Small Binocular Reports Three Families
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This is one in a series of "Small Binocular" reports that will detail and summarize all my findings from eight months of tests and measures on over 30 binoculars. Sizes ranged from 7x50, 8x32 and 8x40 up to 8x42 and 10x42 roofs, 10x50, 10x60 and 12x50s. These are all sizes that could be hand-held and used for either terrestrial use or astronomy.

Sprinkled throughout all the other Binocular Reports are one or several benchmark models that give a good indication what all the others should hope to achieve. Throughout all those other reports, while I do give all the table data for the benchmarks and I do provide summary comments for the benchmarks, I do not review any of them in the detail of the report. Well, this one here was going to be the report on the 12x50s, except that I have only ONE 12x50 other than my benchmark Nikon SE 12x50. So here in this report, rather than review just the single 12x50, I have gathered all the leading benchmark binoculars together in their respective families. Also since this review was supposed to be the 12x50s, and the Nikon AE 12x50 would be the main subject, along with all the other benchmarks, I've gathered the rest of the Nikon AE family. So, now I will review those **three families of binoculars, the Nikon SEs, the Fujinon FMT-SXs and the Nikon Action Extremes.**

Once again, be sure to refer to the other reports, especially the Small Binocular Score, the report showing the summary scores for 16 different measured aspects for all 34 binoculars.

Nikon SE 8x32, Nikon SE 10x42, Nikon SE 12x50

Binocular Basics Small Binoculars	actu Mag	Net Aper	actu FOV	use ER	range IPD	oz wgt	gm wgt	spec coat	prism coat	$$$ cost
Nikon SE 12x50	**12**	**50**	**5.0**	**17**	**53-73**	**32**	**908**	**fmc**	**fmc**	**900**
Nikon SE 10x42	**10.2**	**42**	**6.2**	**17**	**53-74**	**24**	**681**	**fmc**	**fmc**	**900**
Nikon SE 8x32	**8**	**32**	**7.6**	**14**	**53-73**	**22**	**624**	**fmc**	**fmc**	**550**
Fujinon FMT-SX 10x70	**10**	**69**	**5.0**	**17**	**56-78**	**78**	**2213**	**ebc**	**ebc**	**679**
Fujinon FMT-SX 10x50	**10.4**	**50**	**6.7**	**13**	**57-76**	**49**	**1390**	**ebc**	**ebc**	**659**
Nikon Action Ex 12x50	12.2	49	5.1	13	56-73	36	1022	mc	MgF	158
Nikon Action Ex 10x50	10.2	48	6.1	13	56-73	36	1022	mc	MgF	**148**
Nikon Action Ex 8x40	7.9	39	8.1	14	56-73	30	851	mc	MgF	124

Values are measured actual magnification x effective aperture, True field of view, usable eye relief, interpupilary range, weight, lens coat/prism coat and retail purchase price.

Nikon Action Extreme 8x40, Nikon AE 10x50, Nikon AE 12x50

The Nikon AE8x40, shown here with both the AE10x50 and AE12x50, all have exactly the same prism housing and eyepiece assembly, except perhaps for eyepiece focal length. The major difference is it has smaller objective cones. This is similar with almost all families of binoculars and can be seen also with the Garrett Classics and the Oberwerk Mariners.

More Basics

The Fujinon are the heavy-weights here. The 10x70 weighs almost 5# (2.2 kilo) and the 10x50 weighs 3# (1400g.). The Nikon SEs are the real light-weights, with the 12x50SE at 32oz. (900g.), the 10x42SE, similar to a light roof prism at 24oz. (680g.), and the little 8x32SE at a very light 22oz. (620g.). The Nikon AEs are about average for their respective sizes. Both the 12x50AE and 10x50AE weigh 36oz (1020g.), and the 8x40AE is 30oz(850g.).

The Fujinon BFL weighs only 24 oz. (680gm.) and is like a little baby binocular in comparison to the monster sized FMT-SX series. Even the 49oz. (1400gm) Fujinon FMT-SX 10x50, which is much smaller than the FMT-SX 10x70, still has considerably more heft than this little 8x42. The 8x42 is not really a member of the FMT-SX family, so is not included here. It is reviewed elsewhere.

Fujinon BFL 8x42, Fujinon FMT-SX 10x50, Fujinon FMT-SX 10x70

I like the one-piece style cover that fits snuggly over both eyepieces. Nikon AEs all have this. I don't like objective push-in caps. The Nikon AEs have push-in caps. All the others here have slip-over caps.

None of the SEs can be used with a standard screw L bracket. Nikon makes a very nice sturdy bracket that captures the center bar of the SEs and holds them steady with the utmost security. All the others can be used with any L bracket or the FarSight Binocular Mounting bracket. The FarSight bracket stays mounted to the tripod while a nut assembly screws into each binocular (I have two nuts). The binoculars then attach via the nut. This allows interchanging

binoculars fairly easily without moving the tripod. Perhaps not as practical for the person intending to stand outside with just one binocular all night, this bracket assembly was absolutely indispensable to me for testing 6-12 binoculars in a night on dozens of occasions.

Pentax PCF WP 10x50, Nikon AE 10x50, Nikon AE12x50
Notice the AE 10x50 and AE 12x50 are exactly the same size

Both the 12x50 AE and 10x50 AE are very similar in size to most 10x50 binoculars. The Nikon SE12x50 is nearly identical to two these AEs, but it fits the hand better. The SE10x42 is very compact, more on the order of a compact 8x42 like the Fujinon BFL 8x42. The Nikon SE 8x32 is downright small, in fact just a bit too small for me. As stated earlier, the Fujinon, especially the 10x70 are monster sized compared to all these others. The 10x50 Fujinon is no taller than the Nikon AE 10x50, but the Fujinon prism housings are very much larger.

The Fujinon and the Nikon SEs all have folding rubber eyecups. Nikon Action Extremes have a hard rubber twist out rubber eyecups with three positive positions click stops with no slip. These have a wide range of adjustability to fit all needs. There is 13mm of usable eyerelief with the eyeguard turned in. Each click out adds 3mm extension. I almost always use them with the eyecups turned out 1 click, even though I wear glasses.

