

**Small Binocular Reports The 10x50s**  
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**3-6-08**

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 the list of binoculars are several benchmark models that give a good indication what all the others should hope to achieve. Here are eight 10x50 porro prism binoculars and one 10x60. Be sure to refer to the other reports, especially the Small Binocular Score, the report showing the total summary scores for 16 different measured aspects for all 34 binoculars.

<b>Binocular Basics</b>	actu	Net	actu	use	range	oz	gm	spec	prism	\$\$\$
Small Binoculars	Mag	Aper	FOV	ER	IPD	wgt	wgt	coat	coat	cost
<b>Fujinon FMT-SX 10x50</b>	<b>10.4</b>	<b>50</b>	<b>6.7</b>	<b>13</b>	<b>57-76</b>	<b>49</b>	<b>1390</b>	<b>ebc</b>	<b>ebc</b>	<b>659</b>
Oberwerk Mariner 10x60	10.0	52	5.1	21	61-73	48	1362	fmc	fmc	169
Pentax PCF WP 10x50	10	49	5.0	13	57-74	35	993	fmc	fmc	179
Leupold WR Mesa10x50	10	48	5.3	17	58-74	32	908	mc	mc	175
Nikon Action Ex 10x50	10.2	48	6.1	13	56-73	36	1022	mc	MgF	148
Nikon Action VII 10x50	10	46	6.5	9	56-73	32	908	mc	MgF	83
Orion Ultraview 10x50	10	46	6.0	13	59-71	30	851	fmc	fmc	169
Bushnell Legend 10x50	10	46	6.4	14	59-72	37	1050	fmc	fmc	114
Garrett Genesis 10x50	10.0	44	6.1	16	60-74	34	965	fmc	fmc	119
Oberwerk 10x50	10.0	43	6.4	13	58-72	38	1078	fmc	fc	129
<b>Nikon SE 10x42</b>	<b>10.2</b>	<b>42</b>	<b>6.2</b>	<b>17</b>	<b>53-74</b>	<b>24</b>	<b>681</b>	<b>fmc</b>	<b>fmc</b>	<b>900</b>

Values are measured actual magnification x effective aperture, True field of view, usable eye relief, interpupillary range, weight, close focus distance, lens coat/prism coat and retail purchase price. The Fujinon FMT-SX 10x50 and the Nikon 10x42SE are included as the benchmarks.

I used a number of different size 10x binoculars in this study. 10x70, 10x60, many 10x50s, 10x42 and several 10x42 roofs. The roofs are all reviewed in Small Binoculars The 42mm Roofs. The Oberwerk Mariner 10x60 is included in this review list, since you will see it is effectively closer to a 10x50 than anything else. The Fujinon FMT-SX 10x50 is included in this report as the ultimate benchmark binocular. Of the 34 binoculars I tested, the FMT-SX 10x50 rated the highest of all. The Nikon SE 10x42 is used as a benchmark both here and in the report on the 42mm roofs. The Fujinon 10x70 will be included in the review of the 12x50s.



From left to right: Nikon Monarch 10x42 roof, Celestron Regal 10x42 roof, Pentax HR11 10x42 roof, Oberwerk 10x42 roof, Nikon SE10x42, Garrett Genesis 10x50, Pentax PCF WP 10x50, Nikon AE 10x50, Oberwerk 10x50, Fujinon FMT-SX 10x50, Fujinon FMT-SX 10x70

#### More Basics

The Orion is the lightest at 30oz. (850g.). The Oberwerk is the heaviest at 38oz. (1080g.) The Bushnell is heavy at 37oz (1050g.). The Nikon Action and the Leupold are quite light at 32oz. (900g.). The Oberwerk Mariner, really a 10x60 weighs in at 48oz. (1350g.)

Several of these have push-in objective caps.. Both Nikons have tight plastic caps although I still don't like the style. The Mariner and Genesis push-in rubber caps shrink in cold weather and then fall out. The Pentax, Leupold, Orion and Bushnell all have what I would call traditional slip over objective caps, which I prefer. I do like the single piece double eyepiece caps.

The Nikon Action Extremes have twist out rubber eyecups with three click positions. These have a wide range of adjustability to fit all needs. There is 13mm of usable eyerelief with the eyeguard turn in. Each click out adds 3mm extension.

I almost always use them with the eyecups turned out 1 click, even though I wear glasses. Nikon Actions, Oberwerk and Garrett all have rubber folding eye guards. Oberwerk Mariner, Leupold, Orion and Bushnell have a twist out hard eyecup with one positive position, full out. The Bushnell have the finest movement, but the Leupold are just as stable and either can be set to any number of intermediate positions with no movement at all. The Pentax hard rubber eyeguard is push/pull and can be used only full in or full out.



