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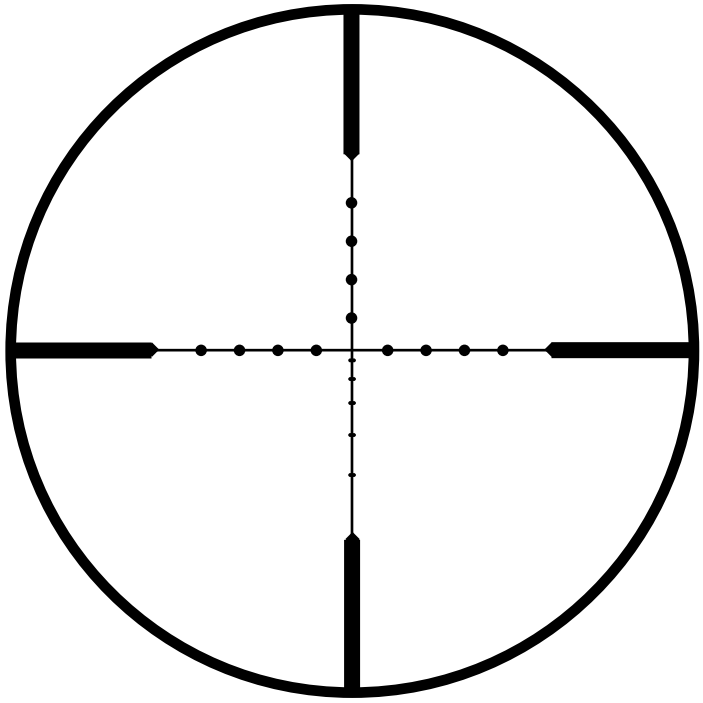
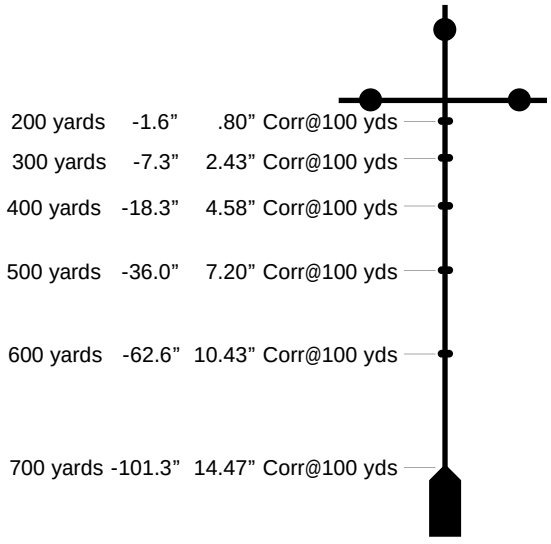
Tech Notes

Ballistic Mil-Dot™ Reticle





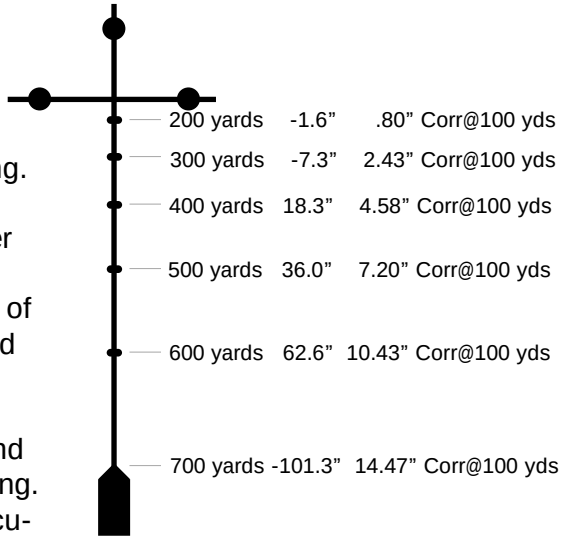
History

In 1998, it became clear to Burris that sportsmen's interests in long range shooting had grown considerably. The advent of laser rangefinders, more long range rifle designs, more magnum cartridges, and super accurate ammunition, long range shooting became more popular and achievable. However, a vital link in long range success is a trajectory compensating scope reticle.

