following influencing parameters:

\[
\text{Exit pupil} = \frac{\text{lens diameter}}{\text{magnification}}
\]

8 x 56 binoculars includes an exit pupil with a diameter of 7 mm, 10 x 30 binoculars 3 mm only. If you reach out your arm and hold the binoculars against a light surface and look at the eyepiece, you can clearly see the exit pupils. These are absolutely round with crisp edges and evenly bright on high-quality binoculars.

The exit pupil can be interpreted as the diameter of the luminous flux that exits the binoculars. The eye also plays a vital part in the perceivable image brightness: the part of the luminous flux that enters the eye contributes to image brightness only. If the user’s pupil is only open 2 to 3 mm during the day, the 7 mm exit pupil of 8 x 56 binoculars cannot be fully utilized. The image through an 8 x 56 model is then no brighter than through 3 x 10 binoculars with a 3 mm exit pupil – assuming all other quality features are identical.

To take full advantage of the emerging light intensity of a binocular the eye pupil has to be at least as large as the exit pupil of the binoculars.

The exit pupil remains the decisive factor in suitability for use at dawn. In this case, the exit pupil on binoculars should be as large as possible but no less than 4 mm. If the exit pupil is larger than the pupil of the eye, the theoretical brightness of the binoculars is not fully utilized but the eye still has a certain amount of flexibility. Despite shaking hands or binoculars not placed exactly in front of the eyes, you still remain “in the picture” literally.

The maximum aperture of the eye pupil largely depends on age. The pupils of children can open up to more than 8 mm, while they seldom exceeds 4 mm in old age.

<table>
<thead>
<tr>
<th>Age</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 mm</td>
<td>8 mm</td>
<td>6 mm</td>
<td>4 mm</td>
<td>2 mm</td>
<td></td>
<td></td>
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</table>

Average maximum pupil diameter (at night) in relation to age.

8 x 56 binoculars includes an exit pupil with a diameter of 7 mm. By comparison, the 2.5 mm exit pupil of a compact 8 x 20 binoculars.
Furthermore, a large and reliable exit pupil is particularly important for fast target acquisition using a riflescope. Typical driven hunt scopes with low magnification provide exit pupils up to 15 mm. Here the brightness of the image is not important but those large "windows" are crucial for fast, reliable aiming.

With variable scopes, the exit pupil at low magnification often does not achieve value possible mathematically. The larger the zoom range the higher the number of compromises. These conditions apply to all brands but due to the importance particularly on driven hunts, hunters can be sure that they have an optimal solution with ZEISS riflescopes.

### Twilight factor (TF)

The larger the entrance aperture the more light that enters the binoculars. And the higher the magnification at the same image brightness the more details that can be observed. The twilight factor is often referred to as a comparative value for the suitability of binoculars when less light is available.

The twilight factor is calculated by multiplying the lens diameter by the magnification and obtaining the square root from the result:

\[
TF = \sqrt{\text{magnification} \times \text{lens diameter}}
\]

This twilight factor is a mere mathematical parameter. The really important performance data of binoculars (image quality, contrast, transmission, color rendition etc.) are not taken into consideration. Every pair of 8 x 42 binoculars, for example, has the same twilight factor – 18.2 – regardless of how good or bad it is in practice, regardless of the brand or price!

The twilight factor can also be completely misleading as shown in the following example: two binoculars, 8 x 56 and 56 x 8 (such a model does not exist but would be feasible theoretically), have the identical twilight factor of 21.2! While an 8 x 56 model is ideal during twilight, a 56 x 8 pair would be totally unusable – even during the day.

The twilight factor alone does not permit any kind of real statement. A correspondingly large exit pupil is always decisive and important for twilight use. Ideally, it should be at least as large as the pupil of the user. Anything with an exit pupil smaller than 4 mm is, therefore, unsuitable in the waning light right from the start – even if the twilight factor is high.

Calculating the twilight factor for riflescopes is slightly different from the above-described definition. Here, only a lens aperture that provides an exit pupil no larger than 8 mm is taken into consideration. Even a very young hunter cannot use more light.

#### Example:

at a 3x setting, a 3 – 12 x 56 scope has an exit pupil of 56 mm/3 = 18.7 mm theoretically. Using this for the calculation makes little sense because no human eye can make full use of this large lens aperture and the resulting large exit pupil. Therefore, the first thing to do is calculate the lens aperture that would deliver an exit pupil of 8 mm at a 3x setting: 24 mm. At the 3x setting, this results in a twilight factor = \sqrt{\text{square root (3 x 24)}} = 8.5
1.5 Field of view

The field of view describes the area seen when looking through the optics – without moving them. For example, if you look at the edge of a forest through binoculars at a distance of 1,000 m and see an area covering 120 m, the binoculars have a field of view of 120 m/1,000 m.

Occasionally, the viewing angle or objective viewing angle is given, e.g. 6°. The field of view and viewing angle can be easily calculated:

\[
\text{Field of view at 1,000 m} = \text{at 17.5 } \times \text{ viewing angle (in degrees)}
\]

The field of view depends on the magnification, i.e. in general lower magnification levels have a larger field of view than higher levels. Therefore, when comparing different binoculars you must compare those with the same magnification only.

Meaning

Field of view and viewing angle
Optical Parameters

Very small fields of view give the impression of looking through a tunnel. There is a lot of black on the outside and a small image area in the middle. This undesired effect occurs on simple products and primarily on many zoom binoculars.

If the field of view is very small, there is the impression of a tunnel vision. Wide angle binoculars, on the other hand, shine with very large fields of view that offer a wide overview and comfortable observation. The field of view is so large that the image circle in the eyepiece appears at an angle of 60° or higher. This angle at which the image is observed in the eyepiece, is the subjective or eye-side viewing angle. The 60° threshold that determines the predicate “wide-angle” is specified in an ISO standard.

Is a field of view, e.g. 120 m at 1,000 m, good or bad for binoculars? The answer depends on the magnification. 10x binoculars with this field of view would be very good (subjective viewing angle approx. 69°), a 7x pair with this field of view would be rather weak (subjective viewing angle of 48° only). The subjective viewing angle shows immediately if the field of view is pleasantly large and comfortable or if a tunnel vision can be expected.

The field of view cannot be calculated from the pure type designation (e.g. 10 x 42) but are specified by the optical design. The size of the prism and the eyepiece in particular determine which image angles can pass through the binoculars. The lens diameter does not affect this it only influences the brightness.

When comparing the edge definition of different binoculars, it is vital to not only use the same types (e.g. 10 x 42) only, but also take the fields of view into consideration. If one pair has a field of view of 120 m and another 100 m at 1,000 m only, it is easier for the second to have better edge definition. However, this “benefit” comes with a considerable loss of field of view.

Unlike binoculars or spotting scopes, riflescopes generally have a smaller field of view and it is given at 100 m instead of 1,000 m. For safety reasons (recoil), however, a complete view can be obtained from a much larger distance (eye relief).

1.6 Eye relief

The exit pupil on binoculars is around 15 mm behind the eyepiece. This distance to the last eyepiece lens element is referred to as eye relief. The pupil of the user should be at exactly this distance from the last eyepiece lens element. This is the only way to obtain an overview of the entire field of view.

False operation, wrong viewing behavior can eliminate the benefit of a large field of view. If the eye is too close or too far away from the eyepiece, blurry edge shading occurs. In the right position, the field of view is not only complete but also visible with an edge defined clearly.

To ensure that the user’s pupils are not too far from the binoculars, the eyecups should be turned inwards if the user wears glasses (which would further increase the distance of the eye to the eyepiece) and pulled or turned out without glasses. However, this is an approximation only. Without glasses, in particular, everyone places the binoculars at different distances to the eyes. Many users literally press the binoculars into their eye sockets; others hold them far away and barely touch the eyecups with their eyebrows. Therefore, the eyecups on the new ZEISS Victory binoculars can be adjusted over several click stops so that everyone can find the setting that best suits his/her needs. This is a key point that is often neglected in practise.
If you do not wear glasses when viewing, the binoculars are used with the eyecups fully extended. If you wear glasses when viewing, the binoculars are used with the eyecups set in close.

With riflescopes on the other hand, the eye relief must be relatively high for safety reasons. 80 mm at a minimum should be maintained. Very high eye relief of more than 100 mm for more safety with extremely large game calibers can only be achieved with considerable compromises to the field of view only. This point is often ignored deliberately.

1.7 Depth of field

Depth of field describes the area in front of and behind the set range that is still perceived by the eye as being sharp. Expanding this area depends on the magnification, distance and accommodation capabilities of the eye.

The higher the magnification the lower the depth of field. 10x binoculars must focus more precisely than a 7x one and readjustments have to be made even for minor changes to the observation distance.

The depth of field is the “reverse proportional to the square of the magnification”: This means that doubling the magnification reduces the depth of field by a quarter. Within equal conditions, binoculars with 10x magnification have half the depth of field as compared with 7x binoculars.

At short distances and up at close range the depth of field is very low and very precise focusing is required. The greater the observation distance the higher the depth of field. If binoculars are focused at infinity (e.g. the horizon), everything from a distance equaling the “square of the magnification” is focused crisply.
Example:
if you set a pair of binoculars to infinity, a 7x pair delivers a
crisp image from about 50 m, a 10x pair from around 100 m.
This is the case for older users. For younger users, the focus
extends considerably farther into the foreground because their
eyes can accomodate better.

Accommodation
Accommodation is the ability of the eye to focus on different di-
stances. This ability decreases with increasing age, i.e. younger
people have a clear advantage – they can perceive a much larger
depth of field. Older people have to refocus more often.

Autofocus
However, really relaxed and longer observation is only possible at
the distance set – even for young people. Everything else tires the
eye which is noticed at the latest when autofocus binoculars are
used.

How the lens elements move mechanically during focusing with
single eyepiece focusing or with a center drive has no effect on
optical properties and depth of field. Even the prism system (Por-
ro or roof prisms), which only affects image inversion in different
ways does not influence the distribution of sharpness – despite
many prejudices to the contrary.
All binoculars with the same magnification deliver practically the
same depth of field – regardless of the brand, prism, or focusing
mechanism.

Can the depth of field be effected?

1.8 Distortion

If there are any straight lines near the edge of the image that
appear somewhat curved it is referred to as distortion. A barrel-
shaped distortion results in a bloated square; with pincushion-
shaped distortion lines are bent inwards.
If a pair of binoculars is absolutely distortion-free the objects at
the edge of the image field appear somewhat smaller than the
objects in the center – which are closer to the observer.