I like these twist out ratcheted eyecups on the Nikon EX

Only the Nikon Action and the Orion Ultraview are NOT waterproof. All the rest are waterproof, a good feature. For the astronomer, waterproof means you don't need to worry so much about water vapor infiltration to the inside. For the terrestrial user, who might be on or near a body of water, waterproof is always a good consideration.

The Pentax has the least pincushion. Nikon AEs and Orion Ultraviews have mild pincushion. Both the Garrett and the Oberwerk have strong pincushion. Pincushion has no affect on astronomical observing. However, it does have considerable affect for terrestrial users. A small amount of pincushion is desirable as it helps eliminate the rolling ball effect for terrestrial use. So some mild to moderate pincushion may be beneficial, since it has no detrimental affect on astronomy and it may add a benefit for terrestrial use.

Worthy of note, the Pentax and the Leupold are the only binoculars in all these that have a focus lock.



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

## Eye Relief – Diopter - IPD

With the exception of the Nikon Action (specified 12mm) and the Bushnell Legend (spec 15mm), all the rest of these have specified eye relief between 17mm and 24mm. The Leupold is actually 17mm and the Garrett is 16mm. Most of the rest are 13-14mm, much less than specified. The Pentax is specified at 20mm, it actually has only usable eyerelief of 13mm. The Orion is specified 22mm and is actually only 13mm. The Orion is fine with the eyecups down, but with the eyecups fully extended, I could not see the entire FOV, even without my glasses. About 10-15% of the fov is blocked. The Nikon Action has only 9mm of usable eye relief and is unsuitable for eyeglasses.

Eye Relief	spec	dist	rcss	usable	usable
Small Binoculars	ER	exit	lens	ER	w/cup
<b>Fujinon FMT-SX 10x50</b>	<b>20</b>	<b>21</b>	<b>8</b>	<b>13</b>	<b>6</b>
Oberwerk Mariner 10x60	23	23	2	21	13
Pentax PCF WP 10x50	20	18	5	13	3
Leupold WR Mesa10x50	18	21	4	17	7
Nikon Action Ex 10x50	17	18	5	13	3
Nikon Action VII 10x50	12	12	2	9	4
Orion Ultraview 10x50	22	18	5	13	3
Bushnell Legend 10x50	15	18	4	14	4
Garrett Genesis 10x50	24	18	2	16	2
Oberwerk 10x50	18	19	6	13	3
<b>Nikon SE 10x42</b>	<b>17</b>	<b>20</b>	<b>3</b>	<b>17</b>	<b>7</b>

The Nikon Action, the Oberwerk Mariner and the Garrett eye lenses, when the eyecups are turned fully down, are only 2mm below the eyecup, insufficient distance to prevent contact with eye glasses, requiring that the eyecup be extended somewhat so my eyeglasses don't hit the binocular eye lens. Both have folding rubber eye guards, so it takes a bit of maneuvering to get a little extra with fully extending the eyeguard.

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. In some cases the metal rim around the eye lens comes in contact with my eye glasses. It would cost me more to replace my eyeglass lenses than it would to replace any of these binoculars. All the rest have 4mm to 5mm depth to the eye lens when the eye guard is fully down.

A very strong caution to any eyeglass wearers when using the Oberwerk Mariner 10x60 with the eye cups closed down. The Oberwerk Mariner 10x60 lens recess is only 2mm and the metal rim surrounding the eye lens is not recessed at all. Depending on the curvature of your eye glasses, they may come in contact with the binocular eye lens and the metal rim will definitely come in contact with your eye glasses. However, fortunately, on this binocular you can still see the entire fov while wearing glasses even when the eyecups are fully extended.

The Orion has the least right diopter range, and it is oddly adjusted such that even with my eyeglasses on, it is set to correct for several diopters. The Bushnell Legend has a right diopter

grip identical to the Orion, but has a greater range of accommodation. The Bushnell diopter grip, like the Orion, is difficult to grasp and use and getting the right diopter focus is a challenge. I need to twist the right eyecup out a bit just to get my fingers on the diopter grip.

Pentax, Leupold and Nikon Action have twist diopters. The Nikon Action and Leupold right eyepiece height changes with diopter adjustment. The Nikon AE has a very easy to grasp right diopter grip, and turning it moves the right eye lens inside the right eyecup without changing the height of the right eye cup. All the twist diopters change the height of the right eye lens compared to the left.