In 1999, Burris introduced the Ballistic Mil-Dot reticle in a 6X-24X Signature Series scope, primarily with the varmint hunter in mind. While under development, Burris recognized that the ballistics of the popular .22-250 55gr varmint load was very similar to that of many flat shooting big game cartridges out to 500 yards or more. Demand for this type of reticle was also strong from big game hunters, and Burris soon expanded the Ballistic Mil-Dot offering to include the 4X-16X and 8X-32X scopes.

This reference piece is designed to be used in conjunction with the Ballistic Mil-Dot reticle guide which is included in the packaging with each scope. A guide to using Mil-Dots for range estimation and wind drift compensation is also included in the packaging with each scope and therefore is not covered in this technical discussion.

Ballistic Mil-Dot
Design Considerations -

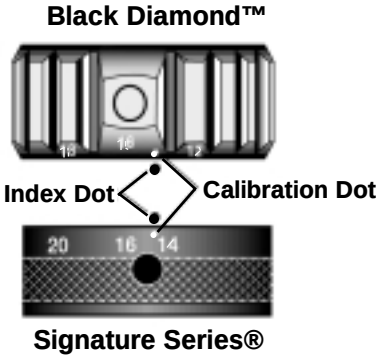


The Ballistic Mil-Dot reticle begins as a standard Mil-Dot with two exceptions. The first is that all the mil-dots are round instead of oblong. Shooter feedback suggested that round dots are easier to distinguish than oblong dots. Second, is the conversion of the mil-dots on on lower vertical crosshair to Ballistic lines. Hundreds of iterations were considered, and the final determination perfectly matches the ballistics curve of a .22-250 55gr Sierra boattail load at a muzzle velocity of 3680fps, fired at 3,000 feet altitude, 59 degrees and barometric pressure of 29.53. Because the comparative need for accuracy is greatest while shooting prairie dog size targets (compared to big game), an average altitude and environmental conditions parameter was utilized for this type of shooting. The Sierra Infinity™ Ballistics software program was utilized for all calculations and verified by field shooting.

Although a miniscule amount of shooting occurs beyond 500 yards, Burris elected to provide a total of 7 sighting references for maximum flexibility and for the purpose of minimal sight picture departure from the standard mil-dot. Per the spirit of the original design, this would allow accurate shooting out to 700 yards.

Some would contend (and Burris would agree) that these cartridges are so flat shooting out to 200 yards, that a separate 200 yard reference is unnecessary. However, significant consideration was given to making the use of the reticle intuitive and not subject to the failings of memory for occasional shooters. As designed, counting the ballistic lines is easier starting at 100 yards as the center reference, rather than “remembering” to start counting at 200 and discounting 100 yards. For those who subscribe to the 200 yard zero, a bit of work with the Sierra Infinity Ballistics software program (or other similar ballistics programs) will still allow the shooter to calibrate and optimize the reticle to his particular cartridge, environmental parameters, and shooting style.

Factory Calibration



Burris Ballistic Mil-Dot scopes are of the American-standard non-magnifying reticle design. As you change the magnification, the reticle remains constant in size as the image changes in size. Therefore, the *reticle’s size in relation to the image size* (reticle subtension) *changes* so the amount of trajectory compensation changes as magnification changes. This necessitates that the scope be set at a specific magnification to be correctly calibrated for trajectory compensation. This is done at the factory by installing the calibration dot at roughly 14X-16X on the power ring. This magnification for calibration was chosen after significant input from our customers. While some would prefer the calibration at the highest magnification, i.e. at 24X on a 6X-24X scope, most felt that 14X-16X was a much more usable magnification because of mirage and field of view constraints associated with higher magnification.

The term “Corr@100” is often used in this article and refers to Correction at 100 yards. This refers to how high a bullet must be at 100 yards in order to impact on target at a target further down range. Some would refer to this as synonymous with Minute of Angle (MOA), which is very similar, however would be misused slightly in this discussion. For your reference, one minute of angle is 1.047 inches at 100 yards. 1.000 inch @ 100 yards versus 1.047 inches at 100 yards seems like a very small difference, however it translates into 1.5 to 3 inches of point of impact variation at 500 yards for most big game cartridges.

