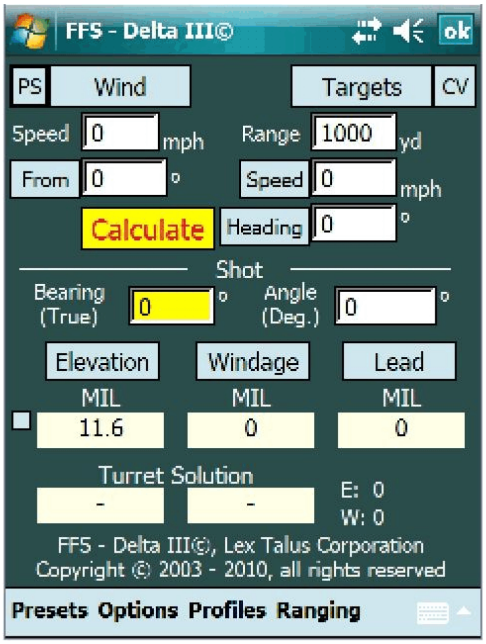
Field
Firing
Solutions©

Delta III© Software

Version 4.7

Real-Time Ballistic Solutions©



FFS - Delta III©

Speed 0 mph

From 0 °

Range 1000 yd

Speed 0 mph

Heading 0 °

Shot

Bearing (True) 0 °

Angle (Deg.) 0 °

Elevation MIL 11.6

Windage MIL 0

Lead MIL 0

Turret Solution - -

E: 0

W: 0

FFS - Delta III©, Lex Talus Corporation

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5 Dec 2011

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INTRODUCTION

Field Firing Solutions© Delta III© runs on a small, hand-held PDA and is used to obtain a real-time firing solution in the field based upon current atmospheric and target data.[1] The trajectory computation engine is the same as used in a desktop program, but has output limited to the specific information needed for a complete firing solution: elevation, windage, lead, and hold-off. Elevation is given in terms of an MOA or Mil adjustment and an actual turret solution; windage is output in terms MOA or Mil for scope adjustment and/or for a wind correction hold-off with either a mil-dot or MOA calibrated reticle; lead is the hold-off correction needed for a moving target given in terms of Mils or, optionally, in MOA (see Options). The shooter will choose the appropriate units for his particular reticle.

OPERATING SYSTEM REQUIREMENTS

Version 4 of the software is designed to run on the following operating systems: Windows Mobile 5.0, and above with Windows Mobile 6.0 being the preferred operating system. In addition, .NET Compact Framework 2.0 must be loaded on the PDA. In newer PDAs this support software is part of the ROM but in the older PDAs the software needs to be downloaded from Microsoft and installed. The software is available free from Microsoft and the link for the download can be found on the Lex Talus website (www.lextalus.com) in the Support section.

TERMINOLOGY: ACCEPT, ABORT, OK, DONE, CLOSE, KILL

As the user accesses the various pages and forms of the program, he will note that closing the form is sometimes accomplished with a "Done" button or menu item; sometimes the menu provides a "Close" or a "Kill" option; most forms have an "OK" at the top of the page and most forms offer the user a choice of "Accept" or "Abort". What do these words mean in the context of this program?

Forms that allow the user to input data that can be used by the program will almost always have "Accept" or "Abort" as the menu items that will allow the user to close the form and exit. "Accept" means to accept the data that is on the form and import it back to the main part of the program for inclusion in the computation.

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[1] Because of the demands the software places on the operating system and CPU, this software is designed to run only on the Windows Mobile Device operating system. Generally, this program will not run on Palm products or PDAs that use the Palm operating system. However, recently Palm has begun to incorporate an Windows layer on some of its operating systems which permits the running of Windows software. This software should run in those environments.

"Abort" means to reject any data in the form and return to the previous display without change. On forms that have an "OK" at the top, choosing OK is the same as choosing "Abort". The reason for this is to make the modification of existing data an unambiguous act on the part of the user. Where data can be accepted, the user must affirmatively "Accept" it.

On some forms there isn't "Accept" or "Abort" options. These forms generally do not import data back to the main part of the program. For example, the user can choose to use the "Calculator" (Main page: Options, Tools). When he is finished, he simply clicks "Done" and the calculator closes. There is nothing to import; the results of the calculation are left on that form and not used elsewhere. A couple of the forms have a check box to enable the program to use the results of the calculations made coupled with a "Done" button. Tapping the "Done" button will close the form and if the user has so elected, the results of the work there will be transmitted back to the main part of the program.

One of the forms has a "Kill" option to close the form - that related to the GPS function. This form has to do with getting data from outside the PDA through serial ports. "Kill" means to kill all processes associated with receiving serial data, close the port, and close the form. However, it is possible to open a serial port and then close the form with those processes running in the background. When the user clicks the "Start" menu item he is activating a serial port which opens and awaits the receipt of data. At this point the the "Kill" menu item changes to "Close" and should the user choose to "Close" the form, the serial port remains open to continue data reception. In this way, other parts of the program can get GPS data without the user having to be directly in the GPS form. The GPS device is essentially running in the background and the program is getting the incoming data, parsing it and distributing it to other parts of the program that can use this data. To stop the processes, the user returns to the original form, selects the "Stop" menu item at which time the "Close" menu item changes back to "Kill." Selecting "Kill" stops all processes and closes the form.

An Important Word about the DK

Two shooters using the same rifle and ammunition in the identical conditions may have very different points of impact at range. The same shooter can experience POI shifts due to a change in shooting technique. Even though muzzle velocity remains the same, a change in components can cause a significant change in POI. Or, manufactured ammunition can vary from lot to lot and result in a changed POI. Even though this program does an extraordinarily good job in calculating down range bullet velocities and times of flight, these calculations by themselves do not necessarily account for point of impact because there are other factors at work that influence exactly where the barrel is pointing at the moment of bullet launch. *It is important for the user to understand that the DK is used to set the POI as predicted by the program to match the real life POI experienced at the range.* Once the DK is set for a particular shooter and round, it will accurately predict trajectories for that ammunition, rifle and shooter - until the shooter changes something about that system. At that point the POI of his rounds may change and he will have to adjust the DK accordingly to bring the program and reality into alignment. Basically, the DK is there to personalize an individual trajectory. It is the final modification to the program and should be based only on data obtained at a range where bullet velocity has dwindled to 1400 to 1200 fps. It should not be used to modify the trajectory at higher velocities.

CAVEAT: Do not, DO NOT, **DO NOT** change the DK from its default value until 1) the scope has been calibrated, 2) the scope has been zeroed, 3) a muzzle velocity has been obtained and verified via the POI method, and 4) a ballistic coefficient has been calculated. Read the entire "Preparation" section starting on page 6 below, complete the work outlined there before changing the DK. If you try to use DK to get agreement between the actual and calculated trajectories using erroneous muzzle velocities and ballistic coefficients, the program will produce a distorted, inaccurate trajectory. The DK was not intended for this purpose and will yield completely unusable data. Don't do it.

HARDWARE BUTTONS

Most Pocket PC type PDAs have hardware buttons that can be programmed (in addition to the button cluster that generally controls the cursor and includes a central button that functions as an Enter key.) The manufacturer of the PDA may dedicate any or all of the hardware buttons to specific functions at which point the buttons will ignore any attempt by the software to change or temporarily alter what the button does when pushed. Delta III© attempts to program both the number 1 and 4 buttons as well as the control cluster. In many of the forms, the far left button (button number 1) generally exits the current form; the far right button usually performs the act of clicking the far right menu item of the current form if there are only two menu items. On the main page button 1 activates the Presets forms (in the Presets form button 1 exits the form and button 4 has no function); Button 2 (from left to right) activates the Targets list; Button 3 activates the Rifles list; and Button 4 activates the Offsets list. You can experiment with the various forms to see what, if anything, the buttons will do. If the PDA manufacturer has hard coded the button to a particular function, it is possible that pressing the buttons will have no effect in the program.

FUNCTIONAL SUMMARY [2]

A. Core Data

The computation of a basic trajectory takes five sets of data:

1. The density of the air through which the bullet will travel. Specifically air pressure, temperature and humidity are needed;
2. The muzzle velocity and ballistic coefficient of the projectile;
3. The height of the scope above the center line of the bore and the range at which the rifle is zeroed;
4. The range of the target; and,
5. The wind speed and direction.

That is all that is needed. This program can be used effectively to compute a firing solution and the user would not need to access any part of the program other than the main page for wind and range and the Presets page for atmosphere, bullet and scope variables.

The balance of the program is comprised of three other functional parts: User preferences, refinements, and support tools.

B. User Preferences

The first five entries of the Options menu relate to user preferences. The user can choose to use English or metric units of measure, MOA or Mils, degrees or the cosine for angled shots[3]. There are a few other preference selections not on the Options menu: Wind direction can be specified in degrees or by "clock" reference. The button labeled "From" directly below the wind speed data label on the main page switches from one to the other. If the metric system is being used, Wind Speed can be selected in terms of meters per second or kilometers per hour. Target speed and direction are may also subject to toggle buttons which alternate between degrees and hours (direction), miles per hour or feet per second (speed). On the Presets page in the Atmosphere section, the user can choose to indicate the current atmospheric pressure either by specifying "Station" or "Barometric" pressure. The difference between the two are explained in the User Preferences section. Finally, next to the Elevation solution window is a small button which sets the significant digits shown in the solution and toggles between one and two significant digits.

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[2] For an outline of these points, see Attachment 1. It is suggested that going through Attachment 1 is an excellent way to familiarize yourself with the software and to make sense of its various attributes and features.

[3] There are also turret related preferences, "Use Turret Windage" and "Positive Click Values", but these will be explained in the section explaining how to build Turret Profiles.

C. Refinements

Using the five data sets to calculate a trajectory will yield a decent solution, but there are refinements to the solution that will increase the accuracy of the calculation. The first set of refinements can be found on the Options menu and are: Spin Drift, Powder Temperature, Vertical Deflection, Coriolis/Eötvös, and correcting for Magnetic Variation. In addition to these refinements to the solution calculation, there is also the ability to specify multiple cross-wind zones on the Wind Vectors page accessed by the "Wind" button.

D. Support Tools

The program incorporates numerous support tools to help the user make a first round, cold bore hits at range. The support tools include:

1. Estimating wind speed at distance using a wind timer (Wind button)
2. Target Table - access to saved firing and target locations (Targets button)
3. Elevation Table (Elevation button)
    a. Vertical holds, time of flight, wind and lead values
4. Windage Table - extended wind values (Windage button)
    a. Wind holds for changing winds
5. Profiles (Profiles menu)
    a. Atmosphere
    b. Bullet
    c. Offsets
    d. Rifle
    e. Solution
    f. Turret
7. Ranging Tools (Ranging menu)
    a. Direct - using rangefinder
    b. GPS
    c. Map
    f. Reticle
8. Field Zero (Options, Tools menu)
9. Calculator (Options, Tools menu)
10. DK calculator (Options, Tools menu)
11. Muzzle Velocity calculator (Options, Tools menu)
    a. Using a chronograph
    b. Using the POI method
12. Scope Calibration Worksheet (Options, Tools menu)
13. Miscellaneous
    a. Profile Summary (Main page, "PS" button)
    b. Bullet and Cartridge database (Profiles menu)
    c. Visual Cues to State of Software
        (1) Bearing (Coriolis)
        (2) GPS button

    (3) Muzzle Velocity - temperature adjusted (Presets)

  d. Offset indicator (main page)

PREPARATION

To use this program effectively, the user must take some time to accurately obtain the necessary data used by the program in computing a firing solution. And the first and very important step the user must take is to calibrate his scope.

SCOPE CALIBRATION

The program outputs two basic numbers that constitute a firing solution: the elevation angle that is necessary to launch the projectile in order to hit the target at a specified range and the windage angle that the shooter must hold the rifle in order to combat the effects of a cross-wind, spin drift and the Coriolis effect. Essentially the bullet is traveling in an arc and the point of the program is to predict where to aim such that the arc of the bullet intersects the line of sight exactly at the plane of the target.

How does the user utilize the elevation and windage outputs? He either dials the elevation and windage using the scope's turrets or employs a hold-off technique using the scopes reticle. Let's focus on the first method here: dialing the necessary correction using the scope's turrets. If the program tells a shooter that for a 1000 yard shot it is necessary to dial 38.5 MOA (11.2 Mil) from the scope's zero, the shooter will simply dial the elevation turret to 38.5 and call it good. But how does the shooter know that he has actually moved the reticle 38.5 MOA? The truth is, he doesn't. Most shooters rely on the manufacturer's representations that each click of the scope is equal to a specific MOA or Mil value. Most shooters never verify the click value of the scope. But if you ask experienced precision rifle instructors, they will tell you that most click values are not as represented. They will tell you that two shooters with the same model scope from the same manufacturer will very commonly measure significantly different click values. What this means is that although the shooter thinks he is dialing 38.5 MOA, the actual movement of the reticle may be 39 MOA or, more commonly, something less like 37 MOA.

That is why the user of this software should spend a little time at the range to calibrate his scope. How? Make a chart at least 45 inches in length with a heavy line at the top and at measured distances down the chart.[4] Put the chart on some kind of cardboard or other suitable backing, place the chart at 100 yards or meters, secure the scope at the firing line so that the scope's horizontal reticle element is at the zero line

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[4] Or you can print out scope calibration sheets that are in the "Documents" folder on the SD card. When placing the chart, make sure that you get an accurate measurement of the distance from the turret of the scope to the chart.

at the top of the chart, and dial in the elevation. As you dial, you'll see the reticle move down the chart. The chart should have about 45 MOA (13 Mil) and you should use all that you can. After you have dialed in about 40 or so MOA, record where the reticle is on the chart. Repeat the process a few times to make sure that you have good data. Then, move the chart to the horizontal position and repeat the operation for windage using the vertical element. Do both left and right windage over a total of around 20 MOA (6 Mil). Once the data has been gathered, use the Scope Calibration tool (Options, Tools) to calculate the actual click values of the scope. At this point, accurate click values of both elevation and windage have been calculated and can be used when creating the turret profile described elsewhere in this manual. When the turret profile is created and used, the program will also have access to the actual click values of the scope and will use the actual click values in computing what the turret setting should be for elevation and windage. (Note that the program can output the corrected elevation in terms of the elevation turret scale but that the windage will simply be output in terms of the corrected Mil or MOA necessary to be dialed. The reason why windage doesn't have its own scale output is that windage is generally small as compared with elevation and can be dialed directly without confusion.)

The chart should be mounted exactly straight up and down or exactly level when tracking the windage. The reason why is that in addition to calibrating the click value, the user will also be able to check that the reticle itself is tracking exactly vertically and not tracking at an angle. To check this, make certain that the scope rail on the rifle is level and then run the elevation up and down. At the extremes the center of the reticle should track exactly vertical. If it doesn't, the scope needs to be turned until the reticle does track correctly; a failure to track vertically indicates that the scope is canted in its rings and when the reticle is canted it is introducing a windage error that increases linearly with range.

The user of this software is urged to calibrate each and every scope he owns that is used for long range shooting and thereafter to build a turret profile for each such scope.

ZEROING THE SCOPE

After calibrating the scope, the next step is to zero the scope after it has been installed on a rifle. First, before installing the scope on the rifle, make sure that the reticle is centered, both horizontally and vertically. An easy way to do this is to cut a couple of "V" notches in a cardboard box that will hold the scope at the tube just fore and aft of the turrets. As the scope is manually turned the reticle will move up/down or side to side but will move less and less as the elevation and windage dials are turned in the proper direction. At some point, the reticle should not move at all which means that the reticle is in the mechanical center of the scope. For windage, this is exactly where the reticle should be as this will ensure that maximum windage, both left and right, is available to the shooter. Further, having the windage exactly centered is a good check that the scope base is properly aligned on the receiver. If after mounting the scope the shooter finds that the rifle is printing a foot right at 100 yards, it will take almost 12 MOA to correct which means that the correction is taken out of what is available for left windage. The reticle is now off center by 12 MOA. And, because the reticle is now off center, the total elevation available to the shooter has been compromised. Therefore, after getting the windage exactly centered, try to keep it that way by adjusting the scope base for any gross misalignment. Use the windage knob only to "fine tune" the windage zero and try to be within 3 MOA or 1 Mil of the exact mechanical center of the scope.