I like these twist out ratcheted eyecups on the Nikon EX

The Fujinon are highly rated waterproof binoculars. The Nikon AEs are rated waterproof. The Nikon SEs are NOT waterproof. For the astronomer, waterproof means you don't need to worry so much about water vapor infiltration fogging up the inside of the lens. For the terrestrial user, who might be on or near a body of water, or out in the rain, waterproof is always a good consideration and may be the deciding factor in a choice.

The Fujinon 10x70, Nikon AE12x50 and Nikon AE8x40 have very little pincushion. Nikon AE10x50s and Nikon SE 12x50 and Nikon SE 10x42 have mild pincushion. The Nikon SE 8x32 and the Fujinon 10x50 have the most. Keep in mind pincushion has absolutely no affect on astronomical observing. However, it does have considerable affect for terrestrial users, and some of these may be considered good size cross-over binoculars. A small amount of pincushion is desirable as it helps eliminate the rolling ball effect for terrestrial use. Pincushion is a meaningful criterion that affects terrestrial users differently than astro users.

None of my Nikon SEs or Fujinon FMT-SX have ever been out of collimation or needed any adjustments. Of these, in 3-4 years I've adjusted only the Nikon AE 10x50.

Eye Relief – Diopter - IPD
The specified eye relief on all of these is quite substantial, between 17-23mm.

Usable Eye relief on the 12x50 and 10x42 Nikon SEs and the 10x70 Fujinon is quite long. All the others have sufficient eye relief for use with eyeglasses. Those with 13mm eye relief are just about at the minimum for use with eyeglasses.

Eye Relief	spec	dist	rcss	usable	usable	
Small Binoculars	ER	exit	lens	ER	w/cup	IPD
Nikon SE 12x50	**17**	**20**	**3**	**17**	**6**	**53-73**
Nikon SE 10x42	**17**	**20**	**3**	**17**	**7**	**53-74**
Nikon SE 8x32	**17**	**19**	**5**	**14**	**5**	**53-73**
Fujinon FMT-SX 10x70	**23**	**27**	**10**	**17**	**9**	**56-78**
Fujinon FMT-SX 10x50	**20**	**21**	**8**	**13**	**6**	**57-76**
Nikon Action Extreme 12x50	16	18	5	13	3	56-73
Nikon Action Ex 10x50	17	18	5	13	3	56-73
Nikon Action Extreme 8x40	17	18	4	14	4	56-73

With the curvature of my eyeglass lenses, at least 3mm depth is needed below the eyeguard to keep eyeglass lenses from hitting and scratching the binocular eye lens, or just as bad, scratching my eyeglass lenses. All of these have at least 3mm depth to lens, and the Nikon SEs have the rubber eyeguard completely cover the eyepiece metal ring to prevent the metal from touching my eyeglasses.

Notice the Nikon 12x50SE, the 10x42SE and the Fujinon 10x70 have 6mm, 7mm and 9mm distance behind the fully extended eyecup to reach the exit pupil point. This can mean some difficulty in finding and holding the correct eyepoint, since the binocular and eyeguard is generally completely held away from the face.

The eye lens on both Fujinon is 27mm in diameter, the largest size eyelens I have seen. Nearly 2/3rds of all binoculars in these tests have a 20-23mm diameter eyelens, with almost all of those at 21-22mm. All six Nikons here fall into the 21-22mm group.

The Nikon SEs have a rotating eyepiece style right diopter. It's smooth and stable. The Nikon AE has an easy to use slide bar under the right eyecup. The Fujinon are individual eye focus, so each eyepiece has individual diopter adjustment and the range is +/- 7 diopter.

All of these have quite substantial IPD range, ranging from 53-73mm for the Nikon SEs to 56-78mm for the Fujinon 10x70. The Nikon AEs all go from 56-73mm. While 58mm is close enough for most people, some adults will need 57mm and many children with close-set eyes need even less to see with both eyes. For those few people wide very wide-set eyes, the maximum ranges here are the 10x42SE at 74mm, the 10x50FMT-SX at 76mm and the 10x70FMT-SX at 78mm.

Close Focus

The Nikon SEs have the closest focus ability, from 20ft to 9ft. The Fujinon are not close focus and would not be considered fast focus. All of these binoculars would be considered slow focus in the range of 3m to 30m. (10ft-100ft). Using 20 ft as the focus point, those that can focus to 20ft have between 75%-83% of the fov overlapped for binocular vision.

Close Focus	****	close	dial	dial
Small Binoculars	focus	focus	3-30	30-100
Nikon SE 12x50	**CF**	**20**	**270**	**120**
Nikon SE 10x42	**CF**	**13**	**300**	**60**
Nikon SE 8x32	**CF**	**9**	**300**	**90**
Fujinon FMT-SX 10x70	**IF**	**50**	**na**	**120**
Fujinon FMT-SX 10x50	**IF**	**50**	**na**	**120**
Nikon Action Extreme 12x50	CF	23	270	60
Nikon Action Ex 10x50	CF	20	200	100
Nikon Action Extreme 8x40	CF	13	330	30

The Nikon SE10x42 and SE8x32, when close focused to 10ft have only 8" and 10" respectively in "binocular vision" field of view. At a distance of 10 feet the Nikon AE can see 50cm with almost 40cm of that field overlapped, so at 10 feet, for binocular vision they see 16 inches out of 20 inches.

In these same binoculars, when viewing at 100 feet (30m) the barrel overlap is off by less than 5% of the fov and you get a 10 foot wide view with most. The Nikon SE8x32 can see 13ft and the Nikon AE8x40 can see 14ft wide at 100ft.

Slow or Fast Focus

As I've done with all the binoculars in the Small Binocular studies, I've attempted to class them as slow or fast focus. But what I found was, fast or slow is not necessarily consistent across all distance ranges. So, I measured the dial degrees turn needed to go from 3 meters to 30 meters (10feet to 100feet) and then measured the degrees turn to go from 30m to 100m (100ft to 300ft). For instance both the Bushnell and the Regal roof take only 30° of focus dial turn to focus from 30M to 100M. Typical fast focus binoculars have a total dial turn 20° to 60° for the 30M-100M range. However, for the range from 3m to 30m, the Bushnell can cover that distance with only 180° of focus dial turn, while the Regal needs 300° of turn. The Regal would not be considered fast focus in the short range.