The Nikon AE and the Nikon Action share the widest IPD range 56-73mm, and both have the closest available setting, 56mm. The Oberwerk Mariner, the most difficult IPD for narrow eyed people, at 61mm minimum will not accommodate some people, especially children. While 58 is close enough for most people, many children and some adults will need a 57mm or 56mm setting to see with both eyes. The Garrett minimum is a wide 60mm. The Orion has the narrowest total range, 59-71mm. The Pentax, the Leupold and the Garrett can accommodate as wide as 74mm.

#### Close Focus

Most of these binoculars have a close focus of 20-23 ft and a few of them 25ft. (6m to 7.5m). The Oberwerk 10x50 focuses to 30ft and the Oberwerk mariner focuses to 50ft. With small variation +/-, they all have only about 80% of the field of view in binocular vision at 20-25ft. Only one or two binoculars in my test group have more than 80% of the fov overlapped at closest focus, (however all the roof prism binocular that have closest focus at about 6-7ft (2m.), when used at a distance of 20ft have approx 90% of the fov in binocular vision).

If using these 10x50 binoculars to close focus (assuming at 20ft) you would get is a "binocular vision" field of view about 18-20 inches wide. 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 binocular vision while only 6-8 inches is not overlapped.

<b>Close Focus</b>	<b>****</b>	<b>close</b>	<b>dial</b>	<b>dial</b>
Small Binoculars	focus	focus	3-30	30-100
<b>Fujinon FMT-SX 10x50</b>	<b>IF</b>	<b>50</b>	<b>na</b>	<b>120</b>
Oberwerk Mariner 10x60	CF	50	na	150
Pentax PCF WP 10x50	CF	20	xxx	90
Leupold WR Mesa10x50	CF	23	135	90
Nikon Action Ex 10x50	CF	20	200	100
Nikon Action VII 10x50	CF	20	180	90
Orion Ultraview 10x50	CF	20	xxx	120
Bushnell Legend 10x50	CF	25	120	120
Garrett Genesis 10x50	CF	25	xxx	210
Oberwerk 10x50	CF	30	xxx	120
<b>Nikon SE 10x42</b>	<b>CF</b>	<b>13</b>	<b>300</b>	<b>60</b>

### 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. 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 the 10x50s the minimum distance is 6-7m, not 3m.

Typical fast focus binoculars have a total dial turn  $20^{\circ}$  to  $60^{\circ}$  for the 30m-100m range. The Pentax, the Leupold and the Nikon Action take a minimum of  $90^{\circ}$  of focus dial turn to focus from 30m to 100m. All the others take more. The Garrett takes  $200^{\circ}$  and is the slowest focus, a desirable attribute for astronomy. Half of all the binoculars measured fall into the fast focus range, although none are 10x50s or larger except for the Nikon AE12x50. So for 30m-100m, none of these are fast focus.

In the close range from 30m to 6m (100ft to 20ft), the fast focus binoculars in my test group cover this distance with anywhere from  $100^{\circ}$  to  $180^{\circ}$  of dial turn. The Leupold and the Bushnell are fast focus with the need to turn the dial only 120-135 $^{\circ}$  to go from 30m to 6m. The Nikons are both at the limit of fast focus turning range.

Generally most of these 10x50s 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. The actual field in degrees that you see will always be based on the field stop diameter. We cannot measure the field stops unless we take the binoculars apart. But we can measure the actual field by observations. Listed below are the actual fov for all these binoculars. The benchmark Fujinon 10x50 is actually slightly larger than specified. A few have an actual field that measures specified, but most are a few tenths to as much as a half degree smaller than specified. The Orion Ultraview is specified as  $6.5^{\circ}$ , but the actual fov is  $6.0^{\circ}$  and not all of that is sharp for a good view.

The Leupold has the best sharp fov, what many would consider sharp to the edge fov, with only 1 arcmin total distortion all the way out at 90% of the field. This is even better than the next best, the Pentax, which has a sharp fov out to 80%. Oberwerk 10x50, Oberwerk Mariner, then Bushnell and Garrett, in that order have the next best marks for field sharpness.

One reason for that high level of outer field sharpness is the fact that some of these 10x50s use very narrow Afov eyepieces. The Leupold has  $53^{\circ}$  eyepieces and the Pentax has  $50^{\circ}$  eyepieces. All these others have eyepieces with  $60-64^{\circ}$  Afov, quite often accompanied by a much greater degree of aberration. Both the Bushnell and the Oberwerk 10x50 do very well with  $64^{\circ}$  Afov eyepieces that hold onto a fair view with no more than 2 arcmin distortion all the way out to 85-90% of the field.