After getting the reticle centered, zero the windage first at 50 yards.[5] Why 50 yards? Because nothing of significance happens to the bullet at 50 yards, even if there is wind across the range. Get the bullet to exactly split the vertical line on the target, then set the turret knob for wind to zero. At that point the shooter can be assured that any movement of the bullet off center is due to something other than a misaligned windage zero.

Getting an elevation zero is a little more complicated. The first place to zero is at 100 yards or meters. Realize that even if the rifle has a zero degree scope base, shooting the round at 100 yards will show a point of impact of 1.5 to 2 inches low. Why? Because the scope is mounted generally 1.5 to 2 inches above the centerline of the barrel, even if the barrel and scope are perfectly parallel to one another, the shooter is looking at a spot 1.5 to 2 inches above where the barrel is pointing. Discounting the small drop of a bullet at 100 yards due to gravity, the bullet must print below where the shooter is looking by the scope height above the bore centerline. Most long range rifles use some form of canted or angled scope base, a 20 MOA scope base being very common. Mounting the scope on this type of base means that the shooter will be looking 18 or 19 MOA below where the barrel is pointing (20 MOA rail less the scope height.) So the first thing to do is dial the turret *to move the bullet down* by 18 or 19 MOA. That should get both the scope and the rifle barrel looking at close to the same spot at 100 yards. Take a couple of well aimed shots to see what has to be done in terms of getting the point of impact to meet the point of aim, adjust the scope accordingly and set the elevation turret to zero. The scope is now zeroed at that range.

Be very reluctant to change the windage zero that was obtained at 50 yards. If the windage has changed due to the 20 MOA movement of the reticle, suspect that the reticle is not moving straight up and down, that the scope is not square with respect to

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[5] This assumes you are shooting a .30 caliber or less. Larger calibers will require a longer distance. For example, a .338 Lapua can be zeroed for windage at 100 yards.

the receiver. Some scopes have reticles that are canted and when the reticle elements look square with the receiver these scopes will actually move the reticle at an angle. This will cause the point of impact of the bullet to move in the opposite direction of the cant; the more elevation that is dialed, the further the bullet will be moved over. Look for other explanations for an incorrect windage zero if the rifle is dead zero at 50 yards. You may find that the scope has an internal tracking problem.

MUZZLE VELOCITY

It is important that the user know as precisely as possible the muzzle velocity of the bullet he intends to use. A difference of 50 fps at the muzzle for a .308 Winchester with a 175 gr. SMK bullet translates into a 20 inch difference in point of impact at 1000 yards and can be the difference between hitting and missing the target. Do not believe the muzzle velocity figures given by the manufacturer because that muzzle velocity wasn't measured in the user's rifle. The user must get the data using his rifle, the current lot of ammunition he will be shooting and an accurate chronograph. There is no substitute for personally gathering this information. When obtaining the data, be sure to note the temperature of the ammunition and try not to get the rifle too hot. What is required is a muzzle velocity that was produced by ammunition at a known and recorded temperature. This information will be used later when creating a bullet profile and will then be used by the program as it tries to adjust the muzzle velocity due to atmospheric temperature changes. Throwing a cartridge into a hot chamber heats the powder and the resulting muzzle velocity recorded is that of powder that is potentially hotter than the temperature recorded. This can only lead to errors later.

Be sure to use a decent chronograph. Since chronographs are not self-calibrating, the user is taking a lot on faith that the chronograph is accurately measuring the bullet's velocity. Use the highest quality of chronograph that is available and, if possible, get velocity data from more than one chronograph. Be sure that the data collected is accurate. Then use the program to compute the muzzle velocity (Options, Tools, Calculate MV) realizing that the velocity of the bullet measured 15 or more feet from the muzzle is NOT the muzzle velocity - it is the velocity of the bullet 15 or more feet from the muzzle. For the most accurate downrange trajectories, an accurate muzzle velocity is required.

The program has a tool to check the chronograph and that is the "POI Method" tool (Options, Tools, Calculate MV) . After obtaining a good, measured muzzle velocity, check the results by shooting at a target at around 300 to 600 meters. Note distance the bullet is striking above or below the point of aim and use the POI Method tool to calculate the actual muzzle velocity that accounts for the impact point. If the chamber has cooled and cartridge is at ambient temperature, use the calculated muzzle velocity. It is probably a better number than the data being generated by the chronograph. Remember this: the trajectory doesn't lie; it is the actual manifestation of the various effects upon the bullet during flight and trumps all other theoretical numbers. If the trajectory doesn't match the computations, first suspect the muzzle velocity, then the ballistic coefficient.

CALCULATE A BALLISTIC COEFFICIENT

Now that you've got a calculated and verified muzzle velocity, take the chronograph and place it down range. How far? Far enough that the bullet will experience a meaningful reduction of velocity but not so far as to risk hitting the chronograph. Depending upon the size of the bullet path opening, you should be able to safely put bullets over the chronograph at 300 to 500 yards/meters. Fire a number of rounds at this new range and obtain an average velocity for this bullet type. At this point, you can calculate a ballistic coefficient for the bullet that will be good for this bullet into the subsonic region using this program. (Options->Tools->Calculate BC.) See Calculating a BC in this manual.

However , the work here is far from finished. As was mentioned, chronographs are not self-calibrating. The shooter has no idea if the chronograph is outputting data that is accurate or merely "close" or, for that matter, not even close. If the muzzle and down range velocities are off, the calculated BC for the bullet will be off as well although the error will be proportionately less. So, for example, if the velocities are high by 10%, the calculated BC will be high by approximately 5%. Therefore it is necessary that the user figure out if the chronograph is reporting accurate velocities and, if not, 1) determine the actual velocity for use in the bullet profile and 2) obtain an error factor to recompute the down range velocity for purposes of computing a more accurate ballistic coefficient.

CALCULATE MUZZLE VELOCITY BY THE POI METHOD

Using the chronograph muzzle velocity and the calculated ballistic coefficient, set up a target at around 400, 500 or 600 yards/meters, adjust the scope for the range of choice and fire five (5) carefully aimed shots. Measure the point-of-impact distance above or below the point-of-aim, open the POI Method tool (Options->Tools-> Calculate MV->POI Method; see "POI Method - Muzzle Velocity in the Field" in this manual) and compute the muzzle velocity as shown by the actual impact points on the target. Depending upon how well the user shoots and how small the resulting group is, this is an extremely accurate way to determine muzzle velocity. Once the actual muzzle velocity is known, first update the bullet profile with this known muzzle velocity. Then, use the original muzzle velocity obtained from the chronograph and divide by the POI Method muzzle velocity. This will give you an error factor. Use that error factor to modify the down range velocity obtained from the chronograph and that will give the actual down range velocity. Using these two corrected velocities, compute the ballistic coefficient again. (It is assumed here that whatever error existed when using the chronograph near the muzzle, that same error will be present at the down range target. It is important, therefore, that the two measurements be taken at near the same time and under the same conditions to maximize the chances that this is true.)

Using this newly calculated ballistic coefficient, run through the process again: if the turret solution remains unchanged, assume the same POI distance on the target and recalculate the muzzle velocity, get an error factor, using the error factor compute the down range velocity and using these two velocities calculate the BC for the bullet. It should be very close to the previous result. If the scope setting did change, then adjust the scope and fire five (5) more carefully aimed rounds at the target, measure the POI versus POA distance and recompute the muzzle velocity, then proceed with obtaining an error factor, apply the factor to the down range velocity and recompute the BC. At some point this iterative process will not produce any meaningful change in velocity and BC at which point the user can be very sure that he has a correct muzzle velocity for that load/bullet and a BC that will produce optimum down range elevation and windage calculations well into the subsonic region.

The user may well be asking why it is necessary to go through all this work just to use the program. The answer is that it isn't. But the user must understand that the program will assume the accuracy of all data that is input and based upon that data will provide a firing solution. If the input data is erroneous, the resulting firing solution will be probably be erroneous as well. In order to discover the errors in the measuring devices that shooters depend upon, it is necessary to check them and to make allowances for their inaccuracies when detected. There really are no shortcuts in this regard.

USER PREFERENCES

OPTIONS MENU

Most user preferences are found by clicking the Options menu item. The user can choose to have the output in English units (the default), metric units, or English units except for range which will be shown in meters; MOA or Mil units; and whether to show the shot angle in terms of degrees (which is the default) or as the cosine of the angle for those using a cosine indicator gauge. These preferences are fairly self explanatory. Note that when a option is selected, it will be remembered by the program thereafter. Although self-explanatory, the option "Angle Cosine" deserves a reminder of its limitations. While angles of fire can be expressed in terms positive (upward) and negative (downward) degrees, a cosine can be expressed only in positive terms; there are no negative cosines. Therefore, entering a cosine will always convert to a positive angle. If a negative angle is entered and then converted to a cosine, the program attempts to remember the sign of the angle and to restore the negative angle when toggling back from the cosine option. Altering the cosine value, however, will probably lose the original sign of the angle and upon conversion back to degrees, the angle will most likely be shown as positive.

Two options not self-explanatory are the "Use Turret Windage" and "Positive Click Values". These option are explained in the Turret Profile section of this manual.

WIND OR TARGET DIRECTION - DEGREES VERSUS CLOCK

There are two other preferences that require some explanation. On the main display page the user can choose to display wind or target direction in terms of degrees (default) or, by pressing the "From" (or "Heading") button, to switch to clock system of wind or heading calls. Direction in terms of a clock face can be input in terms of whole hours (and since each hour represents and additional 30 degrees, the user will necessarily have to be satisfied with a wind call plus/minus 15 degrees), decimal hours or hours and minutes. For example, the user can input 10.5 or 10:30. The two are equivalent and both equal 315 degrees. When moving between the two formats, degrees will be rounded to the nearest 0.5 degree. This is because the program rounds decimal degrees to the nearest whole minute. So converting 270.8 degrees will be shown as 9:02 hours even though it is closer to 9:01.5 hours. Converting 9:02 hours back to degrees will yield 271 degrees, the correct conversion of 9:02 hours. Both wind and target headings work the same way.

STATION VERSUS BAROMETRIC PRESSURE

The second of the two other preferences is the "Station versus Barometric Pressure" election found in the Atmosphere section of the Presets page. Station pressure is the actual pressure at a particular location. Generally if the user has access to a pressure measuring device, such as a Kestrel pocket weather meter, he can get the actual atmospheric pressure at his current location and use that pressure in his trajectory computations. Barometric pressure is different from Station pressure in that Barometric pressure has been "normalized" to sea level. This is the pressure given by meteorologists on television weather stations. The reason for Barometric pressure is so that pressure maps of a region reflect the pressure as measured by a common scale. For example, the standard ICAO sea level pressure is 29.92 inches of Mercury; in Denver at 5000 foot elevation, normal, standard pressure is less because the column of air being measure is 5000 feet shorter. The standard ICAO pressure for 5000 feet is 24.89 inches of Mercury. In other words, on a standard day in Denver, a 24.89 in. Hg. barometer reading would not be a low pressure reading; it would be a normal reading and if Denver were to be magically moved to sea level, it pressure reading would be 29.92. So, for national weather forecasting on a normal day in Denver, the pressure is shown as 29.92 in. Hg. so viewers can tell that the pressure in the Denver area is neither high nor low, but equal to standard conditions.

How does the program use Barometric pressure? When the Barometric pressure preference is checked, the user is asked for both pressure and altitude. If a user learned that the weather station was reporting that Denver had a pressure of 29.92 in. Hg., the user would input 29.92 for the pressure and 5000 for the elevation. The program would use the pressure and altitude to convert the Barometric pressure to the equivalent Station pressure and use that figure for computation purposes.

Clearly the most accurate pressure value is a measurement of pressure directly at the user's location, i.e., Station pressure. If for some reason Station pressure is not available, the next best data is Barometric pressure, which is widely available in broadcasts, plus the elevation of the user's location (generally obtainable from maps.) The Barometric pressure obtained in this manner will be approximate because Barometric pressure is generally broadcast for a large area. But, it is better than a complete guess.

The program's default is to use Station pressure as it is the most accurate; the program was written to be practical so the Barometric pressure as an option was included. But the user is urged to acquire a means of measuring the pressure and temperature where the shot is to be taken. This information is necessary not only for the calculation of a trajectory, but is necessary to fix a zero for a scope (as explained in the Fixed Zero section.) And getting an accurate temperature is important for building a bullet profile and being able to alter the muzzle velocity based upon temperature changes. Get some device that can accurately measure both temperature and atmospheric pressure.

Mils and MOA

Immediately below the Elevation and Windage buttons are the main output windows for the firing solution. The solution will be given in terms of Mils or MOA depending upon user preferences. When the user chooses Mils as the basic unit for expressing elevation and windage data, all solution windows are displayed in terms of Mils. This makes sense if the user has a "coordinated" scope setup, i.e., where the turret scale matches the reticle scale. If both are the same then it is appropriate for the solution to have common units of measure. So, if the user has a Mil-dot reticle and a Mil turret, he will prefer that the firing solution be given in terms of Mil units. Conversely, if the user has an MOA turret and an MOA reticle, he will prefer solutions given in MOA units.

What about the "uncoordinated scope"? It is not uncommon, at least in the United States, for users to have a Mil-dot reticle paired with MOA turrets. With this scope setup the user will want the firing solution to be in terms of MOA units but will want the Lead for a moving target to be given in terms of Mils since he will be using his Mil reticle for all hold offs. To accomplish this setup, choose "MOA units" from the Options list and then press the Lead button to toggle between MOA and Mil units. Once the user has selected these options they will remain in that state thereafter until changed by the user. The program will "remember" these settings between uses. In addition, these preferences will be reflected in the Elevation and Windage tables. Essentially, the Lead units tell the program what type of reticle is being used and reticle related measurements will be output in those units.

Positive Click Values

The turret elevation solution in general produces a result in the form [turret #] "+" or "-" [offset clicks]. Consider a Mil turret with 0.1 Mil click values. A elevation solution of 4.8 Mils can be expressed either as 4 + 8 or 5 - 2. Both are equivalent. Some users prefer to see only positive click values and selecting this option will insure that all turret solution will show positive click values. In terms of the above example, the program would normally show 5 - 2 but with option selected the solution would show the positive click equivalent, 4 + 8. See the "The Turret Profile" section below.