Most of these binoculars, in the close range from 30m to 3m (100ft to 10ft), take about 300° of dial turn to focus. Based on the 34 binoculars in my test group, this is very SLOW focus for this close 3m-30m range. The fast focus binoculars in my test group cover this same distance range with anywhere from 100° to 180° of focus dial turn. The Nikon AE10x50 takes 200° to focus from 3m to 30m, so it's almost fast focus. Only ONE binocular, out of all 34 measured, was slower focus than 300° in this range, the Nikon AE8x40.

Typical fast focus binoculars have a total dial turn 20° to 60° for the 30m -100m range.
Half of all 34 binoculars measured fall into the fast focus range, although none are 10x50s or larger except for the Nikon AE12x50. So for 30m-100m, the Nikon AE8x40 is the fastest focus needing on 30° of dial turn. Besides that only the Nikon AE12x50 and the Nikon SE10x42 are fast focus with 60° of turn. All the others are slow focus.

Generally most of these binoculars would be considered slow focus instruments.

FOV and Field Sharpness

The actual field of view you see thru binoculars is almost always somewhat less than the specified FOV. The specified value is based on the eye lens, but that generally has a small amount of distortion, sometimes purposely built-in. The actual true field in degrees that you see will always be based on the field stop diameter without distortion. The actual field stops cannot be measured unless we take the binoculars apart. But we can measure the actual true field of view by observations. Listed below are the actual fov for all these binoculars.

While I consider 1 arcminute of distortion in a 10x binocular (for 10x= 600arc") as the sharp limit, I consider 2 arcminutes in a 10x binocular (for 10x =1200 arc") the limit of useful field of view in a binocular. 600 arcseconds apparent in a 10x binocular is seen when viewing a 60 arcsecond pair of stars. A 12x binocular must be able to observe a 50" pair to achieve the same results. 8x binoculars need only see a 75" pair to achieve the same result.

By the point of 600arcseconds apparent distortion, you have lost a nearly a full magnitude from view. 1200 arc" of apparent total distortion in your image no longer provides useful information. Stars or pairs of stars are either distorted blobs or long streaks. The image has lost perhaps close to two full magnitudes of faint stars out at 1200arc" of distortion. You won't gain any other information beyond 600arc", but at least if stars are bright enough you can tell there is something out there. What's there would not be apparent.

The true field of view and the fov sharpness of the Nikon SEs and the Fujinon FMT-SXs is simply impressive. Three of the five actually have a true fov that is slightly larger than specified. The other two have a true field that measures as specified. Most of the other 34 binoculars in this entire study are a few tenths to as much as a half degree smaller than specified. All of these best binoculars have 85% or more of the field of view that is capable of resolving 60o arc". Four of the five literally have 100% of the fov usable.

Field of View degrees Small Binoculars	spec FOV	actu FOV	calc Afov	sharp% 600arc"	sharp% 1200arc"	sharp fov	limit fov
Nikon SE 12x50	**5.0**	**5.0**	**60**	**95**	**100**	**4.8**	**5.0**
Nikon SE 10x42	**6.0**	**6.2**	**63**	**85**	**100**	**5.3**	**6.2**
Nikon SE 8x32	**7.5**	**7.6**	**61**	**95**	**95**	**7.2**	**7.2**
Fujinon FMT-SX 10x70	**5.0**	**5.0**	**50**	**85**	**100**	**4.3**	**5.0**
Fujinon FMT-SX 10x50	**6.5**	**6.7**	**70**	**95**	**100**	**6.4**	**6.7**
Nikon Action Extreme 12x50	5.5	5.1	**62**	**75**	**90**	3.8	4.6
Nikon Action Ex 10x50	6.5	6.1	**62**	**65**	**80**	4.0	4.9
Nikon Action Extreme 8x40	8.3	8.1	**64**	**60**	**65**	4.9	5.3

There are few other binoculars in these tests that even come close (none are equal) to the field of view sharpness marks of any of the Nikon SEs or the Fujinon. None of the Nikon AEs fall in the second best group. The closest second best group are the Leupold WR Mesa10x50, Celestron Regal 8x42 Roof, Fujinon BFL 8x42, Oberwerk Mariner 7x50, Captain's Helmsman 7x50 and William Optic 7x50 ED.

Nikon SE 12x50 has only 40 arcsec total aberration at 90% out.
Nikon Action EX 12x50 has 45 arcsec total aberration already at 70% out.
Nikon Action EX 10x50 has 60 arcsec total aberration at 70% out.
Nikon Action EX 8x40 has 60 arcsec total aberration already at 50% out.

One design feature we often see that contributes to a high level of outer field sharpness is the use of very narrow Afov eyepieces. Only the Fujinon 10x70 have narrow 50° eyepieces. It's a bit of a surprise, but they do not have the sharpest fov. All the rest of these have wide-field eyepieces, in which it is generally more difficult to control outer field aberrations. The three Nikon SEs and the Fujinon 10x50 do a superb job of controlling aberration and creating a sharp to the edge fov.

The Nikon AEs show typical performance for a widefield eyepiece. Sharpness falls off quicker and gets poor before we reach the outer edge of the fov. The Nikon AE 8x40 deteriorate rapidly and have only 65% of the fov usable, but since they start out with a very wide Tfov, that still results in more than 5° usable fov, not bad, but nowhere near the usable fov of the 8x32SE, 10x42SE or 10x50Fujinon.

Curvature and Depth of Field

The Nikon Action Extreme has by far the most field curvature. The Nikon AE12x50, Nikon AE10x50 and Nikon SE10x42 have almost the same degree of curvature, all three only about 1/3rd that of the AE8x40. Both Fujinon and the Nikon SE12x50 have remarkably little field curvature.

Binoculars with more field curvature have greater apparent depth of field in front of the focus point. It would seem therefore that a field flattener lens, which would be desirable for an astro viewer to get as flat a field as possible, might work against a terrestrial viewer looking for the greatest depth of field. The Fujinon 10x70 has extremely shallow depth of field.

An astronomer would prefer all binoculars to have as little field curvature as possible so the entire plane of the fov has as little distortion as possible. The Fujinon and the 12x50SE certainly provide that, the Nikon SE10x42 and the Nikon AE12x50 to a lesser extent. .

