Modeling Index-Adjustable Iron Sights

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Abstract

Iron sights are the simplest means to accurately aim a firearm. The iron sights on the M16/ AR15 platform are extremely versatile and adjustable for distances out to 800m in 100m increments beyond 300m. A model for these indexed sights has been developed and is used to assess the long distance accuracy from theses iron sights.

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Sight alignment on a rifle involves setting the vector described by the "line of sight" through the rear and front sights to the target with the angle of the barrel bore so that a fired bullet will strike the aiming point. At short ranges, this angle can be zero and the target will be hit, however, for long range shooting the barrel must be angled upwards such that the bullet trajectory crosses the line of sight twice, once close to the firing position and a second time under the pull of gravity, ideally striking at the target distance.

The M16/ AR15 platform was designed with indexed, adjustable iron sights to support target ranging out to about 800m. These sights are easily recognizable with the rear sight being housed in the rifle carrying handle and the front sight sitting high on the barrel. The sights are typically comprised of a front post with protecting leaves on either side, and a rear circular aperture sight. The front sight post can be raised or lowered, and the rear sight can also be raised and lowered and adjusted left and right for windage.

The sight alignment process is based on a preset zero position on the rear sight vertical adjustment knob. With the rear sight on the "Z" position, the front sight post is raised or lowered until for some distance to a target, the point of aim and the point of impact of the bullet match. The distance of the target in this initial zeroing alignment step ultimately sets all of the other range adjustments of the rear sight. Left to right variations are handled with a separate control on the rear sight.

The recommended target distance (US Army 2010) for the initial zeroing of the rifle is 25m. This means that when looking through the rear sight and placing the top of the front sight on the target, the bullet impact point and the point of aim are the same. The front sight post is approximately 2.6 inches above the center line of the barrel. Over the 25m of travel to the target, the bullet must rise 2.6 inches in the zeroing process. This defines the zero angle between the rifle bore and the line of sight. By adjusting the front sight post, height variations can be compensated. To keep things simple, for our simulations we will stick with the front sight being 2.6 (66mm) inches high. Simple trigonometry leads to a required bore to sight line angle of 2.64mrad.

This bore to sight line angle as been determined assuming that there was negligible bullet fall over this distance, and the 5.56mm/ 223cal cartridge has enough velocity for this to be practically true. The other settings on the rear sight are 8/3, 4, 5, 6, 7 or 6/3, 4, 5, depending on the type of sights employed. The differences between the two are subtle and the interested reader is encouraged to review them independently. The remainder of this discussion will focus on the 6/3, 4, 5 type of sights. On these sights, the 6/3 setting is 2 clicks below the "Z" position, and the 4 position is 6 clicks above the 6/3 position. Between 4 and 5 is 8 clicks and between 5 and returning to 6/3 is 10 clicks. A click will move the point of impact by a ½ minute of arc or 0.145mrad. The angular variations for the sight positions are recorded in table 1.

Table 1: Rear sight adjustments expressed as clicks and angles for the type 6/3 rear sights.

Setting	Clicks (increasing clockwise)	Angle (mrads)
"6/3"	0	2.4
Z	2	2.64
4	4	3.2
5	8	4.4
"6/3"	10	5.9

Using these parameters for the rear sight and the 66mm high front sight, a ballistics calculator (McCoy 1999) can be used to evaluate what bullet characteristics will deliver the expected range performance. Using the 6/3 setting, when the sight is in the fully lowered position, the sights should place the round on target at 300m. Using a 55gn bullet with a hypersonic drag coefficient of 0.2 a velocity of 2850fps or 868.7 mps provides an on target strike within 0.05m. It should be noted that this is not a particularly high velocity for the 223/5.56 mm round. Upper limits are closer to 3200 fps, so this letter discusses only one possible realization. Using the values in table 1, the impact points for the various settings and the 2850fps, 55 gn bullet can be calculated and are shown in table 2. The milspec accuracy for the iron sights is normally considered as 4 minutes of angle and will be used here.

Table 2: Rear sight adjustments expressed as clicks and angles.

Setting	Radius in Meters of 4-MOA Diameter	Zero Crossing Distance (meters)	Vertical Offset @ Setting Range
"6/3" (300m)	0.18	295	-0.025m
Z (25m)		25	0m
4 (400m)	0.24	400	0.0m
5 (500m)	0.29	525	0.15m
"6/3" (600m)	0.35	660	0.55m

The results shown in table 2 demonstrate that the rear sight settings, with a 25m zero, and a bullet that will impact at 300m on the 6/3 setting will at longer range settings remain within the 4 MOA impact diameter out to 500m. Some accuracy for this round seems to be lost at 600m but some sight adjustment could likely minimize this error. Certainly two clicks back on the sights below the 6/3 setting hits the target. Table 2 shows that the iron sights are perfectly reasonable for 4MOA work out to beyond 600m.

This letter has explored only a single bullet weight and velocity combination, but has demonstrated the inherent accuracy of the indexed iron sights. Many users of these sights never plan to use them over ranges beyond two hundred meters. By choosing a different zero crossing point a different set of impact points can be calculated and can result in a simple aiming process. In such cases the angles shown in table 2 can be easily adjusted to accommodate the new zero crossing, while practically it will be accomplished by altering the front sight post height. This makes the index-adjustable iron sights extremely practical for a wide range of applications.

Author Biography

Scott W. Teare is Professor of Electrical Engineering at New Mexico Institute of Mining and Technology in Socorro, NM. He has co-authored over 100 technical and scientific works, with 1 patent awarded and two currently under review.

References

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