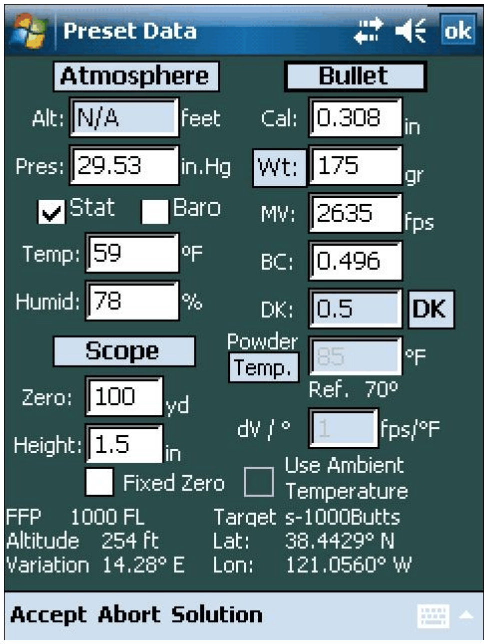
ELEVATION SOLUTION SIGNIFICANT DIGITS

To the immediate left of the elevation solution window is a small unlabeled button whose function is to toggle between the one and two significant digits of the elevation solution. The reason for this option is that some shooters want the elevation solution to be expressed with one significant digit so that the Mil solution can be directly interpreted as a turret setting. For example, a solution of 8.1 Mils is directly understood as dialing to the number “8” on the turret plus one tenth of a Mil, one more click. (Of course this only works if the turret click value is a true 0.1 Mil per click.) Other shooters want to see the amount rounded so that they can “favor” either high or low depending upon the value rounded. If, for example, the actual solution was 8.06, the nearest value is round up to 8.1 which means that the shooter will dial slightly more than needed and can “favor low”. If, however, the 8.1 was rounded down from 8.14, the shooter would favor high due to the fact that the solution was actually a little more than was dialed.

GETTING STARTED - THE BASICS

To use this program it is not necessary to build profiles or use any of the other tools which are provided. To compute a trajectory and to obtain the necessary elevation and windage, the user need only input five sets of data and access only two pages of the program - the main page and the presets page. On the Presets page (click on "Presets" on the Main page menu) enter the following:

1. Atmospheric data consisting of the local station pressure (or the Barometric pressure and an altitude - see Station versus Barometric Pressure in the User Preferences section), the current temperature and the humidity. The humidity has only a tiny impact on atmosphere density so if the humidity isn't known, use 50% and call it good. The temperature and pressure, however, have definite impacts upon the local density of the air which has a consequent impact upon the resistence the bullet will experience as it travels its trajectory to the target. It is important that these values be as accurate as possible.



Alt: N/A feet
Pres: 29.53 in.Hg
☑ Stat ☐ Baro
Temp: 59 °F
Humid: 78 %
Cal: 0.308 in
Wt: 175 gr
MV: 2635 fps
BC: 0.496
DK: 0.5
Powder Temp. 85 °F
Ref. 70°
dV / ° 1 fps/°F
Zero: 100 yd
Height: 1.5 in
☐ Fixed Zero
☐ Use Ambient Temperature
FFP 1000 FL
Altitude 254 ft
Variation 14.28° E
Target s-1000Butts
Lat: 38.4429° N
Lon: 121.0560° W

2. Bullet data consisting of the muzzle velocity (on the importance of obtaining a good and accurate muzzle velocity see the Preparation section, Muzzle Velocity), bullet weight, bullet ballistic coefficient. Leave the DK set at the default of 0.5 until a custom DK has been computed. (This is explained in the Using the Refinements section.) The muzzle velocity must be measured by the shooter; a manufacturer's published muzzle velocity is not sufficient. However, the manufacturer's published bullet weight and ballistic coefficient is sufficient at least at the beginning. Just ensure that the ballistic coefficient is based upon the G1 drag function. Almost all, if not all, bullet manufacturers use the G1 ballistic coefficient so if it doesn't state to the contrary, the published ballistic coefficient most probably is G1 based. (Later the user will want to calculate his own ballistic coefficient using the tools provided in the program. In the meantime, don't be afraid to vary the ballistic coefficient if doing so improves the predictive ability of the program. Manufacturers

using optimistic ballistic coefficient figures is not an unheard of phenomenon and in any case, the drag function on which their calculations are based is undoubtedly not the drag function used in this program.)

3. Scope data consisting of the scope height above the centerline of the bore and the range at which the scope is zeroed. To get the scope height, find a centrally located place on the scope and measure from the center line of the scope tube straight down to the centerline of the bore. It is not necessary to a two decimal point precision measurement; a measurement to the nearest tenth inch is more than sufficient.

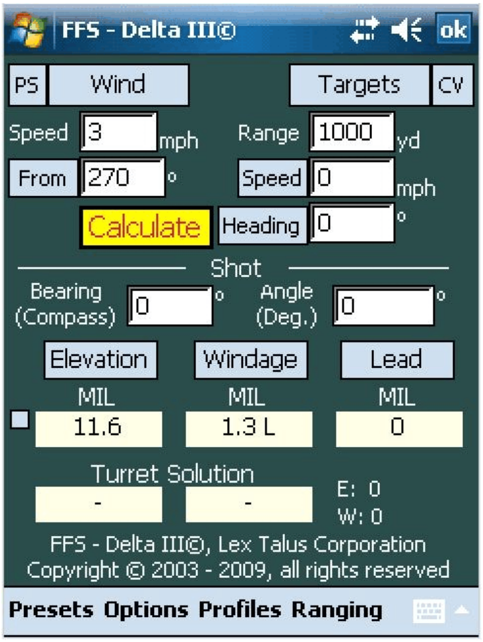
The foregoing data will not change (or will change slowly in the case of temperature and pressure) and generally can be left alone unless the shooting session lasts more than a couple of hours. In that case it's best to recheck pressure and temperature and modify the data as necessary. (Note that the presets page also contains Atmosphere, Bullet and Scope buttons to access the profiles of the same names. The topic of profiles is taken up in the Support Tools section.)

After entry of the Preset data, hit "Accept" and move back to the main page. Once there, enter:

4. The target range and, if the target is moving, its speed and heading. The program will use these to calculate a Lead solution;

5. The wind speed and direction. Remember that wind is called from its source, i.e., where it is coming from, not where it's heading. The program will compute the cross-wind component of the wind and use that to compute a windage correction value.

Following the entry of this data on the main page, hit the "Calculate" button. The results of the computation will be shown right below the "Elevation", "Windage" and "Lead" buttons. These figures represent the firing solution for the data input. Dial the indicated elevation and windage, hold the lead, and shoot.



Speed 3 mph
From 270 °
Range 1000 yd
Speed 0 mph
Heading 0 °
Bearing (Compass) 0 °
Angle (Deg.) 0 °
Elevation MIL 11.6
Windage MIL 1.3 L
Lead MIL 0
Turret Solution - -
E: 0
W: 0

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USING THE REFINEMENTS

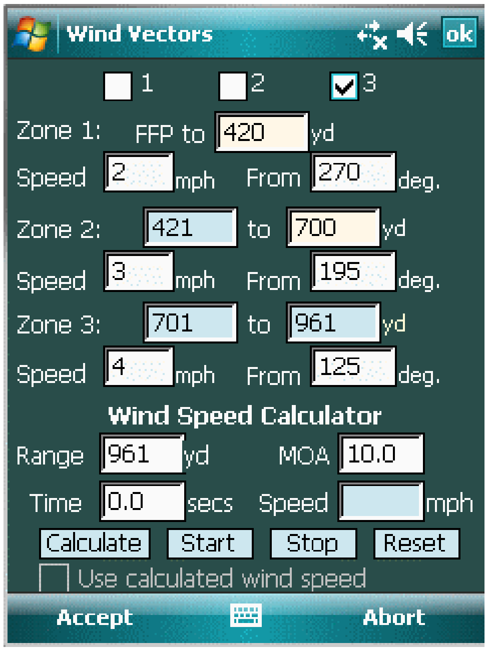
There are several tools added to the program to help refine the calculated firing solution. They are presented here in no particular order.

WIND ZONES

Immediately above the wind speed input window is a "Wind" button. Pressing this button takes the user to a wind zones page where the user can specify up to three separate wind zones that may appear across a course of fire. The purpose of this page is to handle the not so uncommon experience of observing what appears to be wind blowing in two (or even, less commonly, three) directions at the same time.

Check the box for up to three zones, then input the ending range for each zone, the wind speed and wind direction for that zone. Then move to the next zone and input the data pertaining to that zone. When finished, the range should start with 0 in zone one and then finish at the target range for the last zone.

Example: assume that the user is shooting at a target 931 yards away and observes that from his firing position and out for 420 yards wind is blowing in at 270 degrees at 2 mph but then seems to shift and from that point to the target the wind appears to come from 195 degrees at 3 mph in the next zone out to 700 yards and then shifts again to 4 mph from 125 degrees to the target. The setup of the wind zones would look like the image to the right. When the user hits "Accept", the data is transmitted back to the main page but because there is no place to put multiple wind vectors, the wind boxes merely state "Multi" to let the user know that multiple wind vectors are being used; to see the vector values, the user will have to return to the Wind Page.



☐ 1 ☐ 2 ☑ 3

Zone 1: FFP to 420 yd

Speed 2 mph From 270 deg.

Zone 2: 421 to 700 yd

Speed 3 mph From 195 deg.

Zone 3: 701 to 961 yd

Speed 4 mph From 125 deg.

Wind Speed Calculator

Range 961 yd MOA 10.0

Time 0.0 secs Speed mph

☐ Use calculated wind speed

[Note: It is possible to actually track the course of the bullet as it deals with this shift in the wind. From the main page, click the "Elevation" button and look at the far left "Wind" column. This column shows the position of the bullet in terms of MOA or Mils with respect to the range and it is possible to see the movement of the bullet first to the right due to the left wind then slowing in its rightward movement as the wind begins to come from the right. By changing values and direction it is possible to see a right drifting bullet to slow, stop and being to move leftward. As for the never ending argument as to which wind affects the bullet the most, that at the muzzle or that at the target, experiment with the program and see for yourself.]

There is also a Wind Speed Calculator shown on this page, but this tool will be discussed in the Support Tools section. See Wind Speed at Range.

SPIN DRIFT

Spin drift is the movement of the bullet that occurs as a result of the fact that it is spinning about the longitudinal axis and is being subjected to gyroscopic forces resulting from its spin and the aerodynamic forces acting upon it due to the rush of air moving past it. Various and sundry forces arise from these circumstances, but for purposes of this manual let it suffice to say that when the bullet stabilizes in flight after leaving the barrel, its longitudinal axis does not point exactly forward. For clockwise spinning bullets, the bullet comes to a point of equilibrium with its longitudinal axis pointed slightly to the right. In other words, the longitudinal axis of the bullet is not exactly tracking the trajectory; the axis is slightly rotated to the right and the relative wind is striking the bullet slightly more on the left side, pushing the bullet to the right, as the bullet goes downrange. The result of this is what appears to be a drift of the bullet to the right.

While spin drift occurs for all bullets at all ranges, below 500 yards it is relatively a minor measurement and basically ignored. At longer ranges, however, it should not be ignored. A .308 Winchester with a 175 gr. SMK shot at around 2635 fps muzzle velocity will experience spin drift of around 10 inches at 1000 yards. This is nearly one full MOA and obviously significant enough to correct for. The FFS program has the ability to automatically correct for spin drift. On the Options menu, click on Spin Drift and the calculated spin drift will become part of the windage solution. You can check the amount of drift by selecting and then de-selecting Spin Drift and seeing the change in windage.

Irrespective of the range the user intends to shot, there really isn't a reason not to select Spin Drift and leave it selected. At worst, it will have no real impact on the calculations; at best it will keep the user from missing the target.

Rule of Thumb for Spin Drift

In the absence of having the computer handy, is there a fast, "down-and-dirty" way to approximate spin drift? There is. Because spin drift is present in all shots and always is in the same direction for a given barrel twist, it is possible to approximate the amount of drift by assuming a 1 mph cross-wind from 270º (for a right twist barrel). Example: assume wind is 4 mph from 90º to the shooter. Knowing that spin drift has the effect of a 1 mph cross-wind from the left, the net wind is 3 mph from the right and that is the figure the shooter should use to calculate windage. In the reverse situation, if the wind was coming directly from the left at 4 mph, the shooter would add an additional 1 mph and compute the windage for a 5 mph cross-wind. It won't be exact, but it will be close.

POWDER TEMPERATURE

A change in the ambient temperature changes the trajectory of a bullet in two ways: first, a temperature change affects the air density which directly affects the ability of the bullet to move through the air. As the temperature rises, the air become less dense and the bullet will tend to experience less drop over the same range because it is bleeding off its speed at a slower rate. The reverse is also true: a drop in temperature causes the atmosphere to grow more dense, slowing the bullet faster, requiring more time to traverse the same range thereby causing the bullet drop to increase. Bullets will tend to strike the target lower as the air becomes more dense. This direct effect of a changing temperature is handled by the program as part of the way it computes air density from the atmospheric data on the Presets page.

But there can also be an indirect effect of changing temperature. When the temperature drops, powder temperature can also drop, barrel temperature drops and as a consequence of this muzzle velocity drops as well. The reverse tends to be true as well: as temperatures increase, powder temperatures increase, barrel temperatures increase and bullet muzzle velocity tends to increase.

Not all powders behave the same way in this regard and some powders seem to be affected much more that others as a result of temperature fluctuations.[6] In order to deal with this indirect effect of temperature change, an option was included that allows

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[6] The operative word here is "seems". Hodgdon publishes data showing that its "Extreme" brand of powders are very insensitive to changes of temperature. However, the testing methodology is not published. There is at least one article, written by Denton Bramwell in 2003, "Pressure Factors: How Temperature, Powder, and Primer Affect Pressure", that suggests that possibly rising barrel temperature, and not rising powder temperature, is responsible for increased muzzle velocity. Powder temperature may be irrelevant or at least not significant. Find and read the article. There is contrary data, however. Sgt. Glen Roberts, a police sniper who works for the Western Australia Police, has collected interesting experimental data indicating that changing barrel and receiver temperatures does not affect muzzle velocity but changing powder temperature does.

the user to indicate what change of velocity occurs for the powder he uses per degree change of temperature. This requires that the user 1) know what the ambient temperature was when he obtained the muzzle velocity data for his particular load; 2) make some attempt through experimentation to discern how the powder he uses reacts to temperature changes; and, 3) know the current temperature of the powder or at least the surrounding air. All of this data can be input by hand, but is more conveniently stored in a Bullet Profile (discussed in the Profile section of the manual). Upon loading this profile, the program will have the data it needs to modify the muzzle velocity of the cartridge as different atmospheric temperatures are input by the user.

Once the “Powder Temperature” option is checked, the program will assume that the powder temperature is that as recorded in the bullet profile. Or, if the user is experimenting with powder temperatures, the user can keep the powder at a particular temperature and specify that powder temperature irrespective of what the air temperature is. This option is located on the Presets page and is associated with the Bullet data items. Note that when the “Powder Temperature” option is active, the “Powder Temperature” window on the Presets page becomes active and writable.

As an alternative to specifying a powder temperature, the user can simply have the program assume that the powder temperature is the same as the ambient air and make its calculations accordingly. This is done by checking the “Ambient Powder Temperature” box. The user is also free to specify the change in velocity per degree temperature change. As can be seen, while all of the data is conveniently placed in the bullet profile, it is still possible to input all the data by hand. The recommendation is, however, to learn how to create a bullet profile and use that method of storing cartridge data.

As a final note, given Mr. Bramwell’s article as noted in the above footnote and his suggestion that perhaps all powders are relatively temperature insensitive but that barrel temperature actually dictates changes in muzzle velocity, it is possible that this option has been misnamed and should actually be called “Barrel Temperature”. However, as a practical matter it hardly matters. A barrel that has been unfired for a time assumes ambient air temperature. A barrel that is hot transmits that heat to the powder in a fairly short amount of time while the cartridge is sitting in the chamber. We know that hot barrels generally result in higher muzzle velocities, but it would be very difficult to monitor barrel temperature on a shot by shot basis then input the temperature changes into the program in order to change the muzzle velocity. The “Powder Temperature” option is a “refinement” and attempts to make an improvement on the data that is fed to the trajectory calculating engine. On a practical basis, using air temperature and some rate of change metric to vary the muzzle velocity will give an approximation of what is happening to muzzle velocity. It is, in all respects, better than doing nothing at all.