It is not unusual to find that a binocular with much less sharpness out at 60% or 70% in the fov has a much greater amount of field curvature than a binocular which appears sharp out to 80-90% of the fov. A terrestrial viewer might want to consider how field curvature affects the view, and may in fact find field curvature to be a useful aberration. While it does nothing to add to depth of field further distant than the plane of focus, field curvature provides for closer objects to appear in focus as they range out across the fov.

Depth of Field examples:
The Nikon SE 12x50 has little field curvature
15 arcsec at 70% out and approx 30 arcsec curvature at 90% out
when focused at 50m,
40m appears sharper at 70% out
30m target is barely focused at 90% out
25m target cannot be focused at all.

The Nikon AE 12x50 which has twice as much or more curvature
40 arcsec at 70% out, approx 60 arcsec curvature at 90% out,
when focused at 50m,
40m appears sharpest at 40% out
30m appears sharpest at 60% out,
25m is clear and focused at about 80% out.
15m is fairly clear at about 90-95% out.

The Nikon AE12x50 has greater curvature and greater near depth of field than the SE12x50.

The Nikon Action Extreme 8x40 has field curvature of
50 arcsec at 60% out, 120 arcsec at 70% out, 150 arcsec at 90% out.
When focused at 50m,
objects at 40m appear sharpest at 30% out in the field
objects at 30m appear sharpest at 50% out in the filed
objects at 15m are seen clearly at 70% out in the field
objects even slightly closer at 12m are seen clearly focused out at 90% in the field.

The Nikon Action Extreme 8x40, decried in some circles for its outer field aberrations, has one of the strongest measures of field curvature of all the 8s measured. The effect is has on depth of field is dramatic. When the binocular is focused on an object 200 yds distant, the fissures and nodules in tree bark on trees at 60 yds can be studied in detail if positioned at 50-60% out in the field of view. Water droplets hanging from a tree limb at 30yds are seen very clearly in focus at 80-90% out in the fov. When the same experiment is conducted with the Fujinon BFL, no detail can be seen in the tree bark at 60 yds from any position in the field of view and the branches with water droplets at 30yds are a blurry mess.

The Nikon SE8x32 has the least, almost immeasurable, field curvature. The only other binocular in this study that comes close to the lack of field curvature in the SE8x32 is the Celestron Regal 8x42 roof. However the Nikon SE8x32 is an anomaly in the data. Unlike most all of the others here with a lack of curvature, the Nikon SE8x32 has a wide depth of field in front of the focus point. However, the Nikon SE8x32 depth of field is less than the AE8x40 example above. When the SE8x32 is focused at 200yd, the tree at 60yds appears fair. The close limb at 30yds is not focused, but is not a mess either.

From these tests it seems that one the strongest influences on apparent depth of field in almost all binoculars is the amount of field curvature in the lens. Field Curvature, an aberration frowned on by astronomers, can be one of the greatest assets to a terrestrial viewer. Therefore, if it is maximum depth of field that is a big influence in your criteria, then the Fujinon or the Nikon SE12x50 may not be the best choice for your terrestrial viewing.

Aperture

With a few noted minor exceptions, all of these binoculars come very close to the specified aperture. None of these has any significant losses of the light due to exposed prism edges or prisms interfering in the light path. None of these have too tight baffles cutting into the light cone. The Nikon AE10x50 prism shelf aperture stops the main aperture down to 48mm. The 8x40mm Nikon AE is stopped down to 38mm by a too small prism aperture.

You can see from the results in the data table, the three different tests for aperture don't all give the same results. Measuring exit pupil is difficult. In addition, even though my dial caliper can give readings to increments of 2/100ths mm, I round my readings up or down to the nearest $1/10^{th}$ mm, so that could easily account for a small difference in the three types of readings. Measuring the aperture with a loupe is direct, but there is some difficulty in obtaining readings that are any more accurate than to 1 mm, especially if the stop is a baffle in front of the prism,

in which case great care must be taken to insure the proper reading is obtained. So more potential slight variance now exists. The laser is probably the most accurate indicator, but once again, sliding the laser across a glass plate to each position at the indicated edge of clear aperture and recording fine measurements of that diameter is probably no more accurate than 1 mm. So, you can see, it's easy to have differences in the readings from these methods. However, none of the individual methods should be off by more than 1 mm, and certainly none of the methods, nor is the end result off by several mm.

It was essential to measure magnification in order to properly test and use exit pupil for determination of aperture. If measured exit pupil times specified magnification produced a resultant aperture that did not come close to specified, then that binocular was selected to have magnification measured. You can see in the table some magnifications are reported as integer values. Those have not been measured.

Effective Aperture	spec	spec	spec	actu	actu	Aper	Aper	Aper	Aper	chord	Net	Net
Small Binoculars	Mag	Aper	pupil	Mag	pupil	pupil	loupe	laser	avg3	%loss	Aper	Aper
Nikon SE 12x50	**12**	**50**	**4.2**	**12**	**4.2**	**50**	**49**	**50**	**50**	**0%**	**50**	**-1%**
Nikon SE 10x42	**10**	**42**	**4.2**	**10.2**	**4.2**	**43**	**42**	**42**	**42**	**0%**	**42**	**1%**
Nikon SE 8x32	**8**	**32**	**4.0**	**8**	**4.0**	**32**	**32**	**33**	**32**	**0%**	**32**	**1%**
Fujinon FMT-SX 10x70	**10**	**70**	**7.0**	**10**	**6.9**	**69**	**70**	**69**	**69**	**1%**	**69**	**-2%**
Fujinon FMT-SX 10x50	**10**	**50**	**5.0**	**10.4**	**4.9**	**51**	**49**	**50**	**50**	**0%**	**50**	**0%**
Nikon Action Ex 12x50	12	50	4.2	12.2	4.0	49	49	51	50	0%	49	-1%
Nikon Action Ex 10x50	10	50	5.0	10.2	4.7	48	48	48	48	0%	48	-4%
Nikon Action Ex 8x40	8	40	5.0	7.9	4.8	38	39	40	39	0%	39	-3%

Baffles and Blackening

The Nikon SE binoculars are exceptionally well baffled and blackened. All internal metal is very dull gray. There is no bright metal between the objectives and the prisms. The objective cone has a stepped baffle that is near perfectly sized to the light cone between the objective and the prism aperture. The inner section of the objective cone wall is fine ribbed to prevent reflections on the inside of the wall.