When the user swings the binoculars there is an impression of ob-
jects moving from the side into the image, bloating in the center
of the image and then getting smaller on the other side. It recalls
observations of a rotating ball, thus generating the term “globe
effect”.

To counteract this, many binoculars include pincushion-shaped
nominal distortion today. This means that magnification increases
towards the edge and the image is “pulled apart” diagonally.
When observing straight lines at the edge of an image statically
this can be somewhat annoying. However, there is a steadier and
more natural image when the binoculars are moved. Because stiff
geometric figures or grating structures rarely occur in nature but
freehand scanning of the edge of a forest, for example, all the
ZEISS binoculars include this proven and important minor nominal
distortion.
2. **Innovative Technologies Ensure Brilliant Images**

2.1 **About transmission and coating**

*Definition*

Although a high-quality branded 8 x 56 pair of binoculars and any simple 8 x 56 pair have the same exit pupil, the stand hunter will notice a major difference at dawn and twilight. The difference lies in the transmission. This value indicates the percent of incidental light that exits through the eyepiece again. The different impact of exit pupil and transmission on image brightness can be illustrated as follows: the exit pupil refers to the size of the window from which light exits the binoculars. On good branded or cheap binoculars having the same data, this window is generally the same. The transmission value, however, identifies the transparency of this window. Is it clear and bright or cloudy and dark?

First-rate binoculars and riflescopes provide transmission values over 90%; measurements on the ZEISS Victory 8 x 56 T* FL showed a value of more than 94%. In practice, differences of 1 to 2% are unnoticeable. A 5% increase, however, provides decisive reserves in dwindling light and enables considerably longer observation and reliable aiming.

*The ZEISS T* coating allows observation deep into the twilight*

Around the world, binoculars and riflescopes of Carl Zeiss are considered the most powerful in their market and are preferred for use in difficult lighting situations. This is closely linked to the term T* coating which has become synonymous with maximum light intensity and brightest images.

*Background:*

In general, a variety of factors always results in a loss of light in optical devices. Reflections and antireflective coatings on the glass surfaces have the greatest impact because a small portion of light...
is reflected every time the light passes from air to glass (and vice versa). Without an effective coating, this would be 4% for each glass surface; over 6% on elaborate binoculars with large refractive indexes. High-quality ZEISS binoculars include up to 12 lens elements on each side plus two prisms. Depending on the number of cemented elements, 16 to 20 glass-air surfaces may be used. Without an effective coating, the transmission would be considerably less than 50%; the images would show low contrast and be dull.

Uncoated glass reflects about 4% of the light.
Single coating reduces the reflectivity to approx. 1.5%.
Multi coating reduces the reflectivity to approx. 0.1 to 0.2%.

Initial tests were conducted at Carl Zeiss Jena (patent allowed in 1935) and resulted in a method of applying a transmission coating to glass. At that time the T coating – a single coat – was born. It was replaced by the T* multi-coating at the end of the 1970s. The current, constantly enhanced and unique ZEISS T* multi-coating on all glass-air surfaces is not simply a fixed recipe but also an innovative multi-coat procedure with a typical six-coat structure that is individually matched to the single lens elements and glass materials. More than 100 layers evaporated in high vacuum on each side of the binoculars are, therefore, a common sight on ZEISS binoculars.

The T* coating accounts for the increased blue sensitivity of the eye in deep twilight and further optimizes light efficiency when required the most.

In addition to increasing transmission, the coating also serves as an effective, hard surface sealant that protects the partly sensitive optical glass.

In addition to reflections the type of prism system plays a key role in image brightness on all binoculars. Therefore, all twilight-capable roof prisms of Carl Zeiss use the outstanding Abbe-König prism system. Although it is somewhat larger and heavier it does not need a light-swallowing mirror coating like the standard Schmidt-Pechan system. All light deflections inside the prisms take place as total reflections that, unlike a mirror, do not show a loss of light. This applies to Porro prisms as well, which also provide a very good foundation regarding image brightness.

Transmission determining is relatively difficult, which is why the values rarely appear in test reports. The transmission values for spectral colors (different wavelengths) are determined individually by means of nearly 500 measurements. The result is assessed with the sensitivity of the human eye regarding colors (sensitivity curve). The eye is most sensitive to the green spectral range. Accordingly, these colors have the greatest influence. High infrared
or UV transmission, on the other hand, is not included in the assessment because it is not perceived by the eye. The final result is a value known as day transmission.

While the cones in the retina are responsible for daytime vision primarily, it is the rods that take over at night or in very low light. This results in a different sensitivity curve regarding colors: the maximum sensitivity moves to the blue spectrum. If the measured spectral transmission curve is assessed using this night sensitivity now it provides the night transmission. Night or day makes no difference to the binoculars but to the sensitivity of the eye.

### Day and night transmission

<table>
<thead>
<tr>
<th>Visible Spectrum</th>
<th>400 nm</th>
<th>500 nm</th>
<th>600 nm</th>
<th>700 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red line: sensitivity curve of the eye during the day.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue line: sensitivity curve of the eye at night.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Green line: Typical transmission curve of ZEISS binoculars with T*- coating.</td>
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</tbody>
</table>

### 2.2 The LotuTec® protective coating

In addition to the T* coating a further protective coating is deposited on the outer surface of all lens elements used on ZEISS Victory models. It ensures that water beads off without residue immediately and that dirt and fingerprints do not adhere to the surface. This allows fast, easy cleaning of these extremely smooth surfaces without any risk of damaging the valuable optics. The namesake and inspiration for the LotuTec® coating of Carl Zeiss are the leaves of the lotus flower and their hydrophobic effect.

**Comparison between a standard coating and the ZEISS LotuTec® coating.**

Without the LotuTec® coating, water drops, for example, would stick to the surface and, due to the attraction between water and glass, adhere easily. The angle at which the edge of the water drop touches the glass surface is called contact angle. Flat, adhesive drops have low contact angles. Water-repellant coatings, on the other hand, create few contact points. The drops become ball shaped similar to those on a hot plate and run off. The contact angle as a measure of the hydrophobic effect of the coating is very high then. Measurements on the LotuTec® show return values clearly above 110° which documents the very high effectiveness and far exceeds many other hydrophobic coatings.
Innovative Technologies

With LotuTec®: A large contact angle results in globular water drops that roll off.

Without LotuTec®: A contact angle of max. 95° results in water drops that adhere relatively strong.

The same high standards and test methods used to guarantee the durability of T* coatings for decades are applied to determine the durability and resistance of the LotuTec® coating to abrasion.

The LotuTec® coating was developed at Carl Zeiss for eyeglass lenses originally where it has proven its value for many years. Special modifications enabled the transfer of this sophisticated coating technology to the high-quality glass used for Carl Zeiss Sports Optics products.

All products from the ZEISS Victory series are equipped with LotuTec®.

2.3 The FL concept for unparalleled image quality

The different colors white light is composed of are deflected somewhat differently when they pass through a lens element or prism. This results in dispersion into individual spectral colors – this is how a rainbow is created, for example. With optical images, this dispersion results in unwanted visible color fringes around image contours and blurring.

Above: With a standard glass, the light is spread out into the individual colors. Fringes occur that reduce the sharpness and contrast of the image.

Below: The FL-glass minimizes the spread of the color spectrum. Contours are almost without color fringes and the color fidelity is higher. Fine details are clearly visible.

This can be reduced considerably by properly combining different types of glass. Known as achromats, this optical system is the current standard for most applications in observation and photography but still shows minor residual chromatic aberrations.

A further reduction of this “secondary spectrum” can be achieved through the use of special glass containing fluoride (fluoride ion) with so-called “abnormal partial dispersion, where the undesired...
color dispersion is considerably lower from the very beginning in comparison with all other types of optical glass.

However, the glass material alone is not enough. Only the meaningful integration of these FL lens elements into matched optical systems, including the right coating technologies, results in the “FL concept” that stands as a guarantee for outstanding image quality and brightness.

This concept demonstrates its full capabilities with very elaborate optical systems, particularly very large lens diameters, very high magnifications and very wide fields of view. Therefore, only selected spotting scopes, binoculars and riflescopes – being the reference class for observation and hunting optics – bear the FL Seal of Quality only.
2.4 Revolutionary mechanical components and state-of-the-art electronics for useful functions

Nowadays the integration of innovative mechanical components and electronic systems allows for additional functions in many areas of observation and hunting. Since these points are described in detail later, they are mentioned here briefly only:

**Image stabilization**
Eliminating hand tremor to recognize the tiniest details at long range without a tripod: the revolutionary, purely mechanical image stabilization without batteries on the ZEISS 20 x 60 T* makes it possible.

**Laser rangefinding**
Determining the exact distance to a target in a fraction of a second: state-of-the-art laser rangefinders are integrated into the twilight-capable RF binoculars, the compact PRF monoculars and Diarange riflescopes provided by Carl Zeiss.

**Ballistic evaluation**
Determine the bullet drop based on the distance to the target and ballistic specifications: the BIS ballistic information system is available for RF and PRF models.

**Digital imaging**
Observation and digital photography at the same time at the push of a button: the unique ZEISS Victory PhotoScope 85 T* FL offers high-performance optics and digital imaging in one device.

**Night vision**
Turning day into night with a high-performance image intensifier: offered by the ZEISS NV 5.6 x 62 T* night device at the push of a button.

**Illuminated reticles**
Quickly and clearly acquire a target during the day and in the twilight: there is a wide range of reticles available for a wide range of applications.

Red dot reticle for day and night located in second image plane or fine red cross in first image plane: Reticule V69 includes the advantages of both image planes, in bright light and at dawn.

Cock the weapon and the illuminated dot in the riflescope illuminates automatically: developed together with Blaser Jagdwaffen GmbH and implemented in the iC-Varipoint riflescopes, the iC System sets a new standard in comfort and safety.

No calculation, no click counting, or estimated aiming above the target: With the Bullet Drop Compensator (ASV) Carl Zeiss offers an easy-to-use, absolutely reliable adjustment feature that enables you to quickly and precisely make holdover adjustments for long-range shots via the reticle adjustment. Hunters simply set the desired range and remain on target even at long distance.

Long range ballistic reticles that give the right aiming line for different distances. Fast and easy, without difficult calculation offered by the RAPID-Z* reticles.
3. About Binoculars

3.1 General optical design

Lens, inverting system and eyepiece – the key elements found in all optics for nature observation and hunting. Each component has its own special job:

The lens generates an image in the intermediate image plane of the object observed. In general, this image – as with all real optical images – is upside down and reversed. Therefore, the inverting system is positioned in front of the intermediate image plane. It switches top and bottom, left and right when light passes. This results in an upright, unreversed image. Prisms are used on binoculars and spotting scopes; lens elements on riflescopes.

