

Magnification

The number of times larger than normal an object appears is the power, or magnification, of the binocular; usually from 6 to 10. Thus an object seen through a 7 power binocular appears to be seven times closer to the viewer than seen with the eyes alone. Magnification above 10 power is not common as the binocular becomes too big or the image quality begins to suffer. Spotting scopes are generally used for higher magnification. As magnification increases, brightness and clarity may diminish, depth of field may become shallower, and the field of view is commonly more restricted. Images of lower power binoculars are less affected by heat wave distortion and hand movement. Seven and eight power binoculars are adequate for most applications, and ten is used when maximum distance or greater detail is required. Variable power (zoom) binoculars allow great flexibility but suffer in image quality and brightness unless they are very expensive.

Focusing

The three types of focusing systems found on binoculars are center, fixed, and individual focusing. Center is the most common and convenient as it focuses both eyepieces simultaneously, and there is commonly a diopter adjustment on the right eyepiece to compensate for differences in eye strength. Fixed focus gives a focused image no matter what the distance, except that there is a minimum distance of usually 40 to 60 feet. It is sometimes called infinite or permanent focusing, and can be combined with center focusing such as on #241016 which uses a focus lock to switch to fixed focus with a minimum distance of 50 feet.

Individual focusing is like center focusing only each eyepiece is separately adjustable. This is a less convenient setup, but it can allow a binocular to be made simpler or more waterproof. It is found mostly on cheap binoculars or on more expensive marine and military models.

Field of View

This is the widest dimension of the circular viewing area seen through the binocular, normally expressed in feet at 1000 yards distance. Field of view tends to decrease with an increase in magnification, but it is more a function of the size and type of prisms and eyepiece lenses used. A wide field of view allows for excellent scanning and viewing of many subjects, but can result in a single subject getting lost in the surrounding image. A narrow field of view helps to isolate the subject better, but is not as good for scanning a large area as in marine use, and these models tend to have greater sharpness at the edge of the image and be lighter and more compact due to smaller optics.

Aperture

The second number in the binocular designation is the diameter in millimeters, or aperture, of the objective or front lens, normally anywhere from 20 to 50 mm. It determines the amount of light that enters the optical system, and to a certain extent affects the detail and clarity of the image produced. A larger aperture would theoretically produce a better image due to increased light transmission, however a binocular with superior optics and a smaller aperture can produce a better image than a binocular with a larger aperture.

A large aperture is more desirable under low light conditions such as at dusk or at dawn, but could produce too bright an image under extremely sunny conditions. A 35mm aperture is most commonly used for daytime viewing, and a 50 mm aperture is chosen when low light conditions may be encountered. Marine use also employs a 50mm aperture as described under EXIT PUPIL.

Exit Pupil

This is the magnified image in the eyepiece as it leaves the binocular, and it is expressed in millimeters. It is determined by dividing the aperture by the magnification. The main importance of the exit pupil is how it relates to the pupil size of your eye, which varies according to the surrounding light conditions. If the exit pupil is larger or smaller than the eye pupil then image resolution and contrast will suffer, so a binocular should be chosen which will provide an exit pupil that most closely approximates the eye pupil size under the conditions of use. Eye pupil size for daylight conditions varies from 2 to 4mm; at twilight or other low light situations such as cloudy days it varies from 4 to 6mm; and nighttime conditions result in maximum dilation of the pupil at 6 to 8mm. A special situation is when the binocular cannot be held steady such as on a boat. A large exit pupil would be desirable since it would be easier to keep the smaller eye pupil centered in the larger exit pupil and the eye would therefore not lose sight of the image. This is why marine binoculars are commonly 7x50 (exit pupil of 7) even though they are being used during the brightness of the day.

Relative Brightness & Light Efficiency

The light gathering ability of a binocular

increases by the square of the radius of the aperture, so a 50mm lens will let in twice the light of a 35mm lens. The relative brightness, or brightness index, is computed by squaring the exit pupil. A 7x50 has an exit pupil of 7.1 and a relative brightness of 51 (7.1 squared). A 7x35 has an exit pupil of 5 and a brightness of 25, half that of the 7x50. This would imply that the 7x50 binocular would have twice as bright an image as the 7x35, but this is rarely the case. Other factors such as optical quality and eye pupil size also affect the brightness, so this term has limited usefulness. A similar term which many manufacturers use is "relative light efficiency". It is normally determined by increasing the relative brightness number by 50% to account for the increased light transmittance due to glass coatings. There are no industry standards for these terms so they have little significance when comparing binoculars.

Eye Relief

The distance behind the eyepiece at which the entire field of view is visible is the eye relief. If it is very short, say 5 to 10mm, then an eyeglass wearer may not be able to see the whole field of view as the eye could not get close enough to the lens due to the glasses. Most binoculars will have an eye relief of 10 to 20mm, and will have fold down rubber eyecups to accommodate eyeglasses. In general a binocular with long eye relief will tend to have a shorter field of view, so sometimes a compromise must be made for one feature or the other.

Optical Quality & Design

Off-set barrel binoculars use a Porro Prism design, and most models employ this system to achieve low cost, image sharpness, and a wide

field of view. Roof Prism type binoculars have straight barrels and are generally more compact yet more expensive, and can often tolerate rough handling better due to their compact optical design. Most roof prism models have an internal type focusing mechanism which makes them less susceptible to internal fogging, and moisture and dust entry. Image clarity, color quality, brightness, and contrast can be improved by the use of higher quality prisms and glass. Higher quality, and more expensive, binoculars use Bak-4 high density glass to improve the image in place of the more common and less expensive Bk-7 glass. Better binoculars also have glass which is coated. Coatings improve light transmission and contrast, reduce glare, aid in image sharpness, and decrease light loss. More expensive binoculars will also have better collimation, or alignment of the optical system. The optics are secured better to protect against misalignment from vibration and shock, and will thus give a distortion free image. This makes for more comfortable viewing with no eyestrain.