The Fujinon FMT-SX binoculars are very well baffled and blackened. All internal metal is very dark. There is no bright metal between the objectives and the prisms. The entire inner wall of the objective cone is fine ribbed to prevent reflections on the inside of the wall. The objective cone becomes the baffle, however it is not as closely matched to the light cone diameter as the Nikon SEs.

The Nikon AE10x50and AE12x50 baffles are very slightly undersized.

The Nikon Action Ex8x40 baffle is considerably undersized. The light cone edge from the objective too the prism aperture should pass very close to the edge of the baffle. The baffle

edge is well outside the diameter of the light cone. The inside of the objective barrel is well blackened, however all the metal around the prism is bright gray.

Coatings

Fujinon SX (electron beam coating) and Nikon SE coating technology is some of the finest available on the market today. All the Nikon SEs and Fujinon SX binocular have so little reflection from the coatings you have to look hard to see yourself in the objective lens. Coatings should not reflect light. Coatings that reflect more light have less light passing thru the lens.

The Nikon 12x50SE reflects somewhat less light off the objective lens than the Fujinon 10x70 FMT-SX. It's hard to see any reflected light coming off the Nikon 12x50 SE. It's very difficult to see the entire outline of my head. No facial light, no features visible, just a faint dark outline of my head. It's still difficult to see any detail in the 10x70, but the Fujinon 10x50 seems to reflect even less and appears closer to the Nikon SEs.

The Nikon AE lenses are multi-coated, however they are quite reflective. Not only is it easy to see yourself reflected in the objective lens, but you can pick out details in your face and see color in the reflected image. Also, the prisms appear to be only single coated, preventing that one from being labeled FMC.

Limiting Magnitude

With a variety of observations from different nights, I compiled a list of the best Limiting Magnitude for each. All these range under mag 5.2-5.4 skies.
Nikon SE 12x50 reached a limit of mag 10.8
Nikon SE 10x42 reached a limit of mag 9.8
Nikon SE 8x32 reached a limit of mag 9.1
Fujinon 10x70 reached a limit of mag 10.4
Fujinon 10x50 reached a limit of mag 10.3
Nikon AE 12x50 reached a limit of mag 10.5
Nikon AE 10x50 reached a limit of mag 10.0
Nikon AE 8x40 reached a limit of mag 9.6

Fujinon FMT-SX 10x70 under mag 6.0 skies reached mag 10.85
Tests I've done show under a mag 4.5 sky the 10x70 and a typical 10x50 reach nearly the same limiting magnitude. However, under a mag 5.4-5.5 sky the Fujinon 10x70 reaches slightly fainter magnitude than the Fujinon 10x50. Under mag 5.8 skies the 10x70 reaches deeper than I've ever seen with any 10x50, and just as deep as the best 12050SE. The LM gain due to aperture is a lot more significant as sky gets darker.

Typically, better 8x binoculars see about ½ magnitude less than a good 10x50.

On some previous occasions, prior to these tests, I've had some of these binoculars out many times. I had reached as deep as magnitude 10.2 with the Nikon AE10x50, Orion Ultraview and

Garrett Genesis. With the Oberwerk Mariner10x60 I reached mag 10.1 and with Pentax PCF WP 10x50 the highest readings of mag 10.2 and 10.4. However, all those observations were under mag 5.4-5.6 skies. Most of the observations of record in this report are at lower quality skies ranging from mag 4.8 to 5.4, although one night did get to mag 5.5. But, I just didn't have every binocular out on every night, so there is a wide variation in the comparative results for limiting magnitude.

Prism Vignette and Illumination

Light transmission is dependant on more than just good coatings. Excellent coatings and poor internal beam transfer can result in poor output. On the other hand, excellent beam transfer and illumination, even with less than premium coatings may result in a binocular that appears brighter and sees fainter objects.

These binoculars show some of the least vignette measured in the study. Even the Nikon AEs did extremely well in this respect, with some of the highest readings recorded. There is almost no beam tilt in the path in any of these binoculars. The beam transfer covers a good wide area of the objective lens, with 100% beam transfer from as wide an area as 20% to 35% of the central diameter of the objective lens.

A notable exception here is the Fujinon 10x50, which has an exceptional 40% of the central diameter of the lens capable of transferring a full 5° wide angular projection beam completely to the exit pupil.

Normal function shows the entire 5° wide circle and crosshairs laser target pattern will pass thru when the test beam is placed perpendicular to the optical axis and anywhere within the central 20-30% of the objective lens. The Fujinon BFL 8x42 set the highest standard for superior function by transmitting the entire beam pattern from every point in the central 50% diameter of the objective lens.

Light Transfer Small Binoculars	tilt left	tilt right	100% beam	75% beam	Exit Pupil	MAX Lux	LM best 5.2-5.4
Nikon SE 12x50	**0**	**0**	**20**	**55**	**4.2**	**670**	**10.8**
Nikon SE 10x42	**0**	**0**	**20**	**50**	**4.2**	**618**	**9.8**
Nikon SE 8x32	**2**	**2**	**25**	**60**	**4.0**	**603**	**9.1**
Fujinon FMT-SX 10x70	**3**	**3**	**25**	**60**	**6.9**		**10.4**
Fujinon FMT-SX 10x50	**0**	**3**	**40**	**70**	**4.9**	**992**	**10.3**
Nikon Action Extreme 12x50	2	1	35	65	4.0	702	10.5
Nikon Action Ex 10x50	7	10	30	65	4.7	845	10.0
Nikon Action Extreme 8x40	5	5	30	60	4.8	880	9.6

The Nikon AEs appear to have high marks for illumination of the exit pupil. However, generally, as seen from the data in the entire list of 34 binoculars, max lux appears to trend higher for a larger exit pupil. Therefore the larger exit pupils should have higher readings.

Also, I would say from the long list of data, a difference from 700 to 670 for two 12x50s may not be a significant difference. However, the Fujinon 10x50 reading of 990 was one of the highest of all readings.