Adaptability

There are basically four ways to fine tune the calibration of the reticle to a specific trajectory curve. Any method can be used based on your preferences, however one method may produce the most accurate results compared to the other methods.

1. Sight in at 100 yards. Using a ballistics software program, run a ballistics chart for your cartridge using 5 or 10 yard increments. If the software package does not calculate the Correction at 100 Yards (Corr@100) for each yardage, you can perform this task easily with a spreadsheet. Simply type in the yardages and the Bullet Path like in **Example 1**. The third column is calculated as follows: Corr@100 for Cartridge = "Bullet Path" divided by "yards" times "100". Simply match up the Corr@100 for the Ballistic Mil-Dot with the Corr@100 for the Cartridge. For instance, instead of the 500 yard ballistic line being dead-on at 500 yards, you may note that it is dead on at 485 yards, and so forth. **See Examples 1 & 2.**

2. Sight in at 400 or 500 yards using the 400 or 500 yard ballistic line. This will decrease the long range error throughout your self-prescribed yardage limit. This method has the same effect as sighting slightly high or low at 100 yards as is discussed in section 3 below. **See Example 3.**

3. Another alternative is to do some experimentation with ballistics software programs trying several different sight-in yardages from 75 to 190 yards checking each time how closely your 400 or 500 yard trajectory table matches the amount of drop built into the reticle. It can turn out that flatter shooting cartridges may need to be sighted in 1/2 to 1" low at 100 yards to best match the rest of the yardages on the reticle, or 1/2" to 1" high at 100 yards for cartridges with more drop than that calibrated into the reticle. **Example 2** shows that a 100 yard zero results in nearly perfect calibration at 600 yards, however intermediate calibrations are off between 300 and 500 yards by 1.6 to 2.3 inches. Fine tuning in **Example 3** shows that by simply sighting in .4 inches high at 100 yards (the same as a 150 yard zero), allows the calibration to match the reticle to within .6 inches all the way out to 500 yards, and then shoots a bit higher at 600 and 700 yards.

4. For cartridges with a trajectory significantly differing from the factory calibration for the reticle, you can re-calibrate the reticle to another magnification. Based on actual shooting or trajectory charts, calculate the Corr@100 yards necessary for 500 yards, for instance. The Ballistic Mil-Dot is factory calibrated for 36 inches of drop at 500

Example 1:

7STW @ 100 yard zero

yards	Bullet Path	Corr@100 Cartridge	Corr@100 Ballistic M-Dot
270	-6.42	-2.38	-2.43
280	-7.21	-2.58	
290	-8.04	-2.77	
300	-8.92	-2.97	
310	-9.85	-3.18	
320	-10.83	-3.38	
330	-11.86	-3.59	
340	-12.94	-3.81	
350	-14.08	-4.02	
360	-15.27	-4.24	
370	-16.51	-4.46	
380	-17.81	-4.69	-4.58
390	-19.16	-4.91	
400	-20.57	-5.14	
410	-22.04	-5.38	
420	-23.56	-5.61	
430	-25.15	-5.85	
440	-26.79	-6.09	
450	-28.49	-6.33	
460	-30.25	-6.58	
470	-32.08	-6.83	
480	-33.97	-7.08	
490	-35.92	-7.33	-7.20
500	-37.93	-7.59	

*Corr@100 Cartridge = Bullet Path) yards x 100

Example 2:

7STW at 100 yard zero

yards	Reticle Drop	160gr 3200fps Drop	*Drop variance from reticle*	*actual yardage zero*
100	**0**	0	*0*	
200	**-1.6**	-2.3	*-0.7*	*185*
300	**-7.3**	-8.9	*-1.6*	*275*
400	**-18.3**	-20.6	*-2.3*	*375*
500	**-36.0**	-37.9	*-1.9*	*485*
600	**-62.6**	-61.8	*+0.8*	*605*
700	**-101.3**	-93.2	*+8.1*	*735*

Example 3:

7STW at 150 yard zero

yards	Reticle Drop	160gr 3200fps Drop	*Drop variance from reticle*
100	**0**	+0.4	*+0.4*
200	**-1.6**	-1.4	*+0.2*
300	**-7.3**	-7.7	*-0.4*
400	**-18.3**	-18.9	*-0.6*
500	**-36.0**	-35.9	*+0.1*
600	**-62.6**	-59.3	*+3.3*
700	**-101.3**	-90.4	*+10.9*

yards from a 100 yard zero. Therefore 36 inches divided by 5 is 7.2" Corr@100 yards in order to hit the target at 500 yards. Therefore, you would need to hold over 7.2" inches at 100 yards to be dead-on at 500 yards. Lets say that with a 100 yard zero, your specific cartridge drops 55.7 inches at 500 yards as in **Example 4**. This would require 55.7 divided by 5, or 11.14" Corr@100 yards to be dead-on at 500 yards. Fortunately, Burris Ballistic Mil-Dot scopes feature a non-magnifying reticle design. As you change the magnification, the reticle remains constant in size while the image size changes. The *reticle's size in relation to the image size* (reticle subtension) and therefore the amount of trajectory compensation changes as magnification changes. The scope must be set at a specific magnification to be correctly calibrated for trajectory compensation. The factory installs a calibration dot on the power ring at roughly 14X-16X. Going back to the 11.14 inches at 100 yards example, simply place grid paper or a ruler at 100 yards and then turn the power ring until you bracket 11.14 inches between the center of the reticle and the 500 yard ballistic line as shown in **Example 5**.

In **Example 6**, the power ring would be roughly at 10X magnification, providing a dead-on reference for 500 yards, and highly accurate references for 200, 300, and 400 yards. Be sure to somehow mark a new calibration dot or line on the power ring so you can return to the perfect calibration in the future.

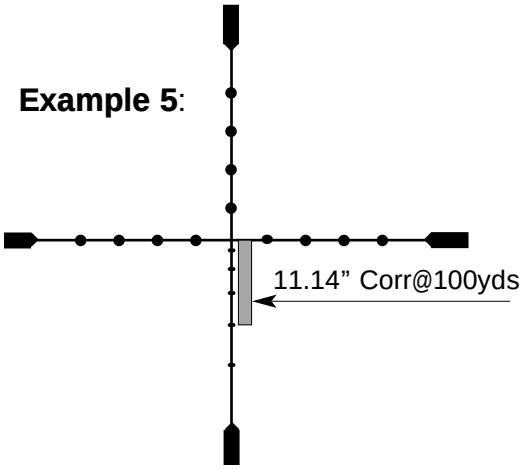
Charts and Ballistics Programs Are Close. Actual Shooting is Better.

The nature of ballistics is such that everything is theoretical and if any variable changes, so does the ballistic table. At long ranges, changes in environmental factors can add up to significant variances. Temperature affects both muzzle velocity and air density. Changes in humidity, barometric pressure, and altitude can all add up to several inches of trajectory variance. The height the scope is mounted above the bore should be factored into generating theoretical trajectory charts. If at all possible, one should shoot at each 100 yard increment at the altitude and environmental conditions he is likely to experience while hunting or competing in order to both develop a trajectory chart and to verify impact for each ballistic line on the trajectory compensating reticle.

Example 4:
.308Win at 100 yard zero

yards	Calibrated Reticle Drop	.308Win 150gr 2820fps Drop	Drop variance from reticle
100	**0**	+0.0	*+0.0*
200	**-1.6**	-3.5	*-1.9*
300	**-7.3**	-13.2	*-5.9*
400	**-18.3**	-30.1	*-11.8*
500	**-36.0**	-55.7	*-19.7*
600	**-62.6**	-92.0	*-29.4*
700	**-101.3**	-141.0	*-39.7*

Example 5:



Example 6: roughly 10X Magnification
.308Win at 100 yard zero

yards	Calibrated Reticle Drop	*Re-Calibrated Reticle Drop*	.308Win 150gr 2820fps Drop	variance from recalibrated reticle
100	**0**		+0.0	*+0.0*
200	**-1.6**	*-2.5*	-3.5	*-1.0*
300	**-7.3**	*-11.3*	-13.2	*-1.9*
400	**-18.3**	*-28.3*	-30.1	*-1.8*
500	**-36.0**	*-55.7*	-55.7	*+0.0*
600	**-62.6**	*-96.9*	-92.0	*+4.9*
700	**-101.3**	*-156.7*	-141.0	*+15.7*

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