In principle, an eyepiece is a magnifier and helps the eye see the intermediate image.

Theoretically, one converging lens for the lens and eyepiece each is enough but the result would be unsatisfactory. Therefore, sophisticated systems have been developed which contain, for example, 10 lens elements for binoculars (Victory 10 x 56 T* FL) on each side or up to 17 lens elements for spotting scopes with zoom eyepieces (DiaScope 85 T* FL with 20 to 75x Vario eyepiece).

Different glass materials with varying properties are also combined (including the very high-quality optical fluoride glass for ZEISS FL products) to achieve brilliant, outstanding results. The many coatings applied to all glass surfaces in a high vacuum and, of course, extremely stringent tolerances in the manufacture of the single parts and during assembly play a key role as well.

3.2 Prism systems

Even if prisms are responsible for the upright image “only”, they play an important and decisive role in the shape of the housing and image quality of binoculars. Two systems are primarily used today:

Binoculars with Porro prisms are relatively wide with lenses farther apart than the eyepieces. Porro binoculars work like traditional “field glasses”.

Binoculars with roof prisms are slimmer; incoming and outgoing light rays show no or very little displacement. Almost all high-quality, state-of-the-art binoculars use roof prisms.
**Accuracy of roof prisms**

Their space-saving properties are the result of using both “sides of the roof” twice as reflective surfaces. The accuracy of these two plane surfaces and the 90° angle between them is, therefore, extremely vital. This also applies to the roof edge: it must have a perfectly sharp edge as any rounding results in stray light and reflections. Running a finger over the prism makes it unusable.

**P coating**

To achieve high image quality, a special coating must be applied to both roof surfaces. This so-called phase-correction coating introduced by Carl Zeiss at the end of the 1980s prevents wave-optical effects (phase shifting) that would otherwise result in a reduction of detail resolution. All roof prisms of Carl Zeiss include this P coating today.

**Schmidt-Pechan prisms**

Roof prisms are usually used in two versions: the Schmidt-Pechan design is the smaller of the two and allows shorter designs but requires a mirror coating on one surface. However, each mirror absorbs several percent of the light unlike total reflection that otherwise occurs inside the prism. If the objective is then maximum image brightness, the Abbe-König design is preferred.

The Abbe-König system is more elaborate, more expensive and somewhat longer but does not require the additional light-swallowing mirror and, therefore, results in brighter images. Therefore, all twilight-capable binoculars of Carl Zeiss include Abbe-König systems which is unique among premium binoculars. It is no wonder then that they are considered the brightest binoculars on the global market.

**Abbe-König prisms**

The Abbe-König system is longer, but allows for an almost loss-free light transmission.

The smaller Schmidt-Pechan systems with generally somewhat lower light transmission are used in the compact ZEISS Victory binoculars up to a lens diameter of 32 mm. To eliminate this “deficiency” a special dielectric mirror coating was developed, which consists of more than 70 layers and applied in a vacuum. It replaces the otherwise common, loss-prone silver coating and therefore matches properties very close to the extremely high transmission properties of the Abbe-König prisms.

**Dielectric mirror coating**

The Schmidt-Pechan prism is very compact. However, it requires a reflective layer. This means a loss of light.
Unlike roof prisms, Porro prisms are easier to manufacture and generally enable very good transmission because they do not require a mirror coating. However, they are large and heavy. Because of their design, watertight binoculars with internal focusing are also very difficult to implement.

The Porro prism is easy to produce, but quite large and heavy due to its design.

The better “three-dimensional observation” through the widely separated lenses is often doubted in many cases. At long ranges, a 2 to 3 cm additional lens spacing does not have a noticeable influence on depth perception.
3.3 About housings and focusing

Mechanical components – particularly the housing and all moving parts – are the guarantee for decades of protection and correct alignment of the optics.

Housing material

The mounts of the lens elements generally consist of extremely solid aluminum or magnesium. In addition to these two materials, state-of-the-art composites such as glass-fiber reinforced plastic materials are used for the entire housing. In addition to the favorable weight and enormous range of shapes, this allows for the intentional flexibility of the housing which is very beneficial, particularly with bumps and jarring. Containing up to 60% glass, these innovative materials can be optimized for many requirements and are also used for car and aircraft manufacture.

Rubber armoring provides additional protection for binoculars and spotting scopes, ensures a secure grip and absorbs sounds when it accidentally hits something.

On all its products, Carl Zeiss selects an optimal mixture of materials to permanently package high-performance optics for use under the toughest conditions.

Focusing

In order to obtain a razor-sharp image at various distances, the lens elements are moved mechanically. A distinction is generally made between internal and external focusing.

External focus

With exterior focusing, the distance is usually set by moving the eyepieces, where the volume of the binoculars always changes. During this process, external air and also small dust particles and moisture are drawn into or pressed out of the binoculars. It is really not possible to seal such systems.

Internal focus

Binoculars with internal focusing are protected considerably better. To focus these models, the internal lens elements are moved only without changing the volume. With the appropriate seal using O-rings, there is no exchange with outside air, i.e. dust and moisture cannot penetrate the housing. This is the only way to manufacture binoculars, which are fully watertight.

With such sealed binoculars – and only with these – it is a good idea to fill the interior with nitrogen or another gas. This prevents the “integration” of moist air that condenses in the winter and can result in fogging inside the binoculars. All Victory and Conquest binoculars (except Conquest Compact), spotting scopes and riflescopes of Carl Zeiss are protected in this manner.
**Diopter compensation**

Binocular devices feature diopter compensation to correct different prescriptions in the left and right eyes. Users set this configuration once only. When glasses are worn, the diopter compensation is set to zero because the glasses already correct any existing differences between the eyes. Ideally, such devices should provide an adjustment range of at least +/- 4 D.

![Diopter adjustment](image1)

*The central wheel of the ZEISS Victory binoculars can be pulled out for required diopter adjustment. After resetting the wheel unintentional adjustment is excluded.*

**Overturn past infinity**

Additionally, binoculars and spotting scopes can be focused past infinity. The focusing knob is not yet in the end stop position even when viewing the moon. This play, or reserves past infinity, is useful for shortsighted users who use binoculars without glasses. With the normal infinity setting of the center drive, there would be no crisp image at long distances due to the insufficient refractive power of the glasses. This is not a problem on binoculars which include overturn. For example Victory FL binoculars, can correct up to 7 D. This problem does not exist for farsighted users who focus “less far” without glasses compared with users with normal vision.

**3.4 Robustness to rough conditions**

The perfect parallelism of optical axes on both sides of the binoculars is vital — for all configurable interpupillary distances (PD). If this is not guaranteed, double images occur sooner or later. Even minor deviations which are practically not perceived initially since the brain and eyes compensate for them, result in symptoms of fatigue and headaches when used for longer periods.

![Parallelism of the axes](image2)

*If the parallelism of the axes is not properly, unpleasant double vision occurs.*

It is also important for all moving parts for focusing, diopter adjustment, folding bridge, and eyecups to work properly and precisely at all temperatures year round. The mounts for lens elements and prisms must also ensure in the long run that the optical system does not fall out of alignment as a result of jolts or vibrations or extreme temperature fluctuations. Extensive quality checks which span the production process at Carl Zeiss far exceeds DIN/ISO specifications ensure that all these specifications are met and provide reliability of brilliant images through the binoculars for years.

**Parallelism of the axes**

**Durability**
3.5 How are binoculars tested?

**General**
In addition to optics, many individual subjective factors are involved which can lead several users to come to completely different conclusions. It is a good idea to gather a lot of information but a personal test is still far more important. Taking enough time to test the binoculars in a situation for which they are intended is the most important point however. Twilight capability cannot be tested on a sunny day in a pedestrian zone.

When comparing different manufacturers, it is important to use binoculars with the same parameters only. There is no use comparing a 7 x 42 with a 10 x 56 from another manufacturer and then take a decision.

When comparing different manufacturers, it is important to use binoculars with the same parameters only. There is no use comparing a 7 x 42 with a 10 x 56 from another manufacturer and then take a decision.

**Magnification and hand tremor**
It is very important to find out what magnification level can still be used meaningfully. A comparison of binoculars with different magnification shows when hand tremor – different from person to person – has a negative effect on detail recognition. Look at a sign or poster with minute fine structures or small print at a distance of around 50 m and then see which level of magnification provides the best and most stable image.

**Focusing**
If you quickly focus on three objects at different distances, e.g. 10, 25 and 50 m, it will provide a good impression of the speed and reliable operation of the binoculars. You should also do this test wearing gloves.

A rough test of binocular height adjustment can be made by looking at a horizontal edge through the binoculars while holding them about 5 cm in front of your eyes and checking if the edge is the same height on both sides.

The color rendition of binoculars can be determined relatively well with the following test: turn the binoculars around and look through the lens at a piece of white paper. In a direct comparison between paper and image in the lens you can see any color shift (e.g. yellowish tint) relatively quickly. If the image in the lens is clearly darker than that on the paper visible from the same viewing angle, it indicates deficient transmission.
High-contrast details near the edge of the image (e.g. branches against a white sky) identify color fringes immediately. These can be blue, yellow, or red and can be clearly seen at such high-contrast edges. Glass materials containing fluoride result in a considerable reduction of such chromatic aberrations which is reflected in unparalleled brilliance and maximum definition.
3.6 Modern ZEISS binocular lines

Victory binoculars are the reference class and standard for state-of-the-art, high-performance optics developed and manufactured for passionate users who expect high standards regarding their tools. The result is as follows:

- unparalleled bright, brilliant images
- maximum detail definition and contrast
- large fields of view and excellent near range
- many types with additional benefits are available, e.g. laser rangefinding including ballisitic evaluation (BIS®), residual light intensifier etc.

From the smallest Victory 8 x 20 T* pocket binoculars to the Victory 10 x 56 T*, there is a wide range of binoculars for any application. All of them include LotuTec® coating and are nitrogen-filled for the roughest conditions in any environment and weather.

The Conquest models are powerful companions for demanding situations. Positioned below the performance data of the Victory line (e.g. fields of view, near range, mechanical parts of the eyecups, diopter adjustment), they are of equal rank regarding robustness, impermeability, and coatings.