VERTICAL DEFLECTION

Everyone knows that a cross-wind causes a horizontal deflection of the bullet in the direction that the wind is blowing. It is less commonly known that a cross-wind also causes the bullet to be vertically deflected as well.

The reason why the bullet experiences a vertical deflection in a cross-wind has to do with the fact that as the bullet exits the muzzle, within a very short distance, small enough to be measured in few calibers, the bullet noses into the wind. This movement of a rotating body is accompanied by either a dipping or rising of the nose of the bullet until the bullet reaches a state of equilibrium with the various forces acting upon it and results in what is called "aerodynamic jump"[7]. This momentary dipping or rising alters the path of the bullet slightly either slightly uphill or slightly downhill. For a clockwise spinning bullet, a cross-wind blowing from the left will cause the bullet to dip; a cross-wind coming from the right will cause the bullet's tip to lift slightly as it noses into it. The result is that down range, the bullet strikes will tend impact downward and to the right in a left wind and upward and to the left in a right wind along a line intersecting the center of the target and through the 10 and 4 o'clock positions approximately. The movement is relatively small in light winds (6 mph or less) but in heavy winds (10 mph and above) the vertical deflection can become significant which is why it was included.

CORIOLIS ACCELERATION/EÖTVÖS EFFECT

The movement of the bullet due to Coriolis Acceleration is an *apparent* movement that results from the fact that due to the earth's rotation the apparent path of the projectile will seem to curve. In the Northern Hemisphere the curve is to the right; in the Southern Hemisphere the curve is left. In addition, shooting East or West causes the bullet to strike the target higher or lower respectively.[8]

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[7] For more information on this phenomenon, see McCoy, "Modern Exterior Ballistics" (1999), at section 12.9, page 267.

[8] Although commonly referred to as one effect, the vertical deflection in shooting East or West isn't actually part of the Coriolis effect, but is a consequence of shooting on a rotating body. More properly called the Eötvös effect, it is caused by the apparent reduction or increase in the force of gravity as felt by the bullet. When the Coriolis effect option is chosen, the program also computes and applies the both the Coriolis and Eötvös effects to the trajectory.

In small arms, the Coriolis effect is generally ignored. It is basically a time dependent issue and since small arms projectiles are actually in the air no more that 3 to five seconds for extremely long ranges, the amount of target movement is small. Small, however, is not inconsequential. A .308 Winchester shooting a 175 gr. SMK with a muzzle velocity of 2635 fps will have a flight time of nearly 1.8 seconds to 1000 yards and the Coriolis effect will produce an apparent movement of the bullet of about 3 inches in the mid latitudes. Now, 3 inches at 1000 yards is not a great error. On the other hand, it is over 1/4 MOA and is easily correctable with one click of the windage knob. Eötvös effects are similar in terms of degree of magnitude.

The downside to computing a Coriolis/Eötvös error is that the shooter must know his latitude due to the fact that this apparent movement of the bullet is directly influenced by where on the planet the shot is being taken. And he must know his shot bearing to get a complete solution since the bearing will determine the amount of apparent rise or fall of the bullet relative to the target. For this version of the software, this should not be an issue. The software has so many tools that deal with the shooters location that the software expects that the coordinates of the shooting location will be input. And if the user has a GPS that connects to the PDA, getting and inputting the current location is simple. (This topic is fully explained in the GPS and Map Ranging sections of the Support Tools chapter.)

Furthermore, while shooters may argue about the need for a Coriolis/Eötvös computation, if the shooter is using software to compute a firing solution, there is no reason not to include the calculation as a refinement. It costs nothing and can only add to the precision of the solution. Having said that, if a shooter did not have access to a ballistics computer and was computing a firing solution manually, there is little question that the time it would take to include a Coriolis/Eötvös calculation would not be justified. No matter where on earth the shot is taken, the Coriolis/Eötvös components are going to be small and could be zero. In the absence of an automated computing device, there would be no reason to dwell on the subject and the effect should be ignored.

CALCULATING A DK

Most ballistic programs use the same information to calculate a ballistic solution. Once the data is input and the "Calculate" button is pushed, the program churns out an elevation in terms of an angle measurement, conventionally as an MOA or Mil value. The problem is that the point at which the bullet may strike the target is dependent upon more that the bullet, scope, atmosphere and range data the user provides. In particular, the mechanics of the bullet ignition, barrel vibration and shooter interaction with the rifle during recoil all affect and influence the point of impact. That is why it is a fortunate shooter who can buy ballistic software and find that it is dead-on accurate. How could the software anticipate how that particular shooter managed his rifle? How did the software accommodate the varied mechanical aspects of the rifle from ignition to the bullet exiting the muzzle? The short answer is that it doesn't and didn't. As a mind problem, consider two trained snipers and one M40A3 rifle shooting good M118LR ammunition. The proper elevation for a 1000 yard shot is dialed and each sniper shoots five rounds. The rifle is cleaned and allowed to cool before the second sniper fires his five rounds. Same rifle, same scope, same lot of ammunition. What are the chances that the two five round groups will be located in slightly different places? The chances are actually quite good because even though each sniper received similar training, the exact movement of the rifle during the ignition and explosive phases of the bullet launch will not be the same; the rifle/body interface is not the same from individual to individual and each person sees the image produced by the scope slightly differently. These differences can and will cause differences in the precise location of the barrel when the bullet exits which consequently will cause the bullets to impact in a slightly different location on the target. That is why snipers take extensive notes to record how their individual rifle shoots in a variety of conditions and why the previous user of the rifle cannot just pass on his log book. The data for one sniper will not necessarily fit or be useful for another sniper, even though each is shooting the same identical rifle.

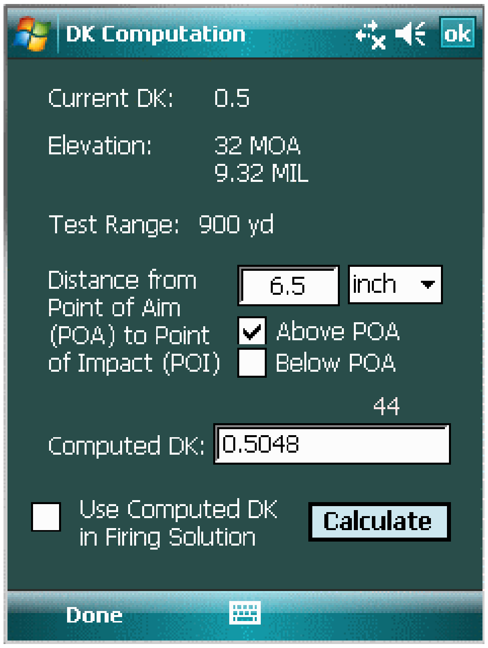
How to deal with this? The answer is to create a way to "customize" the trajectory to enable the user to get the program and his actual experience on the range to match - meaning that if it takes 38.3 MOA for shooter A to get the rounds to hit in the center of the target at 1000 yards, he would like a way to get the computer to predict an elevation of 38.3 MOA for that range. If shooter B shooting his rifle takes 37.8, he wants the computer to predict 37.8 for the elevation. To accommodate both shooters, the software has a constant, the DK value, which will alter the point of impact of the bullet without changing the other calculated parameters such as drop, path, time of flight, etc.. In essence, the trajectory will be customized for the individual shooter.

In order to customize the trajectory for the user of this software it is first necessary that the user follow the Preparation section of this manual. He absolutely must calibrate his scope, obtain a highly accurate muzzle velocity for the specific cartridge he is using, calculate the bullet's ballistic coefficient, and accurately measure and record the atmospheric pressure and temperature the existed at the time of the testing that will be described below. Only after the preparatory work is done does it make any sense to attend to customizing the DK. However, once a DK is found, that DK is good for that rifle, cartridge and shooter thereafter, assuming that the user doesn't alter his shooting style or make changes to his rifle system. If he does, it is best to take the steps necessary to re-establish a DK. Until these steps are taken, the user can and should use the default DK of 0.5. It is amazing how well the default value works for a variety of bullet calibers and weights.

Gathering the Data

The idea behind the DK calculation is to find out the actual drop of the bullet at sufficient range. Given that most of us don't own a backyard Doppler radar, the only practical way we can know how much a bullet drops is to measure the drop by means of the scope turret. Whatever the user must dial to reach a distant target is the angle equivalent of the bullet drop at range. That is why it is so important to calibrate the scope so that the drop measurement is accurate.

After the shooter has calibrated and zeroed his scope and established the muzzle velocity, the user will then take a series of shots at range to compare what the program predicts as the bullet drop with where the bullets actually hit the target. **It is important that this data is gathered at sufficient range. "Sufficient range" means a range where the bullet's velocity has decreased to somewhere around 1200 to 1400 fps.** Do not try to compute a DK from data gathered at high velocities. Trying to gather DK data for a .308 Win. at 300 yards is a complete waste of time as the user is trying to create a value of great sensitivity for rather gross errors. The program is designed to correct the trajectory at distances where well shot rounds begin to significantly diverge from shot to shot. At 300 yards any divergence of bullet impacts is shooter error related and it will take huge changes of the DK to account for relatively small distances at that range.



Current DK: 0.5

Elevation: 32 MOA
9.32 MIL

Test Range: 900 yd

Distance from Point of Aim (POA) to Point of Impact (POI): 6.5 inch

☑ Above POA
☐ Below POA

44

Computed DK: 0.5048

☐ Use Computed DK in Firing Solution

Example: Assume that the user is shooting a .308 Winchester using a Sierra 175 gr. SMK and has measured the muzzle velocity at 2635 fps on a day when the pressure is 29.60 in. Hg. and the temperature is 71 degrees F. The scope height was measured at 1.75" and the scope is zeroed at 100 yards. According to the program, the elevation required for 900 yards is 32 MOA. The user dials 32 MOA and because he has calibrated his scope he knows that the elevation dialed is correct. At the 900 yard line, the user takes five well aimed shots and notes where the center of the cluster is relative to the point of aim. Let's assume that the cluster is centered on the target but above the point of aim by 6.5 inches. Clearly the trajectory is actually slightly flatter in real life than as predicted. What we want is the program to predict an impact point 6.5" higher. Having gathered the data, we can use the “Calculate DK” located on the Options menu. The user merely indicates the distance and direction of the group from the point of aim and taps the “Calculate” key. The program will go into a iterative loop where it changes the DK slowly until the correct elevation is computed for the input conditions.

This DK will work for the user even where the atmospheric conditions change from those that existed at the time of the test. The DK relates to the rifle system and the manner in which the shooter launches the projectile and as long as those conditions remain constant, the DK remains valid. As shown by this example, the higher the DK, the flatter the trajectory, rather like the ballistic coefficient. The user will take this DK and input it into the bullet profile which he has created for this particular round and the trajectories computed will be customized to his shooting.

There is a subtle potential error in this calculation that may have may have perceived. When the user dials in the firing solution, he can only dial in whole clicks. If the elevation is calculated at 32.2 MOA, for example, the turret output will be to the nearest whole click value, or 32 MOA assuming a 1 MOA per click turret. This means that when a shooter dials an elevation solution he can only get within plus or minus a one-half click value with his turret. The implication of this is that if bullet impacts are within one-half of the click value above or below the point of aim, no further correction is necessary as a practical matter. The program anticipates this problem and actually calculates the turret error, compensates for it, calculates the actual distance from the POA the bullet strikes were and then calculates the DK. Therefore, irrespective of the turret error and how close the point of impact is to the point of aim, the program will calculate an accurate DK. The point here is only that any firing solution is only as close as the turret click values permit. A 1 MOA per click scope does not get any more precise because the user calculates a DK out to 5 decimal points. And the resulting firing solution can only be implemented by the scope plus or minus one-half of its click value. So, don’t get carried away with computations that have no real meaning or application given the equipment available.

There are other reasons why the 6.5 inch error arose including the possibility that the derived muzzle velocity was off by a few feet per second, or the calculated ballistic coefficient was slightly off, or there was a slight undetected updraft on the range that day. Be reluctant to change the default DK and do so only after all other factors have been resolved.

SUPPORT TOOLS

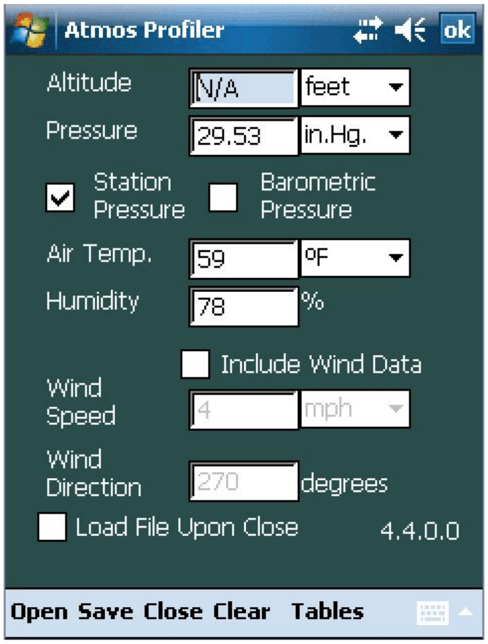
There are a number of tools offered in the program to help in various ways to support a cold clean bore, first round hit at range and to thereafter aid the user in rapidly engaging multiple targets. Where possible, useful data is pre-packaged in files called “profiles”; tables are provided to organize target acquisition, elevation and windage data; data for each individual shot can be logged; timers are offered to help compute the speed of objects, people or wind at distance. This chapter will explore in detail each support tool offered in this software.

PROFILES

As the user reads through the profile section, be aware that all profiles, once completed and saved, can be loaded automatically upon exit by checking the “Load File Upon Close” box. In prior versions of the software, once a profile was completed, the user was required to save the data file, close the profile form, return to the main program window, choose profiles from the Options menu and then “Open” the relevant profile and choose the file he just created. In this version, all “just created” profiles can be loaded directly from the profiler form upon close.

A. THE ATMOSPHERE PROFILE

The program comes with two standard atmosphere profiles: the ICAO and Metro profiles. These are the two most commonly used standard atmospheres and are included mainly as examples although if the user wanted to compare the data produced by this software with some published ballistic tables, it is likely the case that the tables were produced using one of the included atmosphere standards.

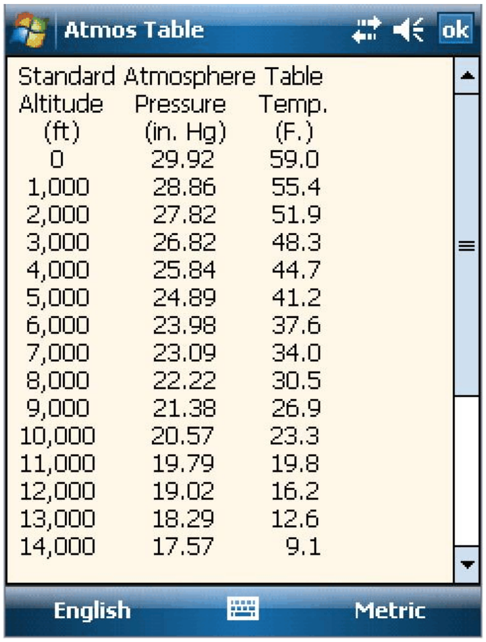


Altitude N/A feet
Pressure 29.53 in.Hg.
☑ Station Pressure ☐ Barometric Pressure
Air Temp. 59 ºF
Humidity 78 %
☐ Include Wind Data
Wind Speed 4 mph
Wind Direction 270 degrees
☐ Load File Upon Close 4.4.0.0

To build, edit or to simply inspect the content of an atmosphere profile, the user taps “Profiles” on the main menu, then “Atmosphere” then “Build/Edit”. At this point the Atmosphere Profile form appears and looks like this except the various data window areas will be blank. The user can create an atmosphere profile by filling in the pressure, temperature, etc., and then tapping the “Save” menu item and giving a name to the profile. Why would a user want to save this data? If the user commonly shoots in an area where the weather conditions are generally the same from week to week, saving the data is a quick way to load all of the data at one time and then making small modifications on the Presets page as necessary. It is a time saver and nothing more. Note that the user can choose whether to save a wind speed and direction in the profile. If a particular location has a prevailing wind, opting to include a wind speed and direction makes sense.