Field of View degrees	spec FOV	actu FOV	calc Afov	Sharp% 600arc"	Sharp% 1200arc"	sharp fov	usable fov
<b>Fujinon FMT-SX 10x50</b>	<b>6.5</b>	<b>6.7</b>	<b>70</b>	<b>95</b>	<b>100</b>	<b>6.4</b>	<b>6.7</b>
Oberwerk Mariner 10x60	5.3	5.1	51	75	80	3.8	4.1
Pentax PCF WP 10x50	5.0	5.0	50	80	85	4.0	4.3
Leupold WR Mesa 10x50	5.5	5.3	53	90	95	4.7	5.0
Nikon Action Ex 10x50	6.5	6.1	62	65	80	4.0	4.9
Nikon Action VII 10x50	6.5	6.5	65	55	70	3.6	4.6
Orion Ultraview 10x50	6.5	6.0	60	65	70	3.9	4.2
Bushnell Legend 10x50	6.5	6.4	64	70	90	4.5	5.8
Garrett Genesis 10x50	6.5	6.1	61	70	75	4.3	4.6
Oberwerk 10x50	6.5	6.4	64	75	85	4.8	5.4

The Orion Ultraview, the Nikon Action, and the Garrett Genesis are the quickest to deteriorate. All have 2 arcmin distortion by 70-75% out, making the field outside that area unusable for any meaningful information. Two arcminutes of total distortion in your image no longer provides useful information. Stars or pairs of stars are either distorted blobs or long streaks. By the point of 1 arcmin distortion, you have lost a full magnitude from view. The image has lost perhaps two full magnitudes of faint stars out at 2 arcmin of distortion. While I consider 1 arcminute (600arc" at 10x) of distortion as the sharp limit, I consider 2 arcminutes (1200 arc" at 10x) as the limit of useful field of view in a binocular. 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 Oberwerk, Leupold and Bushnell have the widest sharp fov. All three are greater than 4.5° of sharp fov. You might find it interesting that although the Pentax has only a 5° Tfov, it has a wider sharp fov than the Oberwerk Mariner the Nikon Action and the Orion Ultraview. It can see the same stars at 80% out that both the Orion and the Nikon AE can see at no more than 65% out, so all three have about a 4.0° equally sharp fov.

The Nikon Action has only 3.6° of fov that is sharp and only 4.6° of fov that has less than 2 arcmin distortion. The Orion Ultraview has a limited useful fov of only about 4.2°. The Bushnell, Oberwerk and Leupold have the widest usable fov of all these. None of these come close to the benchmark Fujinon 10x50.

#### Curvature and Depth of Field

Not all were tested for field curvature. The Nikon Action shows the most curvature, but it's other outer field aberrations are so prominent that it makes it very difficult to see what's going on in the outer fov. The Leupold and Bushnell have the least curvature and the Nikon AE has only slightly more.

Binoculars with more field curvature may have greater 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.

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. 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.

### Aperture

The Nikon AE prism shelf stops the aperture down to 48mm. The Pentax is stopped to 49mm. The Orion Ultraview is both stopped down and losses 6% of the light to undersized exposed prism edges, it therefore has an effective aperture of only 46mm. The Nikon Action is stopped down by a too small prism aperture. The Bushnell Legend is stopped down at the prism aperture and the front prism intrudes considerably into the light path. Both the Oberwerk 10x50 and the Mariner, and the Garrett 10x50, are considerably stopped down by either mis-sized baffles, undersized prisms or both, much more than any of the others.

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. Even though my dial caliper can give readings to increments of 2/100ths mm, I round my readings up or down to the nearest 1/10th, so that could easily account for a small difference. Measuring the aperture with a loupe is direct, but there is some difficulty in obtaining readings that are any more accurate than to a mm, especially if the stop is a baffle in front of the prism. So more potential variance now exists. The laser is probably the most accurate indicator, but once again, actually measuring the sliding position of the laser is probably no more accurate than a mm. So it's easy to have differences in the readings from these methods. None of the methods are off by several mm.