Resolution

The Nikon Action 8x40 and the Nikon SE 10x42 share the best normal power resolution. It is important to compare apparent resolution here, since there is such a wide variety of magnifications. If all else were equal, (even sometimes when it's not), the binocular with higher power will get a lower reading for resolution. Multiplying the binocular power times the reading balances out all the binoculars so they can be compared to each other. The Nikon AE 10x50 has the lowest reading here for normal power resolution, but even at that, it's a good reading. So essentially none of these did poorly in normal power resolution.

Resolution on stars will not be this good. Typically, from previous studies, I have found that 80-90 arcseconds apparent resolution using a line pairs test target in daylight translates to 140-150 arcseconds apparent resolution on star pairs.

Boosting the resolution test power by 6x normal, the Fujinon 10x70 and Nikon SE12x50 share the best readings. Readings near 220 or better are all among the best recorded. Take note that the 12x50s in these tests were able to see line pair resolution of 2.6 and 2.7 arcseconds and the 10x70 was able to see 3.0 arcseconds. Quite impressive! The Nikon AE10x50 reading of 3.2 arcsec is no less impressive.

From observing logbooks, I found I had specifically noted these focus to very fine pinpoint; Nikon 12x50 SE (nothing beats it); Nikon Action Extreme 12x50, Fujinon FMT-SX 10x70. Those old notes seem to correlate very well with these new line pair readings.

Resolution USAF chart	actu	USAF	apprnt	boost	USAF	apprnt	USAF	
Small Binoculars	Mag	res	res	Mag	x6.15	res	res hheld	
Nikon SE 12x50	**12**	**7.2**	**87**	**74**	**2.6**	**189**	**10.8**	**130**
Nikon SE 10x42	**10.2**	**8.1**	**83**	**63**	**3.6**	**227**	**11.5**	**117**
Nikon SE 8x32	**8**	**10.8**	**87**	**49**	**5.7**	**282**	**15.4**	**123**
Fujinon FMT-SX 10x70	**10**	**8.6**	**86**	**62**	**3.0**	**185**	**13.6**	**136**
Fujinon FMT-SX 10x50	**10.4**	**8.1**	**85**	**64**	**3.8**	**246**	**12.9**	**134**
Nikon Action Extreme 12x50	12.2	7.2	**88**	75	2.7	**203**	10.8	**132**
Nikon Action Ex 10x50	10.2	9.1	**93**	63	3.2	**202**	12.9	**131**
Nikon Action Extreme 8x40	7.9	10.3	**81**	49	5.4	**262**	15.3	**121**

The most populated range for hand held resolution is fairly narrow at about 120 to 130 arcseconds. The large majority of binoculars fell into this range. The Nikon SE10x42 stands out with a handheld resolution of 117 arcseconds. Only one other (none here) 10x binocular made it into the top ten handheld resolution.

An interesting difference showed up when I attempted handheld resolution. Even though the Celestron Regal (both) have some of the finest resolution measures are some of the most compact light binoculars, I could not hold the Regal steady enough to get a better reading than the 10x42SE. The Regal ended up in the middle of the pack for handheld resolution, but the Nikon 10x42 SE was able to see approx 20% finer resolution than either Regal. The Nikon SE came out very near the top rank. In fact, the Bushnell Legend is the only roof among the top group for handheld resolution, all the rest are porros smaller than 10x.

Chromatic Aberration

A few notes on false color; the only astronomy notes on false color are associated with observing the moon. For astro viewing, I noted very mild false color in all, forced at the edges. Very little or none on axis. In daylight Fujinon 10x70 shows yellow green band at edge when looking at tree branches against bright skylight background. The Fujinon 10x50 shows very slight purple. All the Nikons show a minor green if forced off-axis. None of them show color on-axis. None of them were obtrusive.

When all these are pointed 100yds towards a white post in bright sunlight, all show some color if the post is placed far towards the edge of field. The Fujinon 10x50 shows minor blue fringe out towards the edge. The 10x70 shows strong blue, about 3 or 4 times more than any other, maybe at 80% out. The three Nikons show green/purple, but all only in the outer fov. The Nikon AE 12x50 and 10x50, showed little to no color until out about 80%, then I could see a reddish orange. The Nikon AE8x40 was the only binocular that showed color anywhere in the central field. Easily seen at the sunlit edge of the white porch post, reddish/orange started to show by 40% out and at 80% out it was near purple. None had as thick a band of color as the Fujinon 10x70.

Observing

M1 M78 observations

A few extended object comparisons are included here to give some indication of the ability of these instruments to deliver on low contrast objects.

M78 under mag 4.9-5.0 skies
Fujinon 10x50, M78 was immediately visible. Central stars are not seen.
Nikon Action 10x50, not easy but was seen OK.
Celestron Regal 8x42 roof, it was just barely seen
Could not find it in any binocular handheld.
Saw in Fujinon handheld braced.

M78 under mag 5.0-5.2 skies
Once I pinpointed its location, I could just barely detect it in 10x50s.
Orion Ultraview 10x50, barely seen
Pentax PCF WP 10x50, barely seen
Nikon AE 10x50, barely seen

In a Nikon SE 10x42, M78 was easy.
Celestron Regal Roof 10x42 it was not easy but was seen OK.

M78 under mag 5.2-5.4 skies
Leupold WR Mesa 10x50, seen good,
Nikon AE 10x50, seen well,
Nikon Monarch ATB 10x42 Roof, also seen good.
Bushnell Legend 8x42 Roof, seen averted
Pentax PCF WP II 8x40, just barely seen

M78 under mag 5.4-5.5 skies
Fujinon FMT-SX 10x50 picked out M78 immediately as a bright and easy target.
Nikon AE 10x50, seen good, but not bright and not easy.

M78 under mag 5.4-5.5 skies
Handheld Nikon SE 12x50s I was easily able to acquire M1
Handheld Nikon SE 12x50s M78 took a little more time. I needed to search around for a while, but passing over it several times showed it in the movement.

M1 under mag 4.9-5.0 skies
Fujinon 10x50, M1 was seen only after concerted effort and chart reference.
Nikon AE 10x50, at first only suspected, then just barely seen averted.
Celestron Regal 8x42 roof, took even more time and when I did suspect seeing it with averted vision, it was questionable. Not seen in any handheld or braced.