The user will chose whether the atmospheric pressure being saved is the actual pressure as measured on site (Station pressure) or the pressure normalize to a sea level value (Barometric pressure). If barometric pressure is going to be used, by checking the “Barometric Pressure” box, the Altitude data window becomes writeable and the user will need to input an altitude associated with the barometric pressure.

Once an Atmosphere Profile has been made and saved it can be quickly accessed by tapping “Profiles” on the main menu, then “Atmosphere” then “Open”. Whatever atmosphere profiles exist on the PDA will be listed in the dialog box. Click on the profile of choice and the atmosphere variables contained in the profile will be fed into the program. The user can check that the data has been successfully imported by either tapping the “PS” key on the main form (upper left hand corner) or by going to the Presets page.



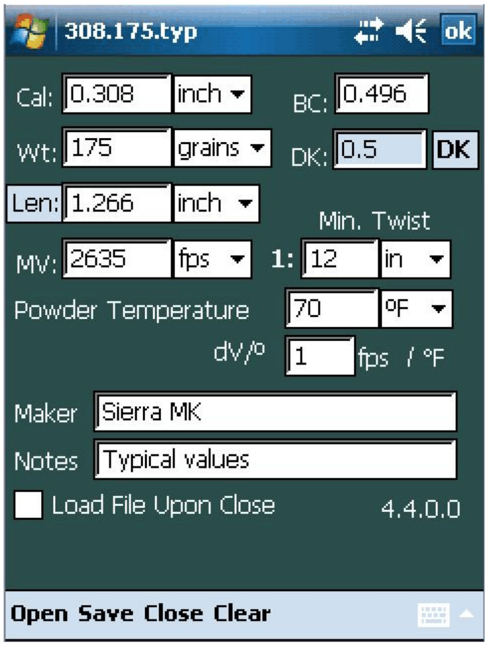
Standard Atmosphere Table

Altitude (ft)	Pressure (in. Hg)	Temp. (F.)
0	29.92	59.0
1,000	28.86	55.4
2,000	27.82	51.9
3,000	26.82	48.3
4,000	25.84	44.7
5,000	24.89	41.2
6,000	23.98	37.6
7,000	23.09	34.0
8,000	22.22	30.5
9,000	21.38	26.9
10,000	20.57	23.3
11,000	19.79	19.8
12,000	19.02	16.2
13,000	18.29	12.6
14,000	17.57	9.1

On the menu at the bottom is a “Tables” item. Tapping this item produces a Standard Atmosphere Table showing data in both English and metric units. This table is provided for reference purposes so that if the shooter has no ability to obtain the station pressure or Barometric pressure, he can figure out a reasonable standard value by interpolating between elevations. Note that if a standard pressure is used in the profile, only the pressure and possibly the temperature would be used, not the related altitude. Why? Because the table is showing the standard *station* pressure at the related altitude. If it were showing the Barometric pressure, all of the entries would be 29.92 in. Hg. (or 1013 hPa). Do not make the mistake of using station pressure plus altitude. The resulting air density will be very low and the trajectories will look very flat.

B. THE BULLET PROFILE

The user is encouraged to complete a bullet profile for each bullet he uses. A completed profile for a relatively common .308 Win. cartridge is shown. It is important that all of the data items are filled in as each is used by the program to compute some part of the trajectory. The failure to complete the form or input erroneous data will cause the program to either malfunction or yield wrong results. As they say, garbage in, garbage out. Of particular importance is the "Min. Twist" data item. When building a Rifle Profile, the user will input the rifles actual twist. In the absence of a rifle profile, the program will look to the bullet profile for the twist information. The program uses the twist information in portions of the trajectory computation and the failure to include it will cause the program to fail. So in completing the Bullet Profile use either the minimum twist as recommended for that particular bullet or use a twist that is representative of the twist rates of the rifles generally used by the user that shoot that bullet.


308.175.typ

Cal: 0.308 inch

BC: 0.496

Wt: 175 grains

DK: 0.5

Len: 1.266 inch

Min. Twist 1: 12 in

MV: 2635 fps

Powder Temperature 70 ºF

dV/º 1 fps / ºF

Maker Sierra MK

Notes Typical values

☐ Load File Upon Close

4.4.0.0

The DK data item is set to the default of 0.5. The value will change only when the user performs the necessary field experimentation and calculation to yield another number as explained in the "Computing the DK" section of this manual above.

The "Powder Temperature" is the temperature at which the muzzle velocity was obtained. Remember that when this data loads, the muzzle velocity may change if the ambient temperature is different from the temperature at which the data was collected.

Note also the dV/º text box. This means "change of velocity per degree" and requires a value representing the powder sensitivity to temperature changes. The velocity will be the same units as used to express muzzle velocity; the degree units will be the same as those used to express the powder temperature. The value that is used is a result of experimentation. Measure the velocity of the particular load on a cool or cold day; repeat on a warm or hot day. Take the difference in muzzle velocities and divide by the difference in temperatures. The result will be the change of velocity per degree.

Finally note the bullet length text box. If the bullet length is unknown, check the bullet database to see if it is listed, or simple take a set of calipers and measure the bullets being used. The length of the bullet is required to compute spin drift as a function of barrel twist rate. In the absence of a bullet length, enter zero and the default spin drift function will be used; it will be the same for all twist rates. While not exact, it will be close.

C. THE OFFSET PROFILE

The offset profile is linked to a particular rifle (which is itself linked to a particular set of cartridges) and provides a method to compensate for a shift in bullet point of impact due to 1) a change of ammunition; 2) a change of shooting position; or, 3) a change of shooter. Any of the foregoing can cause a change in the impact point of the bullet on the target. When a change of this type occurs there are only three basic ways of dealing with it: 1) make a mental note to hold for the change; 2) when dialing elevation and windage, adjust the numbers for the offset and dial the adjusted numbers; or, 3) re-zero the scope. The Offset Profile effectively implements option number 2. By indicating what the offset is and how to bring the new point of impact back to the point of aim, the user has provided the program with sufficient data to "correct" the elevation and windage solutions such that the round will strike where the shooter is aiming without having to adjust the scope.

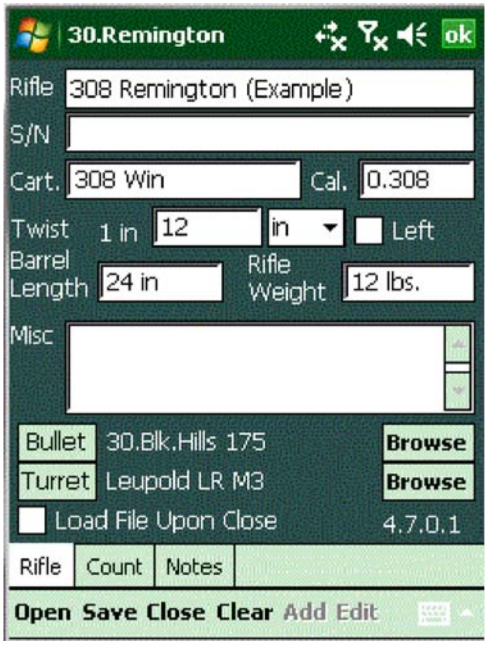
The implication of the offset profile is that each cartridge that causes a change of POI should have his own offset profile. Each position that results in a change in POI should have its own offset profile. For example, if a rifle is zeroed for a particular type of ammunition while shooting off a bipod, if there is a shift of POI when the shooter uses a pack to shoot off of, he need only select the offset profile which corrects for that shift; the program will take care of the rest and continue to give correct firing solutions. Further, it is a good idea to name these files in some descriptive way so that when accessing the file the user can tell what the file relates to just by looking at the file name. There are many ways to do this and the user is encouraged to devise his own comprehensive file naming protocol. A possible approach is set forth in the Appendix.

When an offset profile has been selected it is important for the user to know that it has been implemented and that the elevation and windage solutions have been altered as a result. In the lower right hand corner of the main page are indicators as to the type of correction being made (bipod, pack, bench, etc.) and the corrective elevation and windage offset. When no offset profile has been loaded, these indicators show zero. Any offsets are also visible on the profile summary page discussed below.

D. THE RIFLE PROFILE

The rifle profile has three major functions: first, it is a location to associate a primary bullet profile, all related cartridges used by the rifle, and a turret profile which will be loaded at the same time a rifle profile is selected; second, it refines the twist data to exactly that of the rifle in question; third, it permits the saving of rifle systems that may be used in a unit such that if someone in the unit experiences a PDA failure, another member may be able to quickly obtain ballistic solutions for that unit member's rifle system by simply opening a rifle file reflecting his system.

The rifle profile, shown here, is comprised of a main page which has relevant information about the rifle, including the bullet and turret profile to use, a round count page where daily round expenditures can be logged and a notes page where problems or maintenance reminders can be recorded. Once a bullet profile is selected, the bullet label becomes an active button that will open the bullet profiler to enable the user to make changes to the bullet profile while in the rifle profile work area. The same thing is true for the turret once it is selected. This is designed to save time and present a compact manner of data presentation.



Rifle 308 Remington (Example)
S/N
Cart. 308 Win Cal. 0.308
Twist 1 in 12 in ☐ Left
Barrel Length 24 in Rifle Weight 12 lbs.
Misc
Bullet 30.Blk.Hills 175
Turret Leupold LR M3
☐ Load File Upon Close 4.7.0.1

E. SAVING A COMPLETE SOLUTION

Although the Solution item is listed in the profile menu, it technically isn't a profile at all. Basically saving a solution means to save the entire setup as it then exists. The program does this automatically each and every time the program exits. This is how the program can start from where the user left off in a previous session. When the program starts it looks for a file called "eSession", opens the file and loads the data saved from the previous session. The only time when there is no eSession file is the very first time the program starts.

The value of saving a complete data set is limited. It is helpful if an area where the user generally shoots has a fairly consistent weather pattern and the user shoots the same rifle system. It is also helpful if the user wants to save a particular setup for further analysis at some later time. The program comes with a standard solution called "Reset" which causes everything to zero out to bring the program back to a zero state. A user may make other "zero state" solution files by setting up the program with the basic elements he wants and then saving that solution.

F. THE TURRET PROFILE

1. The Simple Turret Profile

The purpose of the turret profile is to provide an elevation that is correct for the user's scope. The problem is this: assume that the calculated elevation required for a particular range and cartridge is 11.6 Mil (41 MOA). If the scope's correct click values, it is fairly simple to dial the calculated elevation. But if the click value is somewhat in error, dialing the calculated elevation becomes more of a challenge. Say, for example, that the click value on a particular user's scope is is not 0.1 Mil/click, but instead is 0.105 Mils per click. In that event dialing 11.6 Mils would result in an actual movement of the reticle equal to 12.18 Mils (0.105 Mil/click x 116 clicks.), 0.58 Mils too much. The bullet is going to hit almost 0.6 Mils high.

The way to deal with turret click value errors is to create a turret profile where the user will input the "nominal" click value, i.e., the value that the manufacturer intends it to be (in our example 0.1 Mil/click) and the "actual" click value, then one computed by the user when using the scope calibration techniques explained elsewhere in this manual. With these two values, the program can compute not only the required elevation, but the "turret elevation", the elevation that needs to be dialed on the user's scope in order to move the reticle the calculated amount. Going back to the above example, for this particular scope in order to actually move the reticle 11.6 Mils, the user would only have to dial 11 Mils (11 Mils x 0.105 = 11.55 Mils). The turret profile, when loaded into the program, will calculate the correct elevation the owner of this scope must dial and present that value in the "Turret Solution" windows on the main page.

In order to make a simple turret profile, the user need only calibrate his scope to determine the "actual" click values, put in both nominal and actual elevation and windage in the profile, state the zero range and scope height. The profile is finished and usable. For the "simple turret profile," the rest of the profile form can be ignored. Everything below the horizontal line shown in the Turret Profiler (see next graphic) is optional.

2. The Complete Turret Profile

It is possible to convert an elevation calculation into the equivalent turret scale setting. The key to making a complete turret profile is to record the turret scale numbers and associated click values in the lower half of the turret profile. Essentially what this entails is starting from 0 and then sequentially entering the turret numbers of the elevation turret and for each number entered, also entering the number of clicks from zero that turret number represents. Below are three examples: a multi-revolution turret such as is found on many 1/4 MOA scopes; a one or two turn turret such as found on many Mil turret scopes today; and a BDC turret. Irrespective of the type of turret, the idea remains the same: the Turret Profiler gets from the user actual and nominal click values for both elevation and windage, the scope zero, the scope height and the association between the turret numbers and the related clicks for that number so that the program can convert a calculated elevation into an equivalent turret setting using the actual click value for that particular scope.

Example 1: a multi-rev turret that has an actual 0.26 MOA per elevation click (change the value from 0.25 to 0.26 for this example.)

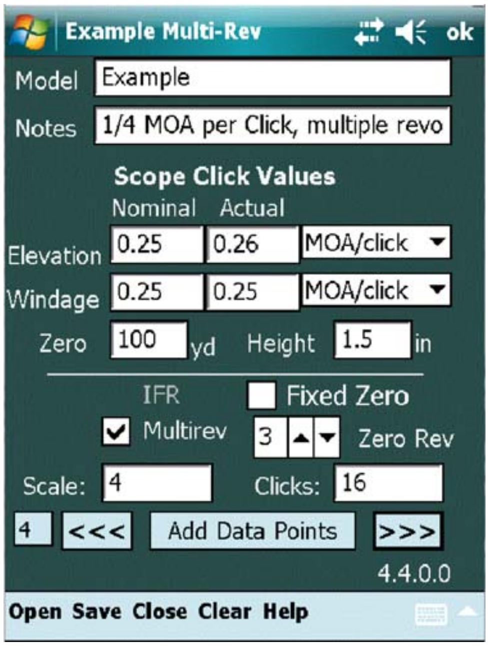
Multi-Rev type turret: Open the "Example Multi-Rev" turret file

Turret Number Scale:	0	1	2	3	4	5	6	7	8	0
Number of Clicks:	0	4	8	12	16	20	24	28	32	36

The actual numbers on this turret only go to the number "8" but it is necessary to account for the **complete** rotation and in this case it takes 36 clicks to make one complete rotation where the beginning number "0" appears.

These numbers in are entered in pairs, first the scale number and second the associated number of clicks. In the example at the right, the numbers 4 and 16 have just been entered and ready to be stored. Next it is necessary to add those data points to memory, so the user taps the "Add Data Points" bar. The program stores that pair of numbers, goes to the next position and waits for the entry of the next pair. When the last pair is entered this way (the 0 and 36 pair), the user hits "Save" to save the turret file. Assuming the other data items have been entered, the turret profile is complete.

Note the little box to the far left of the "Add Data Points" bar. That is simply a counter indicating which number pair is being entered. In this case it is the fifth pair (remember, it starts from 0 not 1), 4 and 16. After these points have been added, the counter will advance to 5 and the "Scale" and "Clicks" windows will be blank waiting for the next pair of numbers.