<b>Effective Aperture</b>	spec Mag	spec Aper	spec pupil	actu Mag	actu pupil	Aper pupil	Aper loupe	Aper laser	Aper avg3	chord %loss	Net Aper	Net Aper
<b>Fujinon FMT-SX 10x50</b>	<b>10</b>	<b>50</b>	<b>5.0</b>	<b>10.4</b>	<b>4.9</b>	<b>51</b>	<b>49</b>	<b>50</b>	<b>50</b>	<b>0%</b>	<b>50</b>	<b>0%</b>
Oberwerk Mariner 10x60	10	60	6.0	10.0	5.3	53	52	50	52	1%	52	-14%
Pentax PCF WP 10x50	10	50	5.0	10	4.9	49	49	49	49	1%	49	-3%
Leupold WR Mesa10x50	10	50	5.0	10	4.9	49	49	48	49	2%	48	-4%
Nikon Action Ex 10x50	10	50	5.0	10.2	4.7	48	48	48	48	0%	48	-4%
Nikon Action VII 10x50	10	50	5.0	10	4.7	47	45	46	46	1%	46	-8%
Orion Ultraview 10x50	10	50	5.0	10	4.9	49	49	50	49	6%	46	-7%
Bushnell Legend 10x50	10	50	5.0	10	4.9	49	48	48	48	6%	46	-9%
Garrett Genesis 10x50	10	50	5.0	10.0	4.5	45	45	44	45	2%	44	-12%
Oberwerk 10x50	10	50	5.0	10.0	4.6	46	46	45	46	5%	43	-13%

### Baffles and Blackening

Most of these 10x50s have un-blackened metal around the prism housing. In the better ones, at least that metal is a dark dull grey. In some of the others, it's quite bright, not shiny bright, but not dull grey. The Pentax has fine, dark, dull black/grey interior baffles.

The Nikon Action baffle is slightly undersized. The light beam hits the edge of the prism aperture well before it comes up to the edge of the baffle. The Nikon Action Ex baffle is very slightly undersized. The Bushnell baffle is a bit undersized.

The Leupold is well baffled and blackened. The internal barrel is ribbed.  
The Orion interior is shiny black and produces some minor internal reflections.  
The Garrett showed some interior reflections of bright objects.  
The Oberwerk 10x50 is not blackened and has no baffles.

### Coatings

All these binoculars appear to have multi-coated objectives and eye lenses. The Oberwerk Mariner may have the coatings that reflect the least amount of light. Coatings should not reflect light. Pentax, Leupold and Orion Ultraview get good marks for least reflective objective coatings. The others are all fairly decent coatings. However, several binoculars appear to have prisms that are single coated. Some of the differences are, it was very difficult for me to see my reflection in the Oberwerk Mariner or the Pentax, and little to no detail at all could be seen, but in the Nikon AE and the Nikon Action it was easy to see at least some detail in my reflection.

When the Nikon Action Extreme coatings are compared to the Orion Ultraview and the Pentax PCF WP, the Nikon AE objective coatings reflect more light than both. There is a significant difference in the reflectivity of the multi-coatings on the objectives of the Nikon AE vs the Pentax PCF WP. The Pentax PCF WP 10x50 is very good, better than the Orion Ultraview. The Pentax PCF WP 10x50 coatings reflect less light than Orion Ultraview and much less than Nikon AE.

The Garrett has nice coatings. Coatings are on a par with the Pentax PCF WP 10x50. Coatings are less reflective than the Nikon Action Extreme 10x50.

The Nikon AE lenses are multi-coated, however the prisms appear to be only single coated, preventing that one from being labeled FMC. Yet the Nikon AE see stars equally as faint as the Pentax and both of them see slightly fainter stars than the Orion Ultraview. This may give some indication that light transmission is dependant on more than just good coatings. Excellent coatings and poor internal beam transfer can result in very poor output. On the other hand, excellent beam transfer and illumination, even with less than premium coatings can result in a binocular that may appear brighter and see fainter objects.

The Bushnell has "rainguard" coatings. If you've ever used RainEx applied to your windshield, you know it virtually eliminates the need to use wipers in the rain. This coating is intended to do the same on the Bushnell.

### Limiting Magnitude

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 Action EX, Orion Ultraview and Garrett Genesis. With the Oberwerk Mariner I reached mag 10.1 and with Pentax PCF WP 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 5.2, 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.

Typical observations across this entire range of 10x50s shows

most of the time I was able to see stars as deep as mag 9.6.

every binocular saw at a minimum of mag 9.5 or mag 9.6

As the benchmark, the Fujinon 10x50 saw a min 10.0 and usually saw mag 10.1 and 10.3.

The Garrett Genesis saw mag 9.8 on two occasions.

The Nikon Action, Pentax and Orion all saw mag 9.8

The Bushnell Legend and leupold saw mag 9.9

The Nikon Action EX saw mag 10.0 twice

### Prism Vignette and Illumination

The Bushnell Legend, Nikon Action Extreme and Pentax PCF WP have the best readings for control of internal vignette and light path tilt. The Garrett genesis and Orion Ultraview take up a second place spot. The Leupold, the Oberwerk 10x50 and the Oberwerk Mariner show readings indicating the most tilt and considerable vignette in the prisms.