From the compact Conquest 8 x 20 T* (the lightest binoculars offered in the entire ZEISS catalog) to the Conquest 10 x 56 T*, this line also offers the right solution for any requirement.
3.7 The proven classics

Dialyt 8 x 56 T*

The timeless black Dialyt design with rubber eyecups is still used for several proven models shown in the ZEISS binocular program. The Dialyt 8 x 56 T* has been the classic among hunting binoculars for decades. Focused on technological essentials, very slim and easy to use, the extremely bright and proven binoculars are repeatedly handed down from generation to generation.

7 x 50 T*

The 7 x 50 T* is very well known in water sports. The robust binoculars provide a large, very bright field of view and each eyepiece can be set separately.

Quick and mobile use of 20x magnification without shake and without a tripod? The 20 x 60 S with mechanical image stabilization is the answer. Without batteries, the cardanic mount of the prism system on a spring joint prevents the transfer of hand tremor to the image at the push of a button, thus enabling a unique visual experience.

20 x 60 T* S

The program is rounded off with different monocular models featuring magnification levels from 3x to 10x. Several of them can be used as magnifiers and are ideal for studying flowers and insects up close.

Monoculars
Innovative measuring systems with invisible and eyesafe laser light in the ZEISS Victory RF products enable an easy, fast and precise measurement of distance, partially up to 1,500 m. At the push of a button, laser pulses are transmitted which hit the target and are reflected back. Sensitive sensors in the instruments register the returning light. When the laser light is emitted, a “stopwatch” starts and measures the time needed for the echo to return. Based on the known speed of light (300,000 km/sec) a microprocessor calculates the exact distance to the target and displays it directly in the field of view on a display whose brightness is automatically adjusted for ambient light to ensure optimal readability.

Based on this information, responsible hunters can better estimate the situation and decide if a shot should be taken or not and which bullet drop is to be expected or compensated for.

Furthermore, there is hardly an easier way to quickly and reliably determine distances between 10 – 1,000 m, be it out in nature or on a golf course.

A laser beam is usually fine and tightly bundled. Nonetheless, it expands with increasing distance. This beam divergence is measured in millirad (mrad). Compared to all other laser rangefinders, the measuring beam on the Victory RF has an extremely low beam divergence of 1.6 x 0.5 mrad, i.e. the measuring spot at a distance of 100 m is approximately 16 x 5 cm. This enables the very precise measurement of even small objects at long range.

If the ranging distance and the flight path of the bullet are known, the required holdover can be determined for every distance. The integrated ballistic information system (BIS®) performs this task in a fraction of a second.

The instruments provide a wide range of programs to adjust for the ballistics and the range. Selecting the right one is based on two statements:

3.8 Laser rangefinding and ballistic information system (BIS®)

Mono 3 x 12 T*. The 3 x 12 Mono is a special product: in addition to the mini-telescope and magnifier, it can be mounted with an adapter to the eyepiece of the large Victory and Conquest binoculars to triple the normal magnification of the binoculars. In the twinkling of an eye, an 8 x 56 becomes a monocular 24 x 56. It is a compact and lightweight solution that can replace a spotting scope in many situations.
a) At which distance was the weapon zeroed?

100 m or GEE (optimal zeroing range) if measured in meters, or 100 yd. and 200 yd. if measured in yards.

b) Which of the available ballistic curves corresponds to the flight path of my bullet?

On the Carl Zeiss Sports Optics website, there is a free, easy-to-use online program that features an extensive ammunition database that lists virtually all known calibers and bullets, and shows the right setting for the binoculars.

Following the measurement at the push of a button, the range is displayed in the image field (in m or yd.) and the corresponding holdover (in cm or in.) shortly thereafter automatically.
3.9 The right binoculars

Due to its large exit pupil and therefore image brightness, the 8 x 56 has been the tool of choice for generations of hunters (twilight and stand hunting).

In deer hunting areas, excellent detail recognition even at longer distances is necessary. 10 x 56 models are being used here increasingly.

7 x 42 binoculars are a more compact alternative for deep dawn, particularly in wooded areas, where a good overview at short range is more important than long distances. The large exit pupil meets all requirements for hunting game at night, delivers an unparalleled large field of view and an extremely steady and thus pleasant image due to the 7x magnification.

The compact models with 30 or 32 mm lens apertures are ideal for stalking game and hunting abroad which primarily takes place in good light, and where more emphasis is placed on weight.

Binoculars with 40-45 mm lenses are somewhat larger and heavier, but therefore more universal. The 8 x 40 or 8 x 42 models are very good all-rounders and suitable for most situations.

For experienced hunters, models with laser rangefinders and BIS® offer decisive additional information for expert shots at long ranges. In addition to the Victory 8 and 10 x 45 T* RF, the more powerful Victory 8 and 10 x 56 T* RF are available for observation and simultaneous rangefinding. Moreover, the integrated BIS ballistic information system BIS® provides information on the expected bullet drop.

The Victory 8 x 26 T* PRF monocular pocket rangefinder offers the same additional electronic functions in a compact form. It is ideal for anyone who wants to continue using proven binoculars for observation but wants to take advantage of the benefits of a rangefinder.
Birders do not need a large exit pupil for their typical daytime observations; standard binoculars have a 40 or 42 mm aperture, making them easy-to-grip all-rounders with sufficient reserves for the oncoming twilight. 8 or 10x magnification is preferred depending on the effect of hand tremor and the desired field of view.

On ornithological excursions and primarily during the day, the 30 or 32 mm lens models are preferred due to their lower weight and smaller size.

Weight and size are the most important criteria for hikers, trekkers, mountain climbers, etc. The 8x 20 and 10 x 25 pocket binoculars are a perfect choice and are always ready for use. The magnification – 8x or 10 x – should be selected based on a test regarding the user’s ability to keep hands steady.

The 30 or 32 mm models (e.g. 8 x 32) are real alternatives for daytime outdoor activities. They are somewhat larger and heavier but offer noticeably more visual comfort.

The same applies to city tours, cultural events etc. Compact binoculars bring many things closer and make it easier to experience far away objects.

7 x 50 Porro models are ideal for nautical applications. The large exit pupil and the low magnification enable the user to quickly get a steady image even in rough seas. Single eyepiece focusing suffices as observations are mostly made at long ranges.
4. About Targeting Optics

4.1 Why a riflescope?

While aiming with open sighting, three things are different when distances must be focused on simultaneously and aligned exactly: front and rear sight and the target. This is hardly possible for older hunters or in low light. Plus, an ethical shot at long range cannot be taken like this.

Therefore, riflescopes have been part of the standard equipment as a targeting aid in everyday hunting for decades and provide numerous key benefits:

a) The optical system delivers a unique image in which the target and reticle are sharply focused at the same time. The eye does not have to focus on different ranges, but can concentrate on one image plane.

b) From an optical perspective, this image is infinite, i.e. the eye looks through the eyepiece totally relaxed. Therefore, if you look through the riflescope while wearing glasses, always use the distance range or your glasses for distance vision.

c) The magnification ensures reliable, very precise aiming for the shot.

d) A quick adjustment to the elevation (ASV) and different long-range reticles (RAPID-Z®) allow compensation for the bullet drop, thus ensuring precise shots even at long distances.

e) Finally, a large selection of riflescopes and reticles enable ideal customization for different types of hunting.

4.2 General design

As with binoculars, the lens creates an upside-down, reversed intermediate image. The position of the image in the riflescope is described as the lens side or 1st image plane.

This image passes through a second optical system (inverting system) where it is rotated again to appear upright and unreversed in the 2nd image plane.

On variable riflescopes, the lens elements of the inverting system can be moved so that there is a change of the size of the image in the second image plane, and, therefore, of the magnification of the riflescope. Contrary to many popular beliefs, there are practically no additional optical parts for the zoom adjustment which visibly impair the transmission of variable scopes compared to fixed magnification.

With the eyepiece as a magnifier, the image is viewed in the 2nd or eyepiece side image plane. To avoid eye injuries caused by shot recoil, the eye relief should be at least 80 mm.
With a few exceptions, the center tube diameter on hunting riflescopes is 30 mm or 1 inch (25.4 mm). The larger diameter offers more room to optimally house the mechanical parts of the zoom system without compromises. Therefore, most 4x zoom scopes include a 30 mm tube, many American 3x zoom scopes a 1 inch tube. With an otherwise identical design, the larger tube, of course, allows larger reticle adjustment ranges and larger fields of view. However, the interrelationships are very complex and often cannot be compared directly. There is no difference regarding brightness and transmission. A thicker tube does not deliver a brighter image—even if this is the prevailing opinion of many users.

4.3 Reticles

Every riflescope is equipped with a reticle as a targeting aid. It is selected based on the hunting situation and personal preferences. It is focused for your eyes by means of the diopter setting provided on the eyepiece. Elevation and windage adjustment turrets are used to align the reticle or the sighting line to the bullet’s trajectory precisely.

Nowadays, illuminated reticles are being used more and more in addition to numerous, traditional reticles such as 4 or 8. With these systems, the light intensity must meet a wide range of different demands: with hunting game at night, there must be a faint glow only without blinding the eye or interfering with the eyes ability to adjust to the dark. On driven hunts, however, bright illumination is required to ensure that the eye can seize the illuminated dot in a fraction of a second in bright daylight.

Examples of the various types of reticles.
Therefore, the hunting situation is a key factor in the selection of an illuminated reticle. The Varipoint models are outstanding if you are looking for a reticle that is both day and night capable, and thus absolutely universal. The illuminated dot on Duralyt models is similarly universal.

The illumination systems of other ZEISS riflescopes is designed for mere use in low light; a large selection of models and designs in the Victory Classic Diavari line is available.

The reticle on a riflescope can be positioned in the 1st or 2nd image plane or – as with the technically advanced Varipoint reticles 60 and 69 – includes elements in both locations. The difference between the 1st and 2nd image planes appears when the magnification changes or on so-called subtensions.

Reticle planes

The reticle in the 1st image plane (in front of the inverting system) changes the same as the actual image does. The reticle and image create a single unit, both increase or decrease in size.

Reticle in the 1st image plane: A change of magnification changes the target image and reticle simultaneously. Cover proportions and dimensions remain constant.

The subtension is therefore the same at all magnification levels so that it is possible to estimate the range easily. For example, if the distance between the horizontal bars on reticle 40 is exactly 70 cm at 100 m and a deer (typical length of 70 cm) fills half of the intermediate space, it is 200 m away regardless of the magnification.

An additional property becomes evident in poor light: the bars and lines become wider at higher magnification, making them easier to see.