Example Multi-Rev

Model: Example

Notes: 1/4 MOA per Click, multiple revo

Scope Click Values

	Nominal	Actual	
Elevation	0.25	0.26	MOA/click
Windage	0.25	0.25	MOA/click

Zero 100 yd Height 1.5 in

IFR ☐ Fixed Zero

☑ Multirev 3 Zero Rev

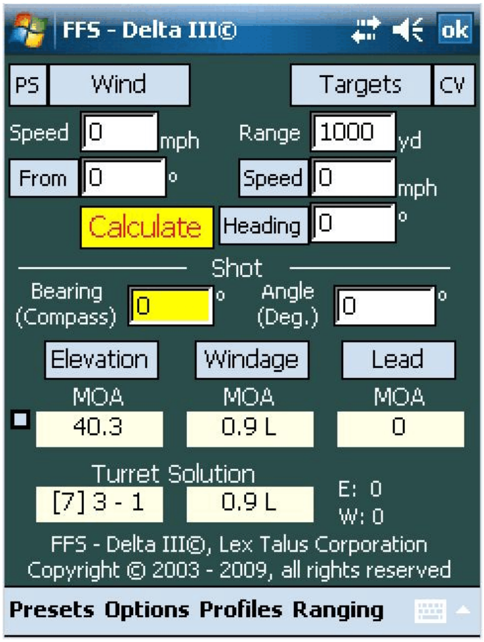
Scale: 4 Clicks: 16

4

4.4.0.0

Important Note: The Multi-Rev turret is the simplest to make since we record the scale numbers and their respective clicks for a single turn only. Once the Scale/Clicks data has been entered for a single, complete revolution that part of the data entry is done. Do not continue to enter data past that single revolution.

Make sure to indicate which revolution is the "zero" revolution, i.e., where the scope is set to the zero range. On most multi-revolution scopes it doesn't have to the first revolution and if the user has a sloped scope rail, it probably won't be. To the right is a firing solution using the example cartridge showing both the elevation in MOA and its equivalent turret solution for the above turret. Note the value in brackets. This is the revolution count. The next number is the turret number and the number following the "-" is the number of clicks to turn back from the turret number. Note also that because the actual value for the clicks of this scope was "0.26" instead of the nominal 1/4 MOA, the turret solution is just a little less that what would be expected for the elevation calculated. (The normal setting for a 40.3 MOA solution is [7] 4 + 1.) That is because with each click, a little more than 1/4 MOA was actually dialed. This small one-hundredth of an MOA error added up to a two click or one-half MOA difference[9].



FFS - Delta III©

Speed 0 mph Range 1000 yd

From 0 ° Speed 0 mph

Heading 0 °

Shot

Bearing (Compass) 0 ° Angle (Deg.) 0 °

Elevation	Windage	Lead
MOA	MOA	MOA
40.3	0.9 L	0

Turret Solution

[7] 3 - 1 0.9 L E: 0 W: 0

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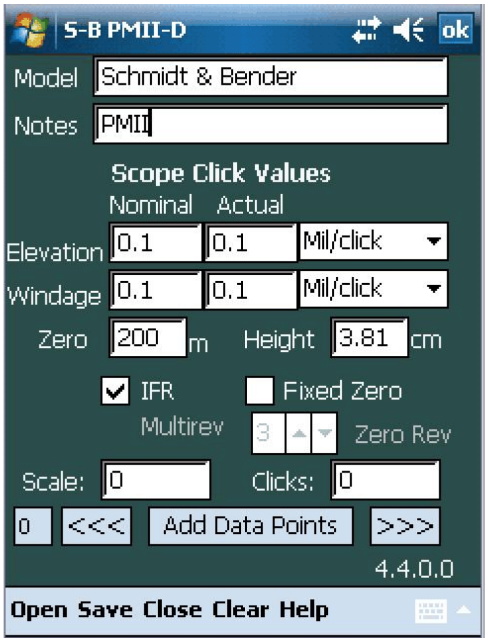
[9] This is the math: the zero revolution for this turret was three, so a value of revolution [7] means 4 x 36 = 144 clicks. Add 4 x 4 clicks + 1 equals 161 clicks. Divide by the nominal click value

Example 2: a standard single or double turn scope.
Standard Turret - single or double turn (Open the "Example Standard" profile)
[This profile is based upon the US Optics SN-3 with ½ MOA nominal click values.]
Turret Number Scale:
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 0
Number of Clicks:
0 6 12 18 24 30 36 42 48 54 60 66 72 76 84 90

This particular scope has only one complete turn. However, for scopes that have two turns and a double scale, the data point entry remains the same. They are treated as if the scale was linear and just continued except that for the end of the first complete revolution there will be a number there instead of 0 because on the scale itself there is an actual number that starts the second revolution.

The rest of the data entry is the same in terms of entering the actual and nominal click values, the zero and scope height, but the "Zero Rev" is meaningless so without the "Multi-Rev" box being checked, all is grayed out as can be seen in the graphic to the right.

What about the "IFR" box? IFR stands for "Incomplete Final Revolution" and applies to scopes that do not completely revolve 360 degrees for the final revolution. For example, the Schmidt & Bender PMII scopes that have the Mil turret are approximately a 1 and ½ turn to go from 0 to the maximum elevation of 26.5 mils. The first revolution goes from 0 to 17 mils which is one complete revolution. The second revolution starts with 17 but ends short of the 0 mark and goes only to 26.5. In these cases, the user must check the IFR box.


S-B PMII-D
Model: Schmidt & Bender
Notes: PMII
Scope Click Values
Nominal Actual
Elevation 0.1 0.1 Mil/click
Windage 0.1 0.1 Mil/click
Zero 200 m Height 3.81 cm
☑ IFR ☐ Fixed Zero
Multirev 3 Zero Rev
Scale: 0 Clicks: 0
0
4.4.0.0

The reason why this is important has to do with how the computer will convert negative elevations into a turret equivalent. For example, if the Example Standard scope is set to a 200 meter zero, to adjust for 100 meters the scope must be

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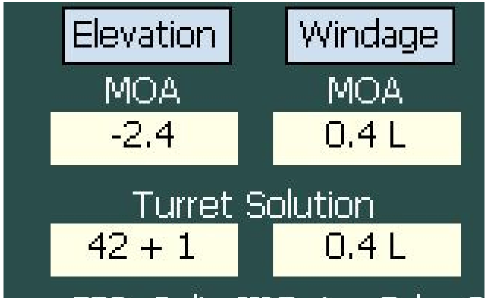
of 1/4 MOA per click (161/4) equals 41.25 MOA. The click value of this particular scope was 0.26 MOA/click and the solution showed [7] 3 - 1. That is four revolutions for 144 clicks plus (3 x 4) - 1 = 11 more clicks for a total of 155 clicks. Multiply the total click by 0.26, the value per click, equals 40.3 MOA. The program correctly showed the correct turret setting for a scope that had an actual click value of 0.26 MOA per click.

dialed *down* a few clicks. On the following page are two graphics showing the result in a rifle shooting typical .308 Win. ammunition with a 175 gr. bullet. Note that in the case of the <u>complete</u> second revolution, the turret solution can be shown by going backwards on the turret and using the numbers on the second scale. (The same thing would happen in the case of a single revolution turret where it makes a complete first revolution. This isn't always the case as shown in the BDC disussion below.) However, where the second revolution is short, it would make no sense to begin counting backwards from the last number since it would take many clicks to get to the last number. Rather, the program will simply subtract the number of required clicks from 0. Anything else wouldn't make sense.

To the right is a turret profile for the Schmidt & Bender PMII which has an incomplete second revolution. The 'IFR" box is checked to denote that condition. As a result, when a negative setting needs to be made, the turret solution will denote this condition by showing zero and a negative number. See the two examples which follows:

Complete Revolution

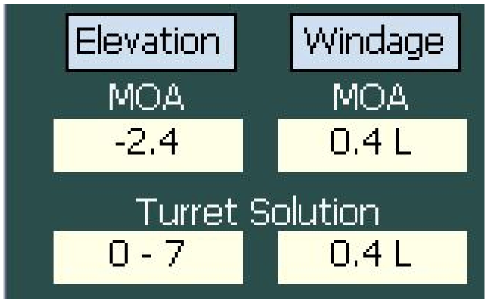


MOA -2.4 | MOA 0.4 L

Turret Solution: 42 + 1 | 0.4 L

Here the solution is expressed in terms of the first turret number below the "0" which is "42." Because the turret completed its last (which can be the only) revolution, counting backwards makes logical sense.

Incomplete Final Revolution



MOA -2.4 | MOA 0.4 L

Turret Solution: 0 - 7 | 0.4 L

This shows a Schmidt & Bender PMII with a Mil turret which does not complete the second revolution. To show a negative elevation, the turret solution does not show the next number below "0" because that next number would be 26.5, many clicks below the 0. Therefore, with the "IFR" box checked, the program does not look for the next lower number, but calculates the turret solution by simply subtracting the number of down clicks from zero.

The PDA program comes with example turrets so the user can open the example turret and move through the pairs to see how it is done. Do not be discouraged if the program produces an error when the new turret profile is used.

Carefully check the data, particularly turret data pairs. Step through the pairs and make sure that they have been entered properly. If not, simply change the values and hit the "Add Data Points" for each changed pair. If the profile is still not working, send the file to TechSupport@lextalus.com and ask for help in tracking down the problem.

Positive Click Values

The turret solution may show a cardinal number and either plus or minus a given number of clicks from that number, such as 4 + 3 or 5 - 2. Some users may not want the turret solution to show negative offsets but would rather have all turret solutions in plus clicks only, so instead of 5 - 2, they would rather see 4 + 8. To achieve this output, choose "Positive Click Values" listed at Option->Turret Options on the main page. With this option checked, all turret solutions will show only positive click values **except** for negative elevations involving IFR turrets. Those solutions will continue to show a negative offset from 0.

MUZZLE VELOCITY FROM A CHRONOGRAPH

The chronograph indicates the bullet's velocity at the location of the measuring unit, not at the muzzle. The military obtains "muzzle velocity" data that is actually produced at 78 feet from the muzzle. It is common for private shooters to measure bullet velocity at 15 to 20 feet from the muzzle. What is clear is that this data reflects the bullet's velocity at some point downrange from the muzzle; the actual muzzle velocity needs to be derived from this downrange data. The program has a tool to help the user in this regard. Choosing Options, Calculate MV, Chronograph, will open a workspace for this purpose and will permit the user to calculate the actual muzzle velocity of the bullet based upon the chronograph data. The distance to be used is measured from the muzzle to a point midway between the two photo-sensors.

POI METHOD - MUZZLE VELOCITY IN THE FIELD

After obtaining the muzzle velocity of any given cartridge by using a chronograph, it is essential to check the data by confirming the trajectory at a range between 300 and 600 meters. The program has a tool to help the user in this regard. Choosing Options, Calculate MV, POI Method will open a workspace designed to correlate the point of impact on the target with a muzzle velocity. The user may ask why this step is necessary given the fact that the muzzle velocity has been measured directly by a highly precise piece of equipment. "Highly precise" doesn't necessarily mean "accurate." A chronograph is not self-calibrating and there is no way for most shooters to determine whether his chronograph is outputting accurate numbers. Using the POI method to determine muzzle velocity is a good way to check the chronograph and these checks may show that the user's chronograph is habitually giving results above or below the actual muzzle velocity.

This tool can also be used to determine the muzzle velocity of cartridges where a chronograph is not available. Essentially, the user must have knowledge of bullet used in the cartridge and its ballistic coefficient and weight. The user will also know at least the published muzzle velocity value and with these numbers can fill in the Presets page. Set a target at 300 to 600 meters and set the elevation as calculated by the program. Assuming that the weight and BC are correct, any deviation from the trajectory will result from an incorrect muzzle velocity. Input the distance above or below the point of aim that the bullet strikes the target and the program will calculate the muzzle velocity necessary to have placed the bullet where it did.

FIELD ZERO

In the Options->Tools menu there is a Field Zero item. The form comes with its own explanation which can be accessed using the on form Help menu. In summary, the field zero function enables a user to verify a previously set zero using a range that is shorter than the zero range. This is a common problem for anyone who arrives in an area of operations after transport of the rifle system and finds that the local area does not permit marking off enough range to verify that the rifle's zero has not changed. The Field Zero tool allows the use of a shorter range and predicts where the bullet strike should be, relative to the point of aim, given a specific zero. So, if a rifle is zeroed at 500 yards but the user has only 75 yards to check the zero, depending upon the exact atmospheric conditions, the round should be hitting around 9 inches above the point of aim (Federal 308 Match) to reach a zero point at 500 yards. While it would clearly be better to check the zero at the zero range, where that is not possible a field zero is the next best thing. The Field Zero form can also be used to change the scope's current zero range to a new range. Just change the "Zero Range" and see what the point of impact should be for that zero range, adjust the scope until the bullet is hitting that spot. The scope has effectively been re-zeroed to a different range.

FIXED ZERO

A related subject to the Field Zero discussion above is the concept of a fixed scope zero. In the physical world when a rifle is zeroed, it is zeroed in certain atmospheric conditions which dictate the trajectory and influence the muzzle velocity of the projectile. At some later time and in another location, the conditions might be very different, but the scope is set up for the earlier conditions. Where is the zero?

Assume that a rifle system shooting Federal 308 Match ammunition was zeroed at 700 yards on an standard ICAO day . The next day the rifle and shooter are transported to a location with an altitude of 5000 ft. The temperature is 75 degrees F and the station pressure is 23.6 in. Hg.. Where is the zero? The relationship between the rifle and the scope has not changed, but the trajectory at 5000 feet is going to be flatter than it was at sea level. In fact, with the scope set for 700 yards at sea level, at 5000 feet and 75 degrees F the bullet will be impacting the target 1.1 MOA high at 700 yards. The actual zero has changed to approximately 733 yards.

It is possible to use this program to account for this change without having to re-zero the rifle. When the zero is first obtained, the user can “fix the zero” by 1) insuring that all of the atmospheric and bullet conditions are entered into the computer and then checking the “Fixed Scope Zero” box in the turret profiler. (In this case enter a standard ICAO atmosphere, use a Federal 308 Match cartridge and assume a muzzle velocity of 2600 fps.) The program no longer assumes a constant zero of 700 yards (which requires a constantly changing or floating reticle to match changing conditions) but assumes a fixed reticle and allows the zero range to change based upon current conditions. The zero range is allowed to change as conditions change; the scope’s setting is fixed.

At sea level the above scope zeroed at 700 yards will require an additional 12.4 MOA to get to 900 yards. At the new location of 5000 feet ASL, a scope zeroed for 700 yards under standard 5000 foot conditions will require only 10.3 MOA to get from 700 yards to 900 yards. But a scope zeroed at sea level conditions for 700 yards and then taken to 5000 feet (using the atmospheric data above) and without changing the zero would require only an additional 9.3 MOA to get to 900 yards. The reason why is that the scope zeroed at sea level but fired at 5000 feet is now shooting 1.1 MOA high at 700 yards. Because of the elevated impact point it takes fewer MOA to get to 900 yards.

When a rifle has changed locations, the user may either re-zero his scope or keep his sea level zero and check the “Fixed Zero” box and allow the program to calculate the turret settings under these new atmospheric conditions. The advantage of not having to re-zero with every change of location is obvious. The program will make the adjustments and give the proper elevation if the user has “fixed the zero” for the original conditions under which the rifle and scope were zeroed.

Note that this advantage disappears for close zeros. The difference between points of impact for a 100 yard zero at sea level and a 5000 foot 100 yard zero is 0.022" or 0.021 MOA (for .308 Win. match ammunition). For all purposes, that zero is not materially different. If the user uses close zeros under 200 yards or, perhaps, even 250 yards, he need not be concerned with shifting zeros in changing conditions. A rifle zeroed at 300 yards, on the other hand, will see a zero shift in POI of nearly 3/4", a quarter of an MOA, and perhaps enough to justify the "Fixed Zero" option. The user is encouraged to experiment to see what changes may occur given his particular zero preference. Remember, these figures are only valid for .308 Win. match ammunition. Different calibers/cartridges will yield different results and flat shooting cartridges may not have significantly changed zeros out to as far as 400 yards.