<b>Light Transfer</b>	tilt	tilt	100%	75%	Exit	MAX
Small Binoculars	left	right	beam	beam	Pupil	Lux
<b>Fujinon FMT-SX 10x50</b>	<b>0</b>	<b>3</b>	<b>40</b>	<b>70</b>	<b>4.9</b>	<b>992</b>
Oberwerk Mariner 10x60	15	30	15	60	5.3	708
Pentax PCF WP 10x50	7	10	30	70	4.9	710
Leupold WR Mesa10x50	15	15	10	70	4.9	715
Nikon Action Ex 10x50	7	10	30	65	4.7	845
Nikon Action VII 10x50	5	2	15	65	4.7	877
Orion Ultraview 10x50	2	0	25	60	4.9	690
Bushnell Legend 10x50	4	4	30	65	4.9	862
Garrett Genesis 10x50	4	10	25	65	4.5	889
Oberwerk 10x50	15	2	10	50	4.6	738
<b>Nikon SE 10x42</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>50</b>	<b>4.2</b>	<b>618</b>

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 100% of the entire beam pattern from every point in the central 50% diameter of the objective lens. You can see here the Fujinon 10x50 does the same from the central 40% diameter of the objective.

The Garrett Genesis and the Nikon Action and the Bushnell Legend have high marks for illumination of the exit pupil. Generally, max lux appears to trend higher for a larger exit pupil. Then the Orion, the Leupold, the Pentax and the Oberwerk Mariner have low readings for illumination.

### Resolution

The Nikon Action the Garrett and the Oberwerk share the best normal power resolution. All three measured the same for on-axis resolution, none of them rating very high in this category. The Leupold had the lowest reading for normal power resolution. This particular category of binoculars, the 10x50s did not perform as well in resolution tests as any other category of binocular sizes in my studies. 86 arcseconds of apparent resolution is not bad, but not one of these binoculars ranked in the top ten in this study. And in fact five of these ranked in the bottom 10 for worst normal power resolution. And four of those also ranked near the bottom for boosted power resolution.

Boosting the test power by 6x normal, the Nikon AE and the Nikon Action held up with the best boosted resolution. Both the Nikon Action and the Nikon Action Extreme produced significantly notable results for boosted resolution. The Action EX recorded 3.2 arcseconds res and the Action 3.0 arcsec. The Oberwerk Mariner, Pentax, Leupold and the Bushnell did rather poorly.

The Bushnell Legend had by far the worst boosted resolution, one of the worst readings recorded out of 34 binoculars. The Leupold and the Oberwerk Mariner both had poor boosted resolution. These poor reading are giving some indication of aberrations present in the system.

<b>Resolution USAF chart</b>	actu	USAF	apprnt	boost	USAF	apprnt	USAF	
Small Binoculars	Mag	res	res	Mag	x6.15	res	res	hheld
<b>Fujinon FMT-SX 10x50</b>	<b>10.4</b>	<b>8.1</b>	<b>85</b>	<b>64</b>	<b>3.8</b>	<b>246</b>	<b>12.9</b>	<b>134</b>
Oberwerk Mariner 10x60	10.0	8.6	<b>86</b>	62	4.8	<b>295</b>	12.9	<b>129</b>
Pentax PCF WP 10x50	10	9.1	<b>91</b>	62	4.8	<b>295</b>	15.4	<b>154</b>
Leupold WR Mesa10x50	10	9.7	<b>97</b>	62	5.1	<b>315</b>	12.9	<b>129</b>
Nikon Action Ex 10x50	10.2	9.1	<b>93</b>	63	3.2	<b>202</b>	12.9	<b>131</b>
Nikon Action VII 10x50	10	8.6	<b>86</b>	62	3.0	<b>187</b>	11.5	<b>115</b>
Orion Ultraview 10x50	10	9.1	<b>91</b>	62	4.1	<b>249</b>	12.9	<b>129</b>
Bushnell Legend 10x50	10	9.1	<b>91</b>	62	6.1	<b>374</b>	12.1	<b>121</b>
Garrett Genesis 10x50	10.0	8.6	<b>86</b>	62	3.8	<b>236</b>	12.9	<b>129</b>
Oberwerk 10x50	10.0	8.6	<b>86</b>	61	4.3	<b>264</b>	12.1	<b>121</b>
<b>Nikon SE 10x42</b>	<b>10.2</b>	<b>8.1</b>	<b>83</b>	<b>63</b>	<b>3.6</b>	<b>227</b>	<b>11.5</b>	<b>117</b>

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 Pentax had a poor reading for hand held resolution. The Nikon Action was a bit better than the crowd.