The advantages of the position in the 1st image plane are increasingly disappearing as a result of developments such as an illuminated reticle and laser rangefinders. While earlier, typically “European” riflescopes were equipped with unlit reticles in the 1st image plane; the trend now is towards illuminated reticles in the 2nd image plane.

Here, the reticle is behind the zoom inverting system, i.e. in the image plane closer to the eyepiece. When the magnification changes (zoom), it does not affect the reticle which remains constantly fine with minimal target coverage: A key benefit on long-distance shots at high magnification.

However, the subtension of the reticles in the 2nd image plane now depends on the magnification setting. The lower the magnification (the smaller the image) the higher the subtension.

Reticle in the 2nd image plane: A magnification change only changes the target image. The reticle remains unchanged. The cover dimensions change with the magnification.
Placing the reticle in the 2nd image plane is more challenging from the technical point of view and more critical than it is in the 1st plane. The moveable parts of the inverting system must be manufactured with extremely narrow tolerances to ensure that the image does not unintentionally move up or down when it is enlarged. Because the reticle is fixed in the second image plane, it would result in considerable deviations in the point of impact in such cases.

Thanks to state-of-the-art manufacturing processes with minimal tolerances in production, Carl Zeiss can also deliver maximum reliability here – in all riflescope classes.

The unique Varipoint reticle 69 allows hunters to alternate between a day and night capable illuminated dot in the 2nd image plane and fine illuminated crosshairs in the 1st image plane depending on the hunting situation.
4.4 Reticle adjustment

The weapon is ranged after the riflescope is mounted. This means that the reticle and sighting line are adjusted to show the exact point of impact of a bullet at a certain distance (e.g. 100 m or GEE).

The riflescopes are equipped with elevation adjustment, i.e. two adjustment turrets on the center tube which are used to align the reticle in windage and elevation.

Most riflescopes include squared reticle adjustment, i.e. there is an equal amount of room for elevation and windage. Special models for longer distances offer an enlarged vertical adjustment range to better compensate bullet drop at long ranges – without compromises for lateral adjustment. On all ZEISS riflescopes it is always ensured that the lateral setting is not influenced when the height is adjusted and vice versa.

With each click of the adjustment knobs, the reticles on most “European” models move 1 cm with a target 100 m away, i.e. 1 cm/100 m. This is 3 cm per click on a 300 m disc. “American” models usually include an adjustment of ¼ MoA = approx. 0.73 cm/100 m (MoA = minute of angle = 1/60 of a degree).

After ranging, the adjustment knobs on most riflescopes can be zeroed, i.e. the scale is set to the starting position (zero) without adjusting the reticle. When the reticle is changed again, e.g. to compensate for bullet drop or side wind, the correct position can be restored easily.

On older riflescopes, this results in the reticle being positioned somewhere in the image field after ranging instead of in the center. Modern centered reticles avoid this by slightly tipping the entire inverting system so that the entire field of view moves. The reticle is always centered in the image.
4.5 Correcting bullet drop with the bullet drop compensator (ASV)

In addition to the (one-time) zeroing, the reticle adjustment is used to compensate for bullet drop and remain on target at long range. This requires that the bullet drop is known. The ballistic data supplied by the manufacturer provides this information which, ideally, you should test at different distances.

Example:
The weapon is zeroed at 100 m, the bullet drop is 12 cm at 200 m and 45 cm at 300 m.
To remain on target at 200 m, the reticle is adjusted 6 clicks (1 click = 2 cm / 200 m), 15 clicks at 300 m. The direction of rotation is the same as the correction of a low shot, i.e. lower sighting line to point of bullet impact.

Instead of counting clicks, the bullet drop compensator developed by Carl Zeiss offers an ingeniously simple and reliable solution: the easy-to-grip adjustment knob features a range scale so that the reticle simply has to be set to the estimated or measured range for long-distance shots enabling the hunter to remain on target.

Different range scales up to 400 m are available as metal stickers to adjust the system to the different ballistic curves. The right scale for the ammunition mentioned above is designed so that a 2 appears (200 m) after 6 clicks, a 3 (300 m) after 15 clicks etc., each with an intermediate setting at 25 m intervals. The larger the bullet drop is (slow or heavy bullets) the more spread out the scale.

The easiest way to select the right, ammunition-dependent ASV scale is via a free software on the Carl Zeiss Sports Optics website which has access to the ballistic data of around 1,500 different calibers.

Software interface for calculating the appropriate ASV scale.
Download: www.zeiss.de/sportsoptics
4.6 Correcting bullet drop with the RAPID-Z® long-distance reticles

**Principle**

The RAPID-Z® reticles include hold lines for distances up to 700 m, which show the bullet drop for the various distances. After estimating or measuring the distance, the target is sighted with the corresponding mark. Very simple and extremely fast.

The reticle is located in the 2nd image plane, i.e. the subtension depends on the magnification. Therefore this is used to adapt the hold lines to the different ballistics.

**Example 1:** RAPID-Z® 7 to 200 meters

**Example 2:** RAPID-Z® 7 to 550 meters

Adjustments for ballistics

Every riflescope with a Rapid Z reticle is equipped with a reference magnification for which the spacing and lines on the reticle reflect the bullet drop of a fast bullet precisely, e.g. .300 Win. Mag, Blaser CDP 10.7 g bullet.

If you use a slower caliber with a larger bullet drop, the distance lines must be spread farther apart. Because the reticle cannot be magnified (2nd image plane), the image size of the target is reduced. By selecting the magnification, the hunter can move the lines of the Rapid Z reticle in relation to the target and thus adjust them exactly to the value of the bullet drop.

With very heavy and slow calibers this requires the selection of a lower magnification which has a paradoxical effect on shooting at long range. In this case you must consider if the ammunition is really suitable for long-range shots. Magnification in the upper ranges must always be selected for typically fast calibers for long distances.

A free software on the Carl Zeiss Sports Optics website helps determine the right magnification setting once the type of riflescope and ammunition have been entered.
4.7 About parallax compensation

A normal riflescope generates an image of the target in the reticle plane - if the target is 100 m away! This is comparable to a camera lens that is set to a focal distance of 100 m. At a range of 300 m, the image is somewhat in front of the reticle plane. There are no problems except for a certain amount of blurring in the image at high magnification as long as the shooter is looking directly through the center of the eyepiece. However, if the shooter looks through the eyepiece at an angle, the distance from the image plane to the reticle plane results in lateral offset between the reticle and the image and thus in a deviation in the point of impact.

This is only relevant for practical everyday hunting with high magnification at long range – this cannot explain a miss with 10x magnification at 150 m. However, precautions should be taken to eliminate these potential mistakes.

The victory FL long-distance riflescopes from Carl Zeiss including high magnification are equipped with parallax compensation, i.e. an easy to use swivel with a range scale from 50 m. This moves the image back to the reticle plane, i.e. it is sharply focused and parallax errors cannot occur even when looking through the eyepiece at an angle.

The position of the reticles – in the 1st or 2nd image plane – is irrelevant.
4.8 ZEISS Victory riflescopes

Victory

Victory stands for innovative, high standard optics and maximum precision for passionate hunters. The line comprises variable riflescopes with unparalleled image quality and an extremely bright, high-resolution target image, the innovative LotuTec® coating, and a wide range of reticles in the 1st or 2nd image plane. The latest technologies, e.g. FL glass and laser rangefinders, are also used.

Victory FL Diavari

The Victory FL Diavari line is the reference class in the ZEISS riflescope program. Outstanding high-performance optics including up to 24x magnification for a reliable shot at long range. This line is known for its high magnification for maximum detail recognition and the FL concept for brilliant, high-contrast images. The practical configuration for precision over long distances include the standard parallax compensation from 50 m, the bullet drop compensator, or the RAPID-Z® ballistic reticle, and an expanded adjustment range for the correction of elevation.

Victory Diavari

Victory Diavari are variable riflescopes with a magnification range of 1.5-12x. The illuminated reticles are designed for low light and can be positioned in the 1st and 2nd image plane depending on the model.

Victory Varipoint

All Varipoint models are known for their extremely variable and practical reticle concept. The day and night-capable illuminated dot is one of the smallest on the market with a large brightness range for any type of hunting. It can be reliably seen at the same size in the 2nd image plane in bright sunshine and in the snow. A black dot is always visible when the illumination is turned off. The additional lines and bars on reticles 60 and 69 are located in the 1st image plane and therefore provide a good feeling for the distance.
Thanks to the iC system (Illumination Control) developed with Blaser, the weapon and optics can be made ready to shoot with a single action for the first time ever. A magnetic sensor on the riflescope eyepiece registers the position of the cocking slider on the Blaser R93 and Blaser R8. When the weapon is cocked, the illuminated dot on the Varipoint iC models illuminates automatically at the brightness level selected previously. When hunting from a stand, this eliminates unnecessary movement and noise. On a driven hunt, there are no unpleasant surprises when you forget to turn on the riflescope in the heat of the battle. Weapon and optics are a single system.

The Victory Diarange models combine performance features of a premium riflescope with sophisticated technology of a laser rangefinder. Aim, measure, transfer distance to the ASV and fire a clean, on-target shot at long range. The distance can be measured exactly in a fraction of a second right up until the shot is fired.

The Classic line is comprised of two groups: the variable Diavari models from 1.1-4x24 T* up to a 3-12x56 T* and the fixed magnification Diatal models with 6, 7 or 8x magnification. Most models are available with a twilight-capable illuminated reticle.
Duralyt stands for high-quality targeting optics for active, passionate hunting: focused on functionality and reliability with an unmistakable dark gray anodized design. Three models are available with standard reticles or a day and night-capable illuminated dot coupled via glass fiber.

Duralyt 3–12x50.

By focusing on clear and meaningful features for successful hunting without LotuTec® coating, assembly rail or BDC, proven ZEISS quality “Made in Germany” can also be offered in the moderate price segment. Be it for a frequently used weapon or for young hunters, they are ideal entrance to the world of Carl Zeiss.

Duralyt 3–12x50 (illuminated Reticle 60).

4.10 ZEISS reflex sights

Reflex sights are the specialists for driven hunts. They do not have magnifying optics but in principle provide a window with a bright illuminated dot to look through. There is no defined eye relief as with riflescopes, i.e. the eye can be at different distances to the eyepiece. Therefore, its position on the weapon is not important, assembly is simplified, and they can even be used without a problem on handguns with arm extended.

ZEISS reflex sights are known for a fine, clear illuminated dot that is adjusted manually and always bright and razor sharp thanks to the LotuTec® coating on the exterior glass surfaces. The diameter of 5 cm at 50 m enables a very precise, parallax-free shot even beyond typical driven hunt ranges.