Wind Speed at Range

Figuring out the wind speed at range is something of an art. There are handy and highly portable wind measuring devices that accurately measure wind speed but those will tell the wind speed only at the shooter's location. Most long range shooters develop skill in doping the wind at range by looking at mirage and the movement of grass, bushes and trees. The FFS program offers an additional tool in this regard.

Tapping the "Wind" button brings up the Wind Vector screen. At the bottom of this screen is a "Wind Speed Calculator". If the user can see some air borne particulate matter at a known range, the user can measure the movement of the matter across the reticle while timing the movement. Basically the user will have timed moving material over a known distance for a known time which can be used to calculate a velocity of the particulate matter which should equal the wind speed.

Example: Say at 950 yards is some burning rubble and the smoke is moving from left to right across his field of view. The shooter starts the timer as the smoke crosses the far left edge of his reticle and when the smoke crosses the far right edge of the reticle he stops the timer. The shooter knows that the entire horizontal element is 10 mils wide. When he stops the timer, 1.9 seconds have elapsed and the calculator declares that the smoke is traveling at 3 mph. That value matches the wind speed he measured at his shooting location so he is confident 3 mph is a good value to use over his course of fire.

So how does the shooter hit the "Start" and "Stop" buttons while he is trying to watch the smoke through his scope? Well, he doesn't have to. The timer in Wind Vectors screen is tied to the button cluster hardware on the front of the PDA, specifically the "Enter" button. Generally the center button of the cluster is the "Enter" button and the first push will start the timer while the second push will stop the timer. Essentially the program turns the PDA into a stopwatch. The shooter merely puts his thumb on the Enter button, looks through the scope, starts the timer and then stops the timer without ever having to look away from the scope. The results appear automatically.

If the shooter wants to use the results of the calculation, he checks the box to use the calculated value and exits. When he is using more that one wind zone, the “Use calculated wind speed” box is grayed out because the program can’t know which zone the calculated value applies to so the user will have to enter the value in the proper speed box.

It is important to note that when observing wind effects through the scope, the shooter is seeing only the component of the wind that is moving at right angles to the line of sight and the speed measured is not wind vector but only that perpendicular component of the vector. Therefore, when the “Use calculated wind speed” box is checked, the program will change the wind direction to either 90 or 270 degrees depending upon the direction of the wind originally shown. Example: if the wind is moving from the shooters left rear at 245 degrees, breaking the wind into its components , a portion of the wind is moving across the direction of bullet travel from left to right (from the 270 to 90 degree direction) and a portion of the wind is moving along the direction of bullet travel from shooter to target. For calculating wind deflection, we ignore the tail wind component and use the cross-wind component. If we use the wind timer, we are measuring only that component of the wind vector that is moving from 270 to 90 degrees; therefore, upon checking the “Use calculated wind speed” box, the wind direction will change from 245 degrees to 270.

THE ELEVATION TABLE

The main page gives the results of the trajectory computation at the target range. By tapping the “Elevation” button the user can get elevation data for any number of ranges. The elevation table displays its data in labeled columns. The column headers on some of the columns will change what the column displays by tapping on the header. For instance, the “Turret” column shows the turret setting for ranges from the “Start” range out to the “End” range (or the target range, whichever is farthest.) Tapping on the Turret header shows the time of flight of the bullet to the listed ranges. This data is helpful in computing or estimating lead for a moving target. Tapping the header again will list the bullet velocities at each range so the user can be aware of the range that the bullet will go subsonic. Tapping on the header again will cause the data displayed to return to Turret data. The next column is the Elevation column and shows the elevation in terms of Mils (or MOA depending upon the user preference.)

Tapping on the Elevation column will list the vertical holds from the current target range to the other ranges listed in the range column. This feature was added to enable the user to quickly access targets at different ranges simply using the reticle to hold off. Tapping again causes the data to be displayed MOA (or Mils, whichever was not shown initially.)

The windage column shows the windage at various ranges for the given wind condition from the main page. Tapping the wind header will alternate between MOA and Mils click values. This is especially valuable for the shooter who has a Mil-dot reticle but has MOA elevation and windage turrets. Clicking on the wind column will permit the Elevation to be shown in Mils while the Wind is shown in MOA thus permitting a turret adjustment for wind while holding off for elevation. Column headers for Lead work in the same way. Just work with the table for a while to see how flexible it is in displaying the appropriate data.

Further with respect to the Lead column, if the user employs an "uncoordinated" scope where the turret units differ from the reticle units, the user will generally want the elevation and windage solution to reflect the turret units while lead should be given in the units employed by the reticle. On the main page it is possible to select the basic units of the display from the Options list. The user may then choose which units should be used for the lead solution by tapping the Lead button. Whichever units are selected, those are the units which will be initially displayed for the Lead column in the Elevation table.

The Range column toggles between yards and meters. To select any given range for import back to the main page, double tap on the range value of interest. The Elevation window closes and the selected range becomes the new target range. A firing solution is then automatically computed.

Using Turret Windage

The Elevation Table shows the needed calculated windage required given the current conditions for the various ranges listed on the table. If the user has calibrated his scope and has found that click value of his windage turret is not as advertised by the manufacturer, he may want the windage output in terms of what he must dial on his scope given its actual click value. If the user wants windage "corrected" to his particular turret, he selects "Use Turret Windage" on the Options list from the Main page. The windage column now lists windage modified by the windage turret error and may be used to dial windage directly.

Using the Capture Function

The content of the Elevation Table can be exported in the form of a CSV (comma separated values) text file which can be opened in Excel® or similar spreadsheet for the purpose of creating a hard copy range card. The user is free to modify the data presented, organizing it in ways that best fits the user's preferences and informational needs.

The Windage Table

The windage table is accessed by tapping the "Windage" button and shows windage needed for various wind speeds in addition to the wind specified on the main page. Note that when wind zones are being used, the Windage button is grayed out since it is not possible to present wind solutions in a multiple wind scenario. But when a single cross-wind is specified, the table shows corrections for wind values from 0 to 40 mph (0 to 70 kph) and shows windage offsets from the specified wind.

This feature exists to enable the shooter to deal with a changing wind. For example, say the prevailing or average wind across a range of fire is 4 mph but that the wind varies from 2 to 6 mph. The shooter can see that for a given range as the wind dies or increases he can adjust by holding the amount shown in the hold off column. So he dials for 4 mph and then varies his hold to account for wind changes. The table tells him how much to hold for any wind condition for the given range. As with the Elevation table, any wind value can be selected by double tapping on the value.

Using Turret Windage

The Windage table shows the needed calculated windage required given the current range for the various wind velocities listed on the table. If the user has calibrated his scope and has found that click value of his windage turret is not as advertised by the manufacturer, he may want the windage output in terms of what he must dial on his scope given its actual click value. If the user wants windage "corrected" to his particular turret, he selects "Use Turret Windage" on the Options list from the Main page. The windage column now lists windage modified by the windage turret error and may be used to dial windage directly.

Note that the hold off column is not affected. Hold offs are a function of the reticle and are not affected by turret error so the hold offs listed are true, uncorrected values.

Getting and Using Magnetic Bearing

Obtaining bearings to a target can be done via a map, in which case true bearings can be used. But in the field getting a target bearing is generally accomplished with a compass in which case the user will be gathering data in terms of a magnetic bearing. Therefore, the program needs to handle both true bearings (map bearings) and magnetic bearings (compass bearings) with equal ease. This also means that a way to obtain the magnetic variation of a particular location is required. Magnetic variation is not constant across the entire globe but varies by locale and in fact changes over time. Unless the user has access to local, current maps, he might not know what the local magnetic variation value is and can not therefore obtain reliable compass bearings. The problem is solved by using data and coding prepared by the National Geospatial-Intelligence Agency for its World Magnetic Model. If the user will look at the SD card with the PDAs File Explorer and find the FFS_Data folder he will find a file called "WMM". On the desktop this file can be opened using Notepad and the content reviewed. Essentially this file contains a database of the magnetic variations all over the world and permits the program to compute a specific magnetic variation based upon a specific set of coordinates. While the variation calculated is not exact, it is very much accurate enough for use in this program.

First, the program needs to know where it is or at least what location the computed firing solutions are going to be used in. One way to tell the program its current location is to create location files in the Map Ranging form and then loading the appropriate file. Another is to connect a GPS device (either by way of a direct plugin to a serial port or via Bluetooth) and to save the location it provides. Or, in the Map form, enter that data as a FFP and Accept that data. (In this latter method, when a new FFP is loaded, the old will be lost.)

For purposes of this explanation of how to use magnetic variation in the program, the assumption is that you have a location file or otherwise know how to input a location (this will be explored in detail in the GPS and Map Ranging sections below.) Once a location is input, tap the "CV" button on the main form in the upper right hand corner. In this case "CV" means "Coriolis/Variation" and represents the access point to input the data needed to compute Coriolis acceleration. On the Coriolis page you will see that only the Latitude window is available for location. While only latitude is needed for Coriolis computation, to compute the magnetic variation both latitude, longitude and altitude is required. At the bottom of the CV page is menu item "Compute" which takes the user to a page where the required location parameters can be input. If a GPS is connected and running in the background, the GPS menu item will be active and pressing it will cause the current location parameters as reported by the GPS to be imported into the data text windows. Once this data importation is complete, the program will automatically compute the magnetic variation for that location. If the user wishes to use that data, he clicks

"Accept" and will exit back to the CV page. Here he will see that the latitude for Coriolis purposes has been updated to the current location and that the magnetic variation has been brought in from the previous page. He can now opt to use Coriolis computations by clicking the box and opt to use the magnetic variation value by checking that box. At that point, the user must "Accept" his elections and exit or "Abort" what he has done.

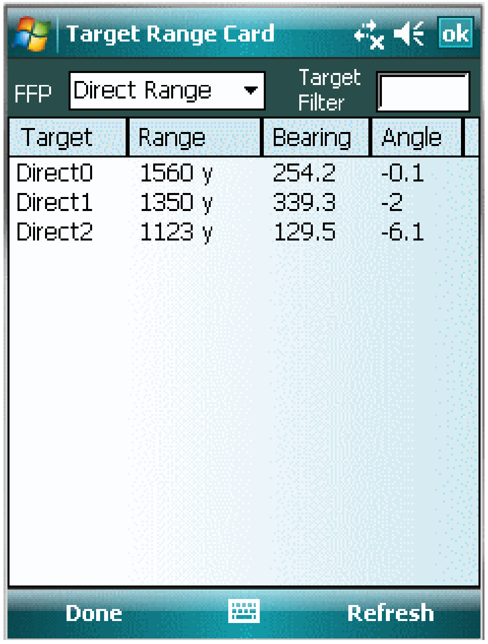
If he has chosen to use Coriolis computations in the firing solutions, the Bearing text box on the main page, which was yellow, is now white. This is a visual cue as to whether Coriolis is being used or not. Also, below the "Bearing" label there is an indication that the Bearing is "compass" meaning that magnetic variation is being used and the bearing figure is a compass bearing. On the other hand, unchecking the Magnetic Variation box on the CV form will cause the Bearing to be "True", i.e., the bearing as shown on a map.

Magnetic variation can also be selected as an option in the Options menu list. If it appears that no actual location has been input, choosing magnetic variation will result in an advisory that "Magnetic Variation equals zero" which generally means that the program is using a default value and that a magnetic variation has not been computed. Choosing to activate Coriolis in the absence of a current location will prompt an advisory that "A current position has not been selected." Looking at the Presets page the user will see all zeros for latitude/magnetic variation, a sure sign that no current position has been input. The user is encouraged to let the program know where on earth the calculations relate to. The program can do many other things if it knows the location of the firing position, as will be shown below.

THE TARGET LIST

Clicking on the "Targets" button immediately next to the "CV" button will produce a list of targets, assuming that the user has created such targets. There two type of targets that will show up on this list: those created by Direct Ranging and those created by Map Ranging. The difference between the two is that Map Ranging files include the location coordinates for both the FFP and the Target; direct ranging include only a range, bearing and shot angle.

The FFP drop down list has as its first item "Direct Range" and is the default when the Targets button is first pushed. An example is shown. Here

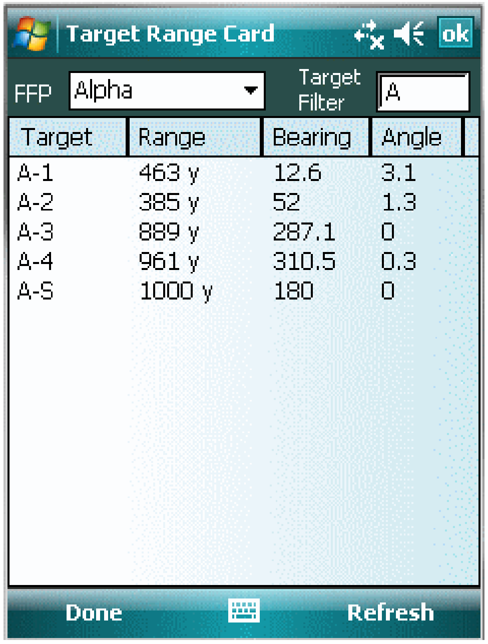


FFP: Direct Range
Target Filter:

Target	Range	Bearing	Angle
Direct0	1560 y	254.2	-0.1
Direct1	1350 y	339.3	-2
Direct2	1123 y	129.5	-6.1

there are 3 targets: Direct0, Direct1 and Direct2. These files were created using the Direct Ranging page (menu item Ranging, then Direct) and show a range, bearing and angle. There are no coordinates associated with these files; the bearing is a true bearing and to the extent that magnetic variation was active when the files were created, the program has corrected the bearing to true when the data is displayed. The bearings shown for all targets on the Target list, direct and coordinate, are true bearings.

The user can select one of these targets by simply double-tapping on the target name. When that happens, the range, bearing and angle data is transmitted to the main page and the Targets form closes. A firing solution is automatically computed for that target and the bearing of the target is displayed in the proper format (compass or true) as has been selected by the user.



FFP: Alpha
Target Filter: A

Target	Range	Bearing	Angle
A-1	463 y	12.6	3.1
A-2	385 y	52	1.3
A-3	889 y	287.1	0
A-4	961 y	310.5	0.3
A-5	1000 y	180	0

When the user creates FFP and Target files using the Map or GPS Ranging tool, the file contains the coordinates and altitude of the location and the program computes the range, bearing and angle of the shot from the coordinates. By dropping the FFP list, all saved FFP files will be shown below the Direct Range entry. For example purposes, FFP Alpha and Bravo have been created and from each FFP three or four potential target locations were mapped. FFP Alpha has been selected. Upon selecting an FFP and the range to ALL targets will be computed. The program doesn't know which targets are of interest. One way to focus on only those targets of interest is to include a target filter when the FFP file was made. In this case the Alpha FFP file has the filter "A" included so only those targets starting with the letter A will be shown. (The filter is case sensitive.) The balance of the targets on the list will be ignored. To get a firing solution for any target on the target list, double click on the target name and the computed range, bearing and angle will be imported to the main form and the firing solution automatically computed.

Relative Wind Changes

The wind vector shown on the main page is a relative wind and is the wind direction relative to the existing target bearing. If the user changes the shot bearing, he must also change the wind direction since, relative to his new bearing the wind direction has changed. In order to facilitate rapid target acquisition and solution computation, when selecting a target from the Target list, the program will assume that the FFP has remained the same but that a new target has been selected. The program will recompute the relative wind for the new target bearing and then compute a firing solution using this new relative wind direction. Locations loaded into the program other than from the Target list will not affect the wind direction on the main page.