M1 under mag 5.2 skies
Several 10x50s, Orion Ultraview, Pentax PCF WP, Nikon AE and GO Classic. It was not seen at first. But after locating it in a 15x70, it was a bit easier to detect in the 10x50s. Of these 10x50s, it seemed easiest in the Nikon AE, it was most difficult in the GO Classic. It was barely detected with great difficulty in the BFL 8x42.
Handheld - M1 was barely detected in any handheld 10x50s. It was not seen in handheld GO Classics.

M1 under sky mag 5.2-5.4
Oberwerk Mariner 8x40 (8x32) M1 barely seen
Pentax WPII 8x40 M1 barely seen
Nikon AE 8x40 M1 not seen
Nikon Action VII 8x40, M1 not seen

More Observing

With a pair of Nikon AE 12x50s
Skies were about mag 4.8-5.0 off and on with intermittent thin haze.
In 15 minutes of handheld viewing, I spotted
M81, M82, M51, M34, M45, M38, M36, M37, M35, M42
M41, M47, M46, M50, M48, M67, M44, M66, M3, (M63 no, M94 no)

Not to bad for a sprint. 19 Messiers in handheld 12x50AEs
I spent another half hour searching and I was on top of but DID NOT SEE
M108, M97, M101, M52, M65, M95, M96, M98, M100, M86

Mounted 10x50 Nikon AEs
Sky mag 5.2 – 5.4
M81 and M82 were much easier than M65, M1, M78 or M46. Well, at least M81 was easier. M81 was fairly large and M82, the more northerly of the two, was not nearly as bright and seemed much smaller.
M46 was a question mark at first, then it appeared, just a sprinkle of very faint stars.
M67 was more an averted glow than seen direct.
M1 I missed it twice. But after a second reference to the charts, I found it. I referred to the charts twice for M78 and still did not see it. Finally, a bit later, I came back to it and I saw it with averted vision.

Fujinon FMT-SX 10x50 vs Leupold Wind River Mesa 10x50
viewing the Double Cluster, reference is “pre”ceding cluster, “fol”lowing cluster
F10 handheld sees 8 stars pre, 11 stars fol
F10 mounted sees 12 stars pre, 21 stars fol
L10 handheld sees 8 stars pre, 8 stars fol
L10 mounted see 10 stars pre, 13 stars fol

Other binocular families – all reviewed in respective size reports

Garrett Optical Classic 8x45 and Classic 10x50

Oberwerk Mariner 8x40 top, 7x50 and 10x60 bottom

Review Summary

Nikon AE 12x50 – 12.2x49, 5.1°, er=13mm, IPD= 56-73, cf=23ft., fmc/fc, $158
The Nikon AE is sound mechanically and has some of the best ergonomics. Heavy at 36oz. Very nice twist up eyecups with 3 positive lock positions. Slow focus. Has moderately good sharp field to 70-80%, usable field provides 4.6°, the smallest of all these, but not much less than SE12x50. Has very little pincushion. You can see as deep as mag 10.4 to 10.5. Scores very well in resolution tests. Some doubles at 14" and 13" can be separated, but a double at 10" can only be seen elongated. M57 can barely be seen as more than just star like. Many deep sky objects can be easily found. Aperture is true 12x49. Light delivery system very well balanced with little vignette. Shows excellent transfer of light beam. Coatings are quite reflective, prisms are single coated. For me a 12x is about the limit of handheld astronomy. A very good moderately priced 12x50 that performs very well and that won't break the bank.

Nikon AE 10x50 - 10.2x48, 6.1°, er=13mm, IPD=56-73, cf=20ft, fmc/fc, $148
The Nikon AE is sound mechanically and has some of the best ergonomics. Heavy at 36oz. Normal resolution is below average, but boosted resolution is one of the best. has moderate pincushion. Slow focus. The aperture shows only minor reduction. Has moderately good sharp field to 65%, usable field provides to 4.9°. Coatings do not rank as the best, but internal

vignette is well controlled and illumination is very good. There are no internal reflections. Limiting magnitude always scores well. Outer field sharpness falls off at 60% out, but holds on fair out to 80%. Eye relief is not ample at 13mm, but there is no chance of hitting the well recessed eye lens with your eyeglasses. Eye cups are widely adjustable and IPD covers a wide range. Diopter is very easy to adjust. Overall, the Nikon AE scores the highest of the 10x50s, but not by much over the Pentax. Each does some things slightly better than the other.
The 10x50 AE binoculars can see many open clusters and in a good dark sky will find a large number of galaxies and nebula. Limiting magnitude can reach just deeper than mag 10.0 to 10.2 and you can separate stars as close as 16" to 15" and with effort 14". The most versatile of the AEs, 10x50 shows a deeper sky, and is not too much to handhold for most people. The best moderately priced 10x50 in this entire study. Highly recommended.

Nikon AE 8x40 - 7.9x39, 8.1°, er=14mm, IPD=56-73, cf=13ft, fmc/fc, $124
The Nikon AE is sound mechanically and has good ergonomics. Normal resolution is excellent. Boosted resolution is OK, not one of the best. Handheld res is very good. Has very little pincushion, The aperture shows only minor reduction. Has moderately least sharp field to 60%, but starting out with wide field results in usable field to 5.3°, wider than the other AEs. Coatings do not rank as the best. Internal vignette is very well controlled, exit pupil is balanced and illumination is excellent. There are no internal reflections. Limiting magnitude scores well. Outer field sharpness falls off at 60% out, and is fair only out to 65%, but that still gives a 5.3° usable fov. Curvature contributes to a very wide range of depth of field. Fast focus only from 30m-100m, slow otherwise. Eye relief is sufficient at 14mm. There is no chance of hitting the well recessed eye lens with your eyeglasses. Eye cups are widely adjustable and IPD covers a wide range. Diopter is very easy to adjust. Overall, the Nikon AE scores the highest of the 8x40s, but not by much over the Pentax PCF WP II, Celestron Regal or Fujinon BFL. Each does some things slightly better than the other. See LM only half a magnitude less than the 10x50, for a lot better compromise magnification that makes handheld easier. Strongly recommended.