The Victory Z-Point includes a closed housing for use under the toughest weather conditions. Dust, rain, and dirt are simply ignored and the hybrid power supply with a battery and solar cell eliminates energy problems right from very start.

ZEISS Z-Point.
The Compact Point is even more compact and lighter. A slim frame is all that surrounds the large optical element and opens up a maximum overview of the field of fire. The electronic components are also packed into the watertight housing.

Both reflex sights are available in different versions for different assemblies to always ensure an optimal low position on the weapon.
4.11 The right riflescope

Zeiss offers a wide range of riflescopes to meet any hunting requirements. There are models with fixed and variable magnification, reticles in the 1st or 2nd image plane (or both simultaneously), illuminated reticles for low light and for bright daylight, and versions whose illuminated dot turns on automatically when the weapon is cocked. There are configurations with an integrated laser rangefinder, special FL models including high magnification, parallax compensation for extremely long distances, and reflex sights for driven hunts at short range. The line is rounded off with many models with and without inner rails for safe mounting.

Regarding optical quality and reliability, there is no difference between first-class fixed and variable magnification models today. Contrary to popular opinion, a riflescope with variable magnification does not necessarily have more glass-air surfaces than a fixed magnification model. Thanks to T* multi-coating, even two additional glass-air surfaces do not have an effect on perceivable brightness.

At short distances, a large field of view is one of the initial criteria in quickly seeing what’s happening. Low magnification is therefore required and also allows the hunter to aim with both eyes open. Based on experience, magnification of 1.1 x instead of 1.0 x is beneficial and places more priority on the targeting eye. During the day, the lens aperture is not important, compact and easy-to-use models are ideal.

A large exit pupil is also important to be able to seize a target in a fraction of a second. The larger the zoom range, the higher the number of compromises which unfortunately have their greatest effect at lower magnification.

Variable driven hunt riflescopes also make it possible at somewhat higher higher magnification to get of a clean shot at promising game.

Typical models, all with the reticle in the 2nd image plane, are the Victory Varipoint 1.1-4x24 T*, the Classic Diavari 1.1-4x24 T*, and Duralyt 1.2-5x36.

On the other hand, reflex sights such as the Z Point and Compact Point as pure specialists are becoming more and more popular.
Lenses with a 42 mm diameter and magnification range of 1.5 to 6x or 2 to 8x are universal riflescopes with a wide range of uses for stalking game, stand hunting during the day, driven hunts and hunting abroad. A 6 x 42 setting (7 mm exit pupil) delivers a surprisingly bright image even in low light which many hunters would not expect of a 42 mm lens.

Models such as the Victory Varipoint 1.5-6x42 T*, the Victory, and Classic Diavari 1.5-6x42 T* and the Duralyt 2-8x42 are the tool of choice among young hunters looking to equip their weapon with an all-rounder.

Higher magnification up to 10 to 12x yet still compact and light: typical features of riflescopes for stalking game in open terrain, in the woods or while hunting in the mountains – even for stand hunting early in the morning with the appropriate twilight performance.

Typical models are the Victory Varipoint 2.5-10x50 T*, the Victory, and Classic Diavari 2.5-10x50 T*, and the Duralyt 3-12x50.
Twilight, stand hunting

Large lenses are used late into the twilight and when sitting game at night. Their excellent twilight performance allows to extend the last light of the day. Moonlight becomes a valued partner: be it a boar at 6x magnification or a fox at 12x. ZEISS stands for the brightest, highest-contrast images for a reliable shot deep into the twilight and at night. Typical models are the Victory Varipoint 3-12x56 T*, as well as the Victory and Classic Diavari 3-12x56 T*.

Long range

High magnification for very good detail recognition at long range, FL lenses that meet these enormous demands, parallax compensation for absolute clarity and precision, integrated bullet drop compensator or Rapid Z ballistic reticles to immediately and reliably compensate for bullet drop and an expanded adjustment range for the correction of elevation: hallmarks of leading-edge optics for long-distance shots. Typical models are the Victory FL Diavari 4-16x50 T*, the Victory FL Diavari 6-24x56 T*, and the Victory FL Diavari 6-24x72 T*
4.12 About assembly on the weapon

Ring assembly

Most riflescope models are available with or without an assembly rail. Assuming that everything was properly assembled, there is no difference regarding recoil resistance and accuracy.

Rings are used on riflescopes without a rail. They are attached either on the center tube or on the center tube and the lens tube. This ring mounting is standard in the USA and many other countries, but is not without problems. Before mounting, the riflescope must be aligned to the reticle very precisely. The rings must then be tightened using 8 screws. Missed shots are often the result of loosened screws. If the front ring sits around the lens tube and is tightened too much, it can damage the optics. Furthermore, the rings leave permanent indentations and grooves on the tube body when the eye relief is changed. Rings assembled incorrectly can even damage the riflescope.

According to experts, the best assembly system for riflescopes is the inner rail developed by Carl Zeiss. A dovetail-shaped hollow rail runs along the lower part of the tube body made of a single piece of material. This is where mounting systems from different manufacturers are mounted with clamping elements – completely without tension, recoil-proof and invisible. No mechanical machining is required on the riflescope itself. This is the best technical solution which has a very elegant appearance, too. Finally, the distance of the riflescope to the eye of the shooter can be quickly and easily changed without leaving a mark on the tube body – when the weapon changes hands, for example.

The inner rail by Carl Zeiss.

The rail provides a lot of room to position the riflescope properly so that the eye relief of e.g. 9 cm is maintained when aiming while stalking game, when taking an off-hand shot while standing or when leaning against an object. This can be a different story when lying, uphill in the mountains or even when stand hunting. When aiming while sitting, your head is often leaned forward and...
you can quickly lose 2 cm. A quick shot on a driven hunt is even worse. You move your head forward as with a shotgun and the eye relief decreases to 5 to 6 cm. With strong calibers, this is far too little to avoid a painful encounter with the eyepiece. You also lose a considerable part of the field of view. Eyeglass wearers must pay additional attention. Their glasses usually sit 1 to 1.5 cm in front of their eyes and reduce the distance from the eyeglass to the eyepiece on the riflescope accordingly.

The viewing distance for riflescopes should be at least 80mm. Some additional eye relief can be obtained while assembling the riflescope. Inform a gunsmith of your habits and have him move the riflescope until the field of view fills the eyepiece, appears sharply defined and the tunnel vision is gone. You have now defined the full eye relief and the right position. The riflescope is now moved 1 to 1.5 cm forward and then mounted. This extra safety comes at the expense of a slight reduction of the field of view, but is easily absorbed by modern riflescopes including large fields of view.

4.13 Tips on shooting with a riflescope

The gunsmith zeroed the weapon precisely but his eye, his aiming, and his trigger behavior are usually not identical to those of the buyer. Therefore, it is always advisable to fire a few test shots. This often identifies the necessity to make minor corrections to the reticle adjustment. This is particularly true for left-handers when the weapon was ranged by a right-hander.

After ranging, the riflescope should be removed and remounted. This can easily be done several times. Then a few shots are fired and the point of impact checked. Careful mounting with quality parts should not exhibit any significant deviations.

Lower mounting, low magnification, and a large field of view: in general, the end of the barrel with the muzzle is now blurred in the lower part of the field of view. Even if this is annoying, it does not have any effect on a good shot.

When looking through the eyepiece – be it a riflescope or binoculars – your eye practically focuses at infinity. If you wear glasses for farsightedness, you should take them off. Modern glasses with progressive lenses often cause problems. Ideally, the shooter should look through the center of the distance zone but even the slightest movement of the head causes the eye to look through the transition zone to the near zone. This results in a blurred image which can easily be seen on the illuminated dot. It can take on any possible shape, just not a dot. Simple single-vision lenses for the distance zone are the better choice here.

As light decreases, many people’s eyes become slightly shortsighted – night myopia occurs. This also happens when looking through the riflescope. However, image definition can be improved by adjusting the eyepiece 0.5 to 1 D in the minus direction. It is easier to adjust the focus during twilight with an illuminated reticle. Simply turn the eyepiece ring until the illuminated crosshair or dot is sharply focused.
4.1.4 Uphill or downhill

Influence of gravity

With a horizontal shot, gravity acts perpendicularly to the direction of the shot and thus results in deviations from a straight path up to the known, practically parabolic downward trajectory. After ranging the riflescope therefore points somewhat downward so that the sighting line intersects the trajectory at the distance of the ranging range. If you shoot straight up or down, gravity has a braking or accelerating effect on the bullet only, but does not lead to a lateral deviation. The trajectory remains a straight line specified by the axis of the barrel. It no longer moves toward the sighting line, but away from it. In practice, the point of impact would thus be always clearly above the target.

In practice, no one shoots straight up or down. However, when hunting in the mountains it is quite common to get off a shot at 30 to 40° angles. The portion of gravity that works perpendicular to the trajectory which is responsible for the directional deviation is then noticeably lower. At an angle of 35°, it is still around 80% (\(\cos 35° = 0.82\)). As a result, the trajectory is less curved, i.e. the fall of shot is less. The result is a high shot! In general, the old “uphill and downhill – aim lower” rule is true.

How noticeable is this effect in practice? State-of-the-art ballistic programs can calculate very precisely; however, very concrete attempts provide a better feeling of the practical effect. One such tests is described in detail in Passion magazine on pages 18 to 25 of the 3/2009 issue. Two different fast cartridges were used; the angle was 35°. The weapons were ranged with a 4 cm high shot at 100 m. This resulted in the following results which are theoretically predictable for uphill and downhill in the same manner:

### Test I with fast bullet:
Blaser R93, 7 mm Blaser Magnum with 9.2 g bullet

<table>
<thead>
<tr>
<th>Range to target:</th>
<th>100 m</th>
<th>200 m</th>
<th>300 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of impact for horizontal shot</td>
<td>+4 cm</td>
<td>0 cm</td>
<td>-24 cm</td>
</tr>
<tr>
<td>Point of impact for 35° shot</td>
<td>+5 cm</td>
<td>+4 cm</td>
<td>-7 cm</td>
</tr>
<tr>
<td>Difference between horizontal and 35° shot</td>
<td>1 cm</td>
<td>4 cm</td>
<td>17 cm</td>
</tr>
</tbody>
</table>

### Test II with slower bullet:
Blaser K95, .308 Win. with 11.7 g bullet

<table>
<thead>
<tr>
<th>Range to target:</th>
<th>100 m</th>
<th>200 m</th>
<th>300 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of impact for horizontal shot</td>
<td>+4 cm</td>
<td>-8 cm</td>
<td>-44 cm</td>
</tr>
<tr>
<td>Point of impact for 35° shot</td>
<td>+6 cm</td>
<td>+4 cm</td>
<td>-18 cm</td>
</tr>
<tr>
<td>Difference between horizontal and 35° shot</td>
<td>2 cm</td>
<td>12 cm</td>
<td>26 cm</td>
</tr>
</tbody>
</table>
These results show that no difficult calculations, which are often more confusing than helpful, are required for normal hunting calibers up to 200 m, even at a 30 to 40° angle (uphill or downhill). Normal aiming is sufficient in this range.