TARGET RANGING

A. DIRECT RANGING

Opening the Direct Ranging page allows the user to manually input a range, bearing and angle and then save the file for later use on the Targets list. These are the target files that will appear when "Direct Range" is selected as the FFP.

B. MAP RANGING

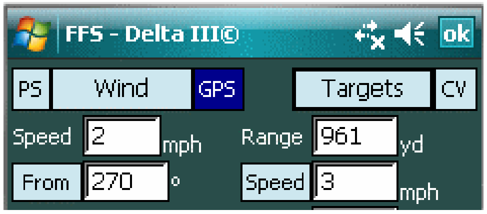
The purpose of the Map Ranging page is to input firing positions (FFPs) and target locations in the form of location coordinates for saving and use on the Targets list. FFP location can be obtained one of two ways: 1) from a map; 2) from a GPS. In the first case, it is necessary to input either lat/lon coordinates, UTM or MGRS coordinates and an altitude manually and then save the files to some meaningful name. In the second case, the user can get the coordinates directly from a GPS running in the background. It is possible to connect a GPS to the PDA, open a serial port and leave it running in the background so that various parts of the program can have access to the location data it provides. In the map ranging page, when a GPS is running in the background the GPS menu item become active and pressing it causes the current GPS coordinates and altitude to be inserted in the proper data text windows. At this point the location can be saved to a file. These files will show up on the FFP drop down list on the Targets page.

There are buttons associated with the FFP and Target labels. By default the FFP button is active so clicking the GPS menu item will cause the data for the FFP to fill. However, if the user wants to channel the data to the target data areas, just click the Target label and the Target data windows become the location for the GPS data. Once the data is obtained, just save the Target file. These files will show up listed in the target area on the Targets page form.

Target coordinates can be obtained a third way. If a current location is listed in the FFP section and the user has the range, bearing and shot angle to a target, he can check the"Target Coordinates" box, input the data and press the Calculate button. These parameters can be entered by hand or by opening an existing Direct Range file which contain just the range, bearing and angle of a target. The program will use the range, bearing and angle information to calculate the coordinates of the target location relative to the current FFP. In this way, once an FFP has been established, the user can survey the area and use his rangefinder to range various likely target locations, inputting the data, calculating the coordinates of each and then saving each file. These target files will become immediately accessible on the Targets list such that engaging multiple target rapidly can be done. Further, using the rangefinder this way will permit the user to transmit a target location accurately should others need to target a specific location.

C. GPS Ranging

A GPS receiver can be attached to a PDA either by a physical connection to one of its serial ports or via Bluetooth. Once a GPS device is connected (see the User Guide for the PDA being used as to how to communicate with a Bluetooth device), the user may open the GPS ranging form and click "Start". The "Kill" menu item changes to "Close" and if the form is closed instead killed, the GPS continues to run in the background providing location data to the rest of the program. When the GPS form is closed and not killed, a button appears on the main page immediately adjacent to the "Wind" button as a visual cue that the GPS is running. In addition, the button provides quick access to the GPS page; by pressing the button the user is taken back to the GPS page. Because GPS signals may not be producing data of sufficient precision, the color of the button will be dark until the precision of the data is of such quality deemed necessary for long range precision work. At that point the color will turn to a light blue which puts the user on notice that the GPS data is usable. In the graphic the data being received is not sufficiently precise for use so the button remains dark blue.


FFS - Delta III©

Speed 2 mph

Range 961 yd

From 270 °

Speed 3 mph

When the GPS serial port is open and GPS data is being received in the background, the data is available to: 1) the Coriolis/Magnetic Variation page; 2) the Compute Magnetic Variation form; 3) the Map Ranging form; and 4) the GPS Ranging form. The GPS Ranging form shows not only the current location, but the number of satellites being tracked, the quality of the data, the current location in both Lat/Lon and UTM or MGRS formats including altitude, the universal Mercator time as reported by the satellites, the local time as recorded by the PDA, and, if traveling, the bearing and speed of movement.

Associated with the GPS Ranging page is a button located on the Local Time line. Pressing this button will synchronize the PDA time to the satellite time.

Continuous Power

The Mode menu item shows a "Continuous Power" option. Checking this option prohibits the PDA from going into Suspend mode where the CPU would otherwise cease functioning, but instead keeps the PDA energized so that it will continuously receive satellite data. The backlight may power down, the unit itself will continue to run. **Caution**: Leaving the GPS running in "Continuous Power" prevents the PDA from automatically powering down in accordance with the user settings and thus will result in the need to recharge the battery sooner than normal.

D. RETICLE RANGING

This form calculates the range based upon the height of the target, the size of the target as seen in the scope and measured in Mils or MOA. The resulting computed range can either be "Accept[ed]" and imported back to the main page for computation of the firing solution or "Abort[ed]".

THE PS BUTTON

The PS key stands for "Profile Summary" and is a fast way to check what basic data is being used by the program including the atmospheric data, bullet data, which turret is currently being employed and data related to the Coriolis correction magnetic variation. It's function is merely to quickly inform. In addition, the PS form contains useful reference formulas and conversion factors.

An interesting value displayed is the "Stability Factor." The gyroscopic stability factor is a value that shows how stable a bullet is as it exits the muzzle. The stability factor must be at least 1.0 or the bullet probably will not stabilize thereafter; it will spin out of control, tumble, and generally fail to generate a useable trajectory. Generally, at normal ICAO or Metro conditions, a stability factor of around 1.5 is a decent value. However, it is not uncommon to see stability factors of 1.2 to 2.5 or even higher. The factor is, therefore, a function of the density of the atmosphere and as the density thins in warmer temperatures or higher altitudes, the stability factor will become larger.

The stability factor not only is affected by the atmosphere, it is also a function of the barrel twist rate and various attributes of the bullet including its mass, diameter and length. As the stability factor increases, the angle of repose also increases which means that the spin drift increases. The stability factor is therefore presented for two reasons: first, it allows the user to quickly check to make sure that bullet is stabile under current conditions; second, the user can assess the magnitude of the stability factor and therefore get an idea as to spin drift changes. In the program, the stability factor is actually used to compute spin drift if the bullet length is supplied by the user concerning the bullet. On the other hand, if the bullet length is set at “0", the stability factor cannot be computed and a generalized spin drift formula is used.

CALCULATING A BULLET’S BALLISTIC COEFFICIENT

The primary bullet attributes that influence a trajectory is bullet velocity and the rate at which the air slows the bullet during flight, i.e., how much drag the projectile experiences. This tool enables a user to verify the G1 ballistic coefficient of the bullet as published by the manufacturer and to compute a BC that will produce optimum results in the program.

The workspace is quite simple: the user will obtain two velocities using a chronograph, the first at the muzzle (actually slightly in front of the muzzle; the actual muzzle velocity must be calculated using the tool provided by the program.) The second velocity is obtained at some down range location where the user can safely and reliable still shoot over his chronograph without hitting it. He then takes a careful measurement of the distance between the muzzle and the mid-point of the chronograph and using these three data items will calculate the bullet’s BC. This BC can be used for this bullet in all applications, ranges, and weather conditions and should be permanently recorded in the bullet’s profile.

BULLET/CARTRIDGE DATABASES

The last two items on the “Profiles” menu are the Bullet and Cartridge Databases. These are generally informational and based upon publically available data. The muzzle velocities shown for manufactured cartridges are as published by the maker and may or may not have relevance to the shooter in his rifle. Both databases can be filtered for a particular caliber, weight, manufacturer, etc. To choose the filtering criteria, highlight a selection (click once on the Maker) and then tap the header of the column for the parameter of interest. For example, if the user was interested in seeing only Berger bullets of the .30 caliber size in the Bullet Database, scroll down to the Berger bullets, highlight any Berger bullet that lists .308 as the bullet diameter, then click on the Maker header and the Diameter header, and hit the “Load Selected Bullet Data” button. Only Berger bullets of the .308 caliber variety will be shown.

The data in the Bullet Database can be automatically inserted in a Bullet Profile merely by double-clicking on the “Maker” for the bullet of interest. The database will automatically close and the data will be inserted in the profile ready to be completed by the shooter and saved.

These databases may be edited to suit the needs of the user through the Edit form shown upon selection of the Edit menu item. Simply highlight an entry of interest and then hit the Edit menu item. The entry can be altered, deleted, changed to make a new entry or serve as a template for a "find and replace" modification of the entire database.

UPDATING DELTA III SOFTWARE

Each program has a unique "fingerprint" which manifests itself through a set of data that must be reproduced by the user in order to purchase updates. Updates are obtained via the Lex Talus Corporation's website by choosing the update required and proceeding through the purchase process. In the initial window which displays the shopping cart, there is a text area for the user to input the required data so that Lex Talus can create the updated software for the user that will be compatible with the SD card the user already owns. At the time of purchase, Lex Talus sales department receives a notice of sale which includes the unique data from the user, uses this data to create the necessary software and emails the updated software to the user. The updated program must then be copied by the user to the \Program Files\FFS_Delta directory on the SD card where it will replace the existing program. At that point, the update is complete.

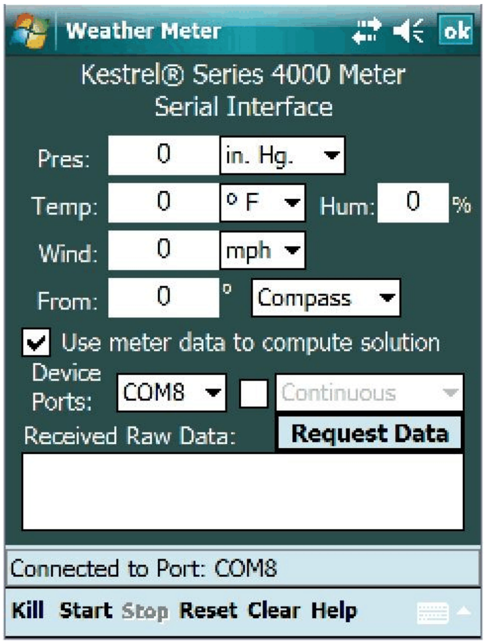
In order for the user to obtain the necessary program information, open the Options->About->Program Info form and click on the "Get Program Identifiers" button. This creates a text file (the content of which is shown in the text window on the form) which is saved in the \Documents directory of the SD card. Simply copy the text file to the desktop computer, open the file and copy the content, and then paste it into the text window of the shopping cart during the purchase process. Alternatively, complete the update purchase and email the text file to Lex Talus sales (sales@lextalus.com) notifying Lex Talus of the purchase and relating the data to the purchase. In this case, it would be prudent to indicate in the shopping cart text form that the program data is being sent separately via email.

KESTREL® 4000 SERIES INTERFACE

Kestrel® weather meters offers Bluetooth communication with its 4000 series. An optional feature of the program is an interface page to connect with the Kestrel meter in order automate the acquisition of pressure, temperature, humidity, wind speed, and in the Kestrel 4500, wind direction.[10]

If the program has the optional Kestrel interface, it will have a "Kestrel® Meter" entry on the Options list. To use the interface, the user must first pair the meter with the PDA (see Kestrel instructions.) On some PDAs, it is not necessary to turn the PDA Bluetooth on prior to using the interface (such as the Nomad) since the software will itself turn the device Bluetooth receiver on; on other PDAs, such as the iPAQ 111, the Bluetooth receiver must be turned on outside of the program in order to use the interface. The user will have to determine what is required for the PDA currently employed.

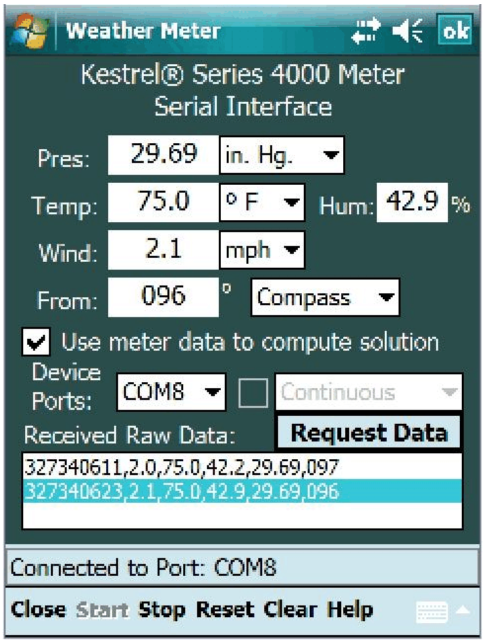
The graphic shows the interface page. First, set the communication port (Device Ports) to the proper port where the Bluetooth signal from the is being received. If the user doesn't know which port this is, just drop the list, select one and then hit the "Start" menu item. If a message appears that the port is "not accessible", it may be that it is being used for some other purpose or by some other program. But it can also mean that the Bluetooth receiver has not been turned on, so to be safe, turn on the Bluetooth on the device even though that specific device might be completely controlled by the software. Once the proper port has been determined, then it can be determined whether the software itself will turn the Bluetooth on and off by itself.



Kestrel® Series 4000 Meter
Serial Interface

Pres: 0 in. Hg.
Temp: 0 ° F Hum: 0 %
Wind: 0 mph
From: 0 ° Compass
☑ Use meter data to compute solution
Device Ports: COM8 ☐ Continuous
Received Raw Data:

Connected to Port: COM8



Kestrel® Series 4000 Meter
Serial Interface

Pres: 29.69 in. Hg.
Temp: 75.0 ° F Hum: 42.9 %
Wind: 2.1 mph
From: 096 ° Compass
☑ Use meter data to compute solution
Device Ports: COM8 ☐ Continuous
Received Raw Data:

327340611,2.0,75.0,42.2,29.69,097
327340623,2.1,75.0,42.9,29.69,096
Connected to Port: COM8

Once the correct port has been identified and the Bluetooth receiver of the device has been turned on, pressing the "Start" menu item will open the port and begin the communication with the Kestrel device.

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[10] Note that the software will not process data from the Kestrel 4100 since this unit does not output atmospheric pressure. The program will process data from the 4000 series devices that come with Bluetooth capability. Only the 4500 also outputs wind direction.

The graphic to the left shows the page once communication has been established. There are a few things to note here: First, the Kestrel meter does ***not*** include the units in its data sent to the PDA. The raw data is shown in the Received Raw Data display area and has the following format: the number of seconds since 1 January 2000, wind speed, temperature, humidity, pressure, wind direction. Note carefully that the units of each value is not included. Therefore, it is critically important that **the user set the units on the interface page to mirror those he has set on the Kestrel device.** If the units are mismatched, the program will become incredibly confused. For instance, the current pressure is 29.69 in. Hg. which is equivalent to 1005.42 hPa. If the user had failed to indicate that the units were "in. Hg." but instead left them in "hPa", the program would use 29.69 hPa, which is equivalent to 0.877 in. Hg, nearly a vacuum. Trajectories would be incredibly flat - and completely erroneous. So, be sure to set the units to mirror those in the Kestrel.

Of special note is the wind direction. Here the wind direction is shown as 96 degrees, almost due East. Remember that wind direction is always referenced by the *source* of the wind, i.e. the direction it is coming from. Second, note that this direction is identified as "Compass". This is because the declination value in the Kestrel unit is set to 0 degrees and the value is uncorrected and thus the direction as reported by the magnetic compass. If the user had, for some reason, set the declination to the local value, the user would have also set the wind direction reference at "True" because the declination will correct the magnetic compass value to the true North reference.[11]

Once the connection has been established, the user can update the values on the interface page by either pushing the "Request Data" button or by pressing the Enter button on the face of the device. The user will note also that the "Kill" menu item has changed to "Close" permitting the closure of the interface page without closing the serial port; the data will continue to be received when requested.

Upon "Closing" the interface page the user will note