Nikon SE 12x50 - 12x50, 5.0°, er=17mm, IPD=53-73, cf=19ft, fmc/fmc, $900
Moderate weight at 32oz. (900g). Quite comfortable handheld, ample eye relief, has most blackout issues due to long eyerelief. Slow focus. Interior baffles and blackening is excellent, no internal reflections. Sharp field of view to the edge. Slight pincushion. Very little field aberration, very little curvature. Shallow depth of field. Reaches deeper LM than any other binocular here. Extended object contrast is superior. Good normal power on-axis resolution, 6x boosted resolution one of the best measured, OK handheld resolution. Not waterproof . Minimal false lateral color in daylight on extreme high contrast. No false color noticed in most astro use. Aperture is true 12x50. Light delivery system well balanced and with little vignette. Shows very good transfer of light beam. Coatings are among the best made. A well made binocular that delivers superior performance.

Nikon SE 10x42 - 10.2x42, 6.2°, er=17mm, IPD=53-74, cf=13ft, fmc/fmc, $900
Very light at 24oz. (680g). Quite comfortable handheld, ample eye relief, not as much blackout issues as the 12x50SE. Relatively fast focus 30m-100m, but slow focus 30m-3m. Mild daylight false color way out at field edge. No false color noticed in astro use. Light field aberrations, mild curvature. Moderate depth of field. Interior baffles and blackening is

excellent, no internal reflections. Reaches the same LM as the 10x42Regal, the deepest of the roofs, and better than many 10x50s. Extended object contrast is superior, better than the 10xRegal. Measures near best in normal power on-axis resolution, 6x boosted resolution and handheld resolution. Nearly sharp to the edge, usable field of view about 90% fov. Not waterproof . Aperture is true 10x42. Light delivery system well balanced and with little vignette. Shows good transfer of light. Coatings are among the best made.

Nikon SE 8x32 – 8x32, 7.6°, er=14mm, IPD=53-73, cf=9ft, fmc/fmc, $550
Moderate weight at 32oz. (900g). Quite comfortable handheld, ample eye relief, no blackout issues. Slow focus. Interior baffles and blackening is excellent, no internal reflections. Sharp field of view to the edge. 7+° sharp 7+° usable the widest usable fov of all. Moderate pincushion. Very little field aberration, almost no curvature. Moderate depth of field. Least LM of any binocular here, but exceeds numerous 8x40/42s. Extended object contrast good. Good normal power on-axis resolution, moderate 6x boosted resolution, very good handheld resolution. Not waterproof . Minimal false lateral color in daylight on extreme high contrast. No false color noticed in most astro use. Aperture is true 8x32. Light delivery system well balanced and with little vignette. Shows very good transfer of light beam. Coatings are among the best made. Very small. Astronomy use would dictate a larger instrument. Extremely compact for terrestrial use.

Fujinon FMT-SX -10x70, 5.0°, er=17mm, IPD=56-78, cf=50ft, lens fmc/prisms fmc, $679
A 10x70 Fujinon binocular is included here, but is considered a special purpose binocular. Not all observers can use it to its full potential. With a 7mm exit pupil, if you do not have eye pupils large enough, you never get to use the entire aperture. However, eye placement would be easier. If you do have eye pupils large enough, your other common foe is bright sky. In moderate 4.5-5.0 skies, the 10x70s show a bright background, performing between a 12x50 and a 10x50. But when used under dark sky, much more could be seen in the 10x70s. Faint nebula stand out more once they are being used in their productive element.
The Fujinon 10x70 has the most false color of all these. Mostly off axis, but extremely wide blue band in daylight high contrast. Definitely obtrusive. False color on moon prominent. Very heavy 5# (2.2kilo). Cumbersome for handheld, ample eye relief, but IF makes it very difficult to hold and focus at same time. Slow focus. Interior baffles and blackening is excellent, no internal reflections. 85% sharp field of view, 100% usable 5.0° fov. Almost no pincushion. Very little field aberration, moderate curvature. Shallow depth of field. Reaches deep LM under dark sky conditions. Extended object contrast is excellent under dark sky conditions. Very Good normal power on-axis resolution, 6x boosted resolution one of the best measured, poor handheld resolution. Not waterproof . Most false lateral color in daylight on extreme high contrast. False color noticed in astro use on very bright objects. Aperture is true 10x70. Light delivery system well balanced and with little vignette. Coatings a bit more reflective than SE12x50 or Fujinon 10x50. A well made binocular that delivers under the right conditions. Not for normal everyday use.

Fujinon FMT-SX – 10.4x50, 6.7°, er=13mm, IPD=57-76, cf 50ft, lens fmc/prisms fmc, $659
Here I cannot say that none of these other binoculars come close to the performance of the Fujinon FMT-SX 10x50. It is still the very top of the pyramid, however, several of these come very close indeed. Yet still, when I find myself searching for a difficult object like M1 or M78,

I pull out the Fujinon 10x50 to locate it. When I'm trying to see a faint star and need to confirm if it is at the location I suspect, I pull out the Fujinon to verify it. Contrast and light transmission in the Fujinon is immediately apparent as better than any other binocular in this group. The Fujinon has no aperture reduction. The field of view is a dramatic 6.7°, wider than any other 10x50 here, and in fact, wider than advertised. The field sharpness is truly sharp to the edge. It has the least overall aberrations and the least field curvature, yet it still has some decent apparent depth of field. It is by far the heaviest at 49oz. (1400g.). The eye relief of 13mm is short but is much easier to use than either the Nikon SE12x50 or the Nikon SE10x42. Any minor idiosyncrasies seem a small price to pay for such excellence. Focus is precise and achieves pinpoint stars that are excellent. Limiting magnitude exceeds most of the other 10x50s by 0.3 to 0.5 magnitudes. Internal vignette is extremely well controlled, illumination is quite high and resolution ranks among the best. Let there be no doubt, these are all reasons why the Fujinon FMT-SX scored the highest of all binoculars out of 34 in this study, and you can see the difference the moment you put them up to your eyes!

Some of the best of the best here. And some very good moderately priced choices. Any of these would be a purchase you'd never be sorry for.

Clear skies, and if not, Cloudy Nights
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