Test shooting uphill.

For slow bullets at longer distances or at even steeper angles, you should take a closer look at how everything interacts; there are then considerable effects on the ballistics and the point of impact. This applies for uphill and downhill as well.

4.15 Point of impact deviation through tilting?

Right up front: point of impact deviations through tilting, i.e. holding the weapon at an angle are negligible. Ballistic programs and practical tests show that even aiming at a 20 to 30° angle with standard hunting calibers at a range of 100 m only resulted in deviations in elevation and windage hardly more than 2 to 3 cm and thus well within the range of dispersion. On a hunt, any tilting angles are considerably smaller anyway – except perhaps during the hectic pace of a driven hunt. However, this is unimportant due to the short distances – in any case, tilting is not an excuse!
Although spotting scopes have a high twilight factor from a mere mathematical perspective, most of them are used primarily in good lighting due to the rather small exit pupil. FL high-performance spotting scopes with a large lens aperture and first-class transmission such as the ZEISS 20 x 60 T* FL can be used well into twilight.

In general, they are useful in many situations: together with good binoculars, a spotting scope is part of the standard equipment for ornithologists or birdwatchers. The same applies to zoologists. Most hunters, game wardens, and wildlife biologists today do not want to do without a spotting scope when dealing with long distances and weak hunters, game warders, and wildlife biologists today do not want to do without a spotting scope when dealing with long distances. A spotting scope can be used with the standard equipment for hunters, game wardens, and wildlife biologists today, a spotting scope is part of the standard equipment for hunters, game wardens, and wildlife biologists today.

Use 5. About Spotting Scopes

5.1 Why spotting scopes?

More than 10x magnification makes sense with binoculars only when you have steady hands, and a support or image stabilization such as on the ZEISS 20 x 60 T* FL. This is when the monocular spotting scope comes into play. They offer up to 75x magnification and thus fantastic detail rendition. With a first-class spotting scope, it is possible to recognize the smallest details of far away objects and see small animals up close. For example, at 75x magnification an object 200 m away looks like it would be at 2.7 m only.

The objective of local hunting grounds, maharana use them to observe their

The objective of local hunting grounds, maharana use them to observe their

The objective of local hunting grounds, maharana use them to observe their
5.2 Typical design

**Designs**

Spotting scopes with a solid housing can be manufactured to be waterproof and dust-proof including nitrogen filling to prevent fogging in low temperatures. Extendable spotting scopes, on the other hand, are compact for transport, but draw in air when extended, i.e. moisture and tiniest dust particles are drawn in and can result in a quality-lowering coating on the internal optical parts and fogging.

**Eyepieces**

Many spotting scopes include interchangeable eyepieces for different magnification levels; zoom eyepieces are, however, clearly preferred. Lower magnification delivers a large field of view and a good overview to find the actual object to be observed. Zooming in makes the desired details visible.

The advantage of fixed magnification over zoom eyepieces is the larger field of view at the same magnification. Nowadays, transmission, image definition, etc. are no longer relevant differentiation criteria.

Magnification depends on the lens and the eyepiece and is calculated as follows:

\[
\text{Magnification} = \frac{\text{lens focal length}}{\text{eyepiece focal length}}
\]

This way, the magnification can also be determined when a short focal length astro eyepiece with astro adapter is used on spotting scopes. On an 85 mm spotting scope (504 mm focal length) a 5 mm astro eyepiece results in around 100x magnification. Adapters for the use of astro eyepieces on DiaScope spotting scopes and vice versa are available.

Hunters generally prefer straight-sighted models that enable them to very quickly seize game when the optics are laid on a backpack or against an object.
Birdwatchers, on the other hand, often use an angled view through the eyepiece because it ensures a more relaxed posture – particularly when looking up – over longer observation periods.
5.3 ZEISS spotting scopes

The Victory DiaScope line enables unparalleled perfection for the observation of birds or game. It comprises models with 65 and 85 mm FL lenses, each with straight or angled viewing. They offer one fixed magnification and two Vario eyepieces that cover a magnification range of 15-75x.

They include a shorter focal length to not only decrease the diameter of the smaller DiaScope 65 T* FL spotting scopes but also to really make them more compact compared with the 85 T* FL spotting scopes. Because the magnification always depends on eyepiece and lens (spotting scope), it results in different magnification levels. This explains, e.g. the designation Vario eyepiece 15-56x/20-75x: the lower values refer to use on the DiaScope 65 T* FL, the higher values are associated with the DiaScope 85 T* FL.

Victory DiaScope 85 T* FL

While only a 25-50 or a 20-60x zoom eyepiece is available for many users, the 20-75x eyepiece for the 85 mm DiaScope really enables the user to dive into nature.

All DiaScope spotting scopes are equipped with DSF (Dual Speed Focus): two focusing speeds are combined with one control knob. The focus is set precisely with pinpoint accuracy in the fine mode. When the wheel is turned in larger increments, the system switches to the fast rough mode automatically, enabling the user to quickly change the distance. Intuitive and controlled with a quick turn, the focusing function adjusts its speed according to the requirements.

The Dialyt 18-45x65 is a robust all-weather and outdoor spotting scope with easy-to-grip rubber armoring for fast and reliable aiming at long range. Compact with a straight viewing tube, fixed design, and filled with nitrogen it is ideal for a backpack, extensive stalking and hunting in the mountains.

Dialyt spotting scope

In one unit the PhotoScope 85 T* FL offers users an outstanding spotting scope featuring 15-45x magnification for observation – and the fascinating option of taking digital pictures at the press of the button simultaneously at just the right moment. This eliminates the time-consuming and sometimes complicated use of adapters, external cameras, remote releases, settings, etc. required in standard digiscoping procedures. Every observation situation can be recorded on an SD card spontaneously, as a 7 megapixel image in JPG or RAW format or as an AVI video file.

The unique zoom adjustment in the lens provides users with out-
spotting fields of view at all magnification levels – a feature unavailable with an eyepiece zoom. The subjective field of view is approximately 69° (80 m at 1,000 m at the lowest magnification) and is constant throughout the magnification range.

Photographers primarily value the long tele focal lengths that deliver an image frame comparable to a 35 mm lens with a 600 to 1,800 mm focal length. The effective aperture values range from 4 to 5.6 depending on the zoom setting.

With this unique integration of observation and image capture, the ZEISS Victory PhotoScope is the tool of reference in the field of digiscoping – taking pictures with a spotting scope.
5.4 About digiscoping – taking pictures with a spotting scope

Using the high-quality optics of a spotting scope with fluoride lenses for photography has always been possible. The ZEISS PhotoScope described above – the integration of a digital camera unit in a spotting scope – represents the most attractive and innovative solution. Traditional spotting scopes in the DiaScope line can also be easily converted for digiscoping with the right accessories.

Most digital cameras including a 3 to 4x zoom lens can be used to take pictures very easily through the eyepiece of the spotting scope. The image is seized with the camera instead of the eye. The ZEISS Quick Camera Adapter is a stable mount for the camera. It provides sufficient room to align the camera exactly and enables the user to quickly switch between observation and photography.

The total focal length of the cameras is calculated as follows:

\[
\text{Focal length} = \text{lens focal length (of the camera)} \times \text{eyepiece magnification}
\]

A 100 mm camera focal length and 30x magnifying spotting scope delivers a focal length of 3,000 mm – a dream for all nature and animal photographers.

Analog and digital SLR and DSLR cameras are suitable only for very small, fixed focal length lenses for direct photography through the eyepiece on the spotting scope. Now there is another solution: the ZEISS Photo Adapter that replaces the eyepiece. It converts the spotting scope to a long focal length camera lens that is also ideal for full format cameras. To attach the camera body (without lens) the corresponding T2 adapter for the different bayonet systems is required.
Combined with the Photo Adapter, the Victory DiaScope 85 T* FL turns into a 1:12/1,000 mm tele lens. Cameras with an APS sensor deliver image frames corresponding to a 1,500 to 1,600 mm 35 mm tele lens. The F-stop of 12 is calculated by dividing the focal length by the lens aperture (12 = approx. 1,000 mm / 85 mm) and cannot be changed. Modern, low-noise image sensors allow for the use of higher sensitivity values, practically eliminating the disadvantages of the aperture being relatively small.

In addition to this short introduction to the possibilities of digiscoping, we also recommend reading the more in-depth manual The Fascination of Digiscoping from Carl Zeiss Sports Optics GmbH. For more information, please go to www.zeiss.de/sportsoptics.

5.5 Practical advice

A spotting scope should always be used on a tripod with solid footing or at least placed on a stick or against a tree. Observation stations with wooden floors and observation decks are generally unsuitable. Other visitors and even the wind quickly cause these locations and therefore the equipment to vibrate. With the high magnification of a spotting scope and, primarily when digiscoping, the slightest vibration affects the results.

It is important to have a really stable tripod with a smoothly sliding video head that enables minimal adjustments without juddering and can be secured properly. Testing the different models is the only way to be sure.

Tripods are available in different materials: wood is relatively heavy and expensive but many users swear by the vibration-absorbent properties of wood. Aluminum offers a very good compromise between weight, stability and price and is therefore the most commonly used material. Innovative carbon models also provide good stability, but are somewhat more expensive.

In general, the center column should be extended in an emergency only, because it is most susceptible to vibrations. All three legs should be extended first.

Haze and heat shimmer limit observations at high magnification over long distances with even the best spotting scopes. The best conditions for perfect images are encountered in the morning when the air is cool and moisture is still seen as dew on the ground.

If possible, low magnification should be selected on the zoom eyepiece in low light. The lower the magnification the larger the exit pupil – the deciding factor for image brightness.

More information about the manual „Fascination Digiscoping“: www.zeiss.de/sportsoptics
6. About Night Vision Devices

6.1 Why a night vision device?

General
Night vision devices are used when even the most powerful conventional binoculars do not offer any real help. These electronic “residual light intensifiers” convert available (minimal) light into electronic energy, amplify it and turn it back into visible light. The light energy is enhanced more than 20,000x, enabling very good observation of game even under a new moon with only the light of the stars.