## Observing

Here are a variety of observations of M78 and M1. All of these are from recent observing sessions with groups of the Small Binoculars.

M78 under mag 5.4-5.5 skies

Fujinon FMT-SX 10x50 picked out M78 immediately as a bright and easy target.

Oberwerk Mariner 10x60 (10x52), seen good, but not bright and not easy.

Leupold WR Mesa 10x50, seen good, but not bright and not easy.

Nikon AE 10x50, seen good, but not bright and not easy.

Garrett Classic 10x50 (10x44) searched, just barely seen, difficult object.

Oberwerk 10x50 (10x43) needed to search, barely seen, difficult object.

M78 under mag 5.2 skies,

Orion Ultraview 10x50 (10x46), barely seen

Pentax PCF WP 10x50, barely seen

Nikon AE 10x50, barely seen

GO Classic 10x50 (10x44), barely seen

M78 under mag 4.9-5.0 skies

Fujinon 10x50, M78 was immediately visible. Central stars are not seen.

Bushnell Legend 10x50 porro, seen Good.

Nikon AE 10x50, not easy but was seen OK.

Nikon Action 10x50, not easy but was seen OK.

Could not find it in any binocular handheld. Saw in Fujinon handheld braced.

M1 under mag 5.2 skies

Several 10x50s, Orion Ultraview, Pentax PCF WP, Nikon AE and GO Classic. Of these 10x50s, it seemed easiest in the Nikon AE, it was most difficult in the GO Classic. Handheld - M1 was barely detected in any handheld 10x50s. It was not seen in handheld GO Classics.

M1 under mag 4.9-5.0 skies

Fujinon 10x50, M1 was seen only after concerted effort and chart reference.

Bushnell Legend 10x50 porro, just barely seen.

Nikon AE 10x50, at first only suspected, then just barely seen averted.

Nikon Action 10x50, took repeated tries to find it, even averted.

Not seen in any handheld or braced.

Nikon AE and Leupold seemed to do better than Pentax and Orion Ultraview

Nikon AE and Bushnell did better than Nikon Action

Bushnell did better than Nikon AE

Nikon AE, Pentax and Orion did better than Garrett

Oberwerk Mariner, Nikon AE and Leupold did better than Garrett and Oberwerk

As an afterthought, I'd add that upon going through all my notes I had only few where I mentioned false color, and it was only ever associated with observing the moon. I noted very mild false color in all, forced at the edges. Very little or none on axis.

## Summary



Nikon Action - 10x46,  $6.5^\circ$ , er=9mm, IPD=56-73, cf=20ft, fmc/fc

The Nikon Action has the widest fov  $6.5^\circ$ , has one of the best on axis resolution measures, but it has very poor outer fov sharpness. It has no functioning internal baffles and is poorly blackened. However, it does illuminate the exit pupil very well. But it is poor mechanically and ergonomically, with a wobbly eyepiece bridge and the shortest eye relief of 9mm. In recent testing, I had to refocus this one at least a half dozen times during the session. Mechanical build, very short eyerelief, poor outer fov, lack of proper baffling and reduced aperture all lower the score on this one.

Leupold Wind River Mesa - 10x48,  $5.3^\circ$ , er=17mm, IPD=58-74, cf=23ft, fmc/fc

The Leupold has only a  $5.3^\circ$  total fov. It has excellent outer field sharpness, one of the best. However, it has poor on-axis resolution, one of the worst. Also it delivers light very poorly across the exit pupil, shows considerable tilt in the light path and has a very low total exit pupil illumination score.

Garrett Genesis - 10x44,  $6.1^\circ$ , er=16mm, IPD=60-74, cf=25ft, fmc/fmc

The Garrett Genesis is the original name of the Garrett Classic. The Garrett loses significant points for the reduction of aperture, but does a few other things very well. It has good resolution, delivery of light is well balanced across the exit pupil, and the exit pupil is very

well illuminated. However, it shows some off-axis internal reflections, field sharpness falls off rather quickly after 70%, and lower end (narrow) IPD is limited. Loss of field sharpness and reduction of aperture keep the score down in an otherwise decent performing binocular. Here you see my several year old Garrett Genesis 10x50 next to my brand new Garrett Classic 8x45.



Oberwerk Mariner 10x60 – 10x52,  $5.1^\circ$ , er=21mm, IPD=61-73, cf 50ft, fmc/fmc  
Also included in this report is the Oberwerk Mariner 10x60, due to the fact its effective aperture is 10x52. The Mariner is stopped down by internal baffles that are too narrow an opening. Eye relief is so long it can cause blackout issues if handheld up close to the eyes. The  $5.1^\circ$  fov makes it one of the narrowest. It has very good outer field sharpness, better than most of the others. Resolution is average. However, the Mariner scores very poorly in internal vignette and illumination of the exit pupil. It has greater axial tilt and lower illumination than any other 10x50 in this comparison. The limiting magnitude results reflect the poor scores above in that, on occasion, this “10x60” was equaled or exceeded by other 10x50s. Diopter is difficult to adjust and eyecups do not hold intermediate position. But, due primarily to dramatic reduction in aperture and poor measures in illumination, LM and axial tilt, the Mariner scored very low in rank. Like the Garrett, were it not for the dramatic reduction in aperture and the accompanying loss of illumination and LM, this binocular would score respectably in the average range of all 10x50s.

Oberwerk 10x50 - 10x43,  $6.4^\circ$ , er=13mm, IPD=58-72, cf=30ft, fmc/fc  
The Oberwerk has near the widest fov  $6.4^\circ$ , has a very sharp outer fov, has very good on axis resolution. However, it has no internal baffles or blackening, the field stop is blurred, it has significant internal vignette and it does not illuminate the exit pupil very well. It has the greatest amount of aperture reduction, in this case due to too small prism shelf aperture. It is the too-small prisms that are contributing to the poor internal vignette and poor illumination.

Orion Ultraview 10x50 - 10x46, 6.0°, er=13mm, IPD=59-71, cf=20ft, fmc/fmc

The Orion has very nice coatings and is the lightest binocular in the group. But, it has poor outer fov sharpness. It has considerably reduced aperture due to prism edges exposed on the prism shelf. Eye relief is a short 13mm. Baffles and blackening are below average. Resolution is below average and it shows considerable tilt in the optical axis. These issues account for why the Orion Ultraview scored the lowest of all 10x50s.

Pentax PCF WP 10x50 - 10x49, 5.0°, er=13mm, IPD=57-74, cf 20ft, fmc/fmc

It has the smallest fov at 5.0°. But it has one of the sharpest outer fovs of any binocular. It has a limited adjustability to the push/pull eyecups, but is otherwise very well built. It has very little reduction of aperture or internal vignette. The Pentax loses most of its points for poor resolution and narrow fov. Other than that it performs pretty well.

Bushnell Legend 10x50 - 10x46, 6.4°, er=14mm, IPD=59-72, cf=25ft, fmc/fmc

The Bushnell also loses points due to reduction in aperture. Significant intrusion into the light path by the front prisms reduces effective aperture even more. Also, normal resolution was below average and boosted resolution was extremely poor, possibly indicating some aberrations. However, it has the widest fov at 6.4° and the field is quite sharp and mostly usable. The illumination of the exit pupil is well balanced and strong, and limiting magnitude test shows it very capable. Although heavy, it scores well mechanically and well overall.

Nikon Action Ex 10x50 - 10x48, 6.1°, er=13mm, IPD=56-73, cf=20ft, fmc/fc

The Nikon AE is sound mechanically and has some of the best ergonomics. Normal resolution is below average, but boosted resolution is one of the best. The aperture shows only minor reduction. Coatings do not rank as the best, but internal vignette is well controlled and illumination is 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.

Garrett Genesis, Oberwerk, and Nikon Action, not by a significant difference, offer three 10x50s that measure up just a bit better than the Orion Ultraview.

Leupold Wind River, Bushnell Legend and Pentax WP, are all a step above those other four 10x50s, but a step below the Nikon Action Extreme.

Just a few notes on the benchmark models included here:

Fujinon FMT-SX - 10x50, 6.7°, er=13mm, IPD=57-76, close focus 50ft, lens fmc/prisms fmc,

None of these other binoculars come close to the performance of the Fujinon FMT-SX 10x50.

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  $6.7^\circ$ , 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.) and has short eye relief of 13mm, but these 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!

Nikon SE 10x42 - 10.2x42,  $6.2^\circ$ , er=17mm, IPD=53-74, cf=13ft, fmc/fmc,  
Very light at 24oz. (680g). No false color noticed. Very little field aberration, but mild curvature. Quite comfortable handheld, ample eye relief, not as much blackout issues as the 12x50SE. Relatively fast focus 30m-100m, but slow focus 30m-3m. 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 and system shows very good transfer of light beam. Coatings are among the best made.

Clear skies, and if not, Cloudy Nights  
edz