Forbidden in riflescopes
But these should be limited to observation. Targeting devices, e.g. riflescopes, with integrated residual light intensifiers are banned in many countries. It is important to remember that not only the use, but also the possession of such devices is punishable in Germany, for example.

Monocular or binocular
Many night vision devices are monocular, such as the ZEISS NV 5.6 x 62 T*. What at first seems to be a disadvantage is in fact a beneficial feature in practice: an eye adjusted for darkness is “blind” after using a night vision device and needs a few minutes to readjust to the dark. If you would look through a night vision device with both eyes, you would be completely “blind” in both eyes for a short time.

Practical advice
For observations with a night vision device, never use your shooting eye.

6.2 The function of the image tube with MCP

The conversion and intensification of the signal takes place in the image converter or image intensifier tube. The light available is projected onto a photo cathode causing electrons to be released by the incidental light energy. These particles charged electrically are accelerated using an electrical current and strike a micro-channel plate (MCP) which is simply a thin plate smaller than 2 cm in diameter containing millions of the tiniest channels. When the electrons pass through these oblique micro-channels, many new electrons are released in a cascade effect through collisions with the walls, which then strike the greenish phosphor screen behind the channels. This results in millions of the tiniest flashes of light that are perceived through a magnifier (eyepiece) as a green image.
6.3 Generations

**Generations 0 and 1**
Night vision devices are differentiated in generations corresponding to their technological level. The simplest instruments of generations 0 and 1 do not include an MCP. Electrons released are not multiplied but only strongly accelerated through high voltage. Compared to state-of-the-art devices with an MCP, they include lower resolution and image brightness, distortion, shading, and blurring on the edge of the image. Unintentional strong incidental light can result in “burn in” and irreparable damage.

**Generation 2**
Tubes from generation 2 are equipped with the sophisticated and expensive MCP which delivers image quality improved enormously; brightness and resolution. Edge definition and, above all, noise behavior are better and tube life was extended. No glow when these devices are turned off.

**Generation 3**
A new material for photo cathodes (gallium-arsenide crystal, GaAs) is the trademark of the 3rd generation and further enhances light yield. However, such systems from the USA are subject to strict trade limitations due to patent and export regulations.

**Current designations**
Thanks to enhanced materials and optimizations on the design, European manufacturers have also been able to achieve considerable improvements in image quality compared to the original Gen 2 models. These tubes are now designated as 2+, Super Gen, 2S or similar – a clear differentiation or definition for the designations is unfortunately unavailable.

The effective performance which is essentially determined by light yield, resolution, and noise behavior is no longer a generational question. Furthermore, the quality of the traditional optical components required as well plays a key role for practical use.

6.4 ZEISS NV 5.6 x 52 T*

With its 62 mm lens, 5.6x magnification, large field of view and one of the most powerful Gen 2+ tubes the ZEISS NV 5.6 x 62 T* provides an ideal foundation to see precise details at long range at night. It is therefore considered by many market participants to be the best device available to civilians.

This practical piece of equipment is also equipped with another feature – the manual brightness control. It allows the user to dim the automatic amplification (image brightness) for viewing comfort, without loss of detail.

If the light available is really too weak for an acceptable image (e.g. a new moon and cloudy sky in the woods) the integrated IR diode of the ZEISS NV 5.6 x 62 T* ensures a bright image of objects up to 30 m away. For longer distances, external flashlights with an IR filter which extend the range up to several hundred meters are mounted using an adapter.

**Manual brightness control**

**IR brightening**

ZEISS NV 5.6x52 T*.
7. Care of the Optics

Modern ZEISS binoculars, spotting scopes, and riflescopes are extremely robust and protected reliably against dust and moisture. This makes them very easy to care for; in particular, this applies to the glass surfaces on the ZEISS Victory products with their hard, water and dirt-repellant LotuTec® coating. Nonetheless, several points should be observed to ensure the performance over many years and decades.

Fingerprints
Modern (clean!) microfiber cloths are the best tool for cleaning the optics. Usually, fingerprints, for example, can be removed by breathing on the lens elements and wiping them with a light, circular motion. It is not recommended to use dry paper cleaning cloths and a fine powder as offered in many optical cleaning sets.

Dust
Dust can be removed with a lens brush or bellows which can be found at any photo store. Before cleaning with a cloth, dust, grains of sand, and other hard particles must be removed carefully.

Water spray
Dried rain drops and primarily salt spray leave deposits and rings. They must be removed by moistening or (with watertight binoculars) with water before a cleaning cloth can be used.

Oily contaminants
Oil or weapon grease on the lens elements should be removed as quickly as possible. The lens elements should be cleaned carefully to the edge using an eyeglass cleanser or an optical cleaning cloth and perhaps a little alcohol.

Contamination
For normal dirt, watertight binoculars, or a dismounted riflescope can be simply rinsed with lukewarm water.

T* multi-coated lenses can be cleaned with pure alcohol. Acetone, random cleanser, or benzene is generally not recommended. They can corrode and damage various materials and coatings.

Watertight, dry nitrogen-filled devices are not subject to mold build-up – at least on the inside. Mold can grow on the exterior lens elements if the device is stored in a moist, warm and dark environment for longer periods. Mold spores are practically everywhere and fingerprints (i.e. grease stains) provide an ideal breeding ground. In such cases or in the tropics, where high humidity is the rule of thumb it is recommended to store the devices in an airy, bright location. If they are warmed by the sun, any moisture on the surface vaporizes; without moisture there is no mold build-up.

Mold often marks its presence with a fine, branching structure on the surface of the lens elements. The problem is that metabolic byproducts damage the surface permanently so that a simple cleaning may remove the mold but not its traces.

Following a winter excursion in the snow, cold binoculars or a riflescope are best stored in a dry, cool room. In a warm room they would fog (exterior) immediately.
Key words

A
Abbe-König prisms 31, 44f
Acetone 133
Accommodation 132f
Adjusted for darkness 126
Adjustment range 50, 72, 79, 86, 99
Angled viewing 113
Anti-reflective coating 34
Assembly 43, 78, 91, 94, 100ff
Assembly rail 90, 100
ASV 39, 70, 80f, 83, 88, 90

B
Ballistic Information System 38, 61f, 65
Beam divergence 61
BIS® 38, 56, 61f, 65
Bullet drop 38, 61f, 65, 70, 79ff, 99, 104
Bullet Drop Compensator 39, 80, 86, 99

C
Camera adapter 121f
Centered reticles 78
Center tube diameter 72
Classic 74, 89, 95ff
Click adjustment 79
Coating 28, 30f, 57
Color fringes 35, 55
Compact-Point 93, 95
Conquest 49, 57, 60
Contact angle 33f

D
Depth of field 12, 23f
Dialyt 49, 58 117
Diarange 38, 88
DiaScope 42, 110f, 113, 116, 120, 122
Diatal 89
Diavari 74, 83, 86f, 89, 95ff
Di-electric mirror 45
Digiscoping 117, 120ff
Dispersion 35
Distortion 25, 128
Driven hunt 16, 87f, 91, 94f, 102, 107
Duralyt 74, 89f, 95ff
Dust 49, 91, 132

E
Elevation adjustment 70, 78
Entrance pupil 13
Exit pupil 12ff, 21, 28, 65, 94, 111, 123
Extendable spotting scope 112
Eyecups 21f, 51, 57
Eyeglasses 21, 50, 70, 102f
Eyepiece 14, 20f, 28, 42f, 48, 60, 70ff, 85, 102ff, 112f, 115f, 119ff, 127
Eye relief 21f, 71, 89, 91, 100ff

F
Field of view 12, 19ff, 37, 56ff, 61, 65, 67, 72, 78, 89, 94, 102f, 112, 118, 129
Fingerprints 33, 132f

G
Generation 58, 65, 128
Globe effect 25

H
Humidity 112, 133
Hydrophobic coating 33f

I
Illumination control 39, 88
Image plane 39, 70ff, 74f, 77, 82, 85ff, 94f
Image intensifier tube 127
Image stabilization 38, 59, 110
Image intensifier tube 127
Inverting system 42, 71f 74f, 77f
IR brightening 129

L
Laser rangefinding 38, 61, 65
Lens aperture 13, 17, 65, 94, 111, 122
Light transmission 38f, 74f, 87, 89f, 94, 104
Long range ZF 99
Long range reticle 39, 70, 82
LotuTec® coating 33f, 56, 89f, 118f, 132f

M
Magnification 11ff, 16, 19f, 23ff, 37, 52, 59f, 65, 67, 70f, 74f, 77, 82f, 85ff, 94ff, 103, 110ff, 118, 123, 129
MCP 127f
Mold 133
Monoculars 38, 59
Mounting 24

N
Night myopia 103
Night vision device 38, 126ff
Nitrogen-filling 49, 56

O
Oil 132

P
Parallax compensation 85f, 94, 99
P coating 44
Phase correction 44
PhotoScope 117ff
Porro prisms 31, 43, 47
PRF 38, 65
Prisms 13, 24, 30f, 42ff, 51

Q
Quick-Camera-Adapter 120
Key words

R
Rangefinder 65, 86
Rail assembly 101
RAPID-Z® 39, 70, 86, 89, 99
Reflex sight 91, 93ff
Residual light intensifiers 56, 126
Reticle 39, 70, 73ff, 77ff, 82, 85f, 94f, 99f, 103f
Reticle adjustment 78ff, 103
Ring assembly 100
Roof prisms 24, 47

S
Salt water 132
Schmidt-Pechan prisms 31, 44f
Sit-and-wait hunting 65, 88
Spotting scope 21, 37, 42, 48ff, 60, 110ff, 120f, 123, 132
Subjective field of view 20
Subtension 74f, 82

T
*T* coating 29, 32f, 89
T2 adapter 121
Tilting 107
Total reflection 31, 44f
Transmission 16, 28ff, 47, 53, 71, 111f
Tripod 115, 123
Tube diameter 72
Twilight factor 16f, 111

V
Vario eyepiece 42, 112, 116
Varipoint 39, 72, 74, 77, 87f, 95ff, 105

Z
Zeoing 78ff, 103f
Zeoing range 61f, 104
Zoom eyepiece 42, 112, 116, 123
Zoom range 16
Z-Point 91, 95

Source directory

Cover (Red deer)
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Page 8/9 (Rocks in the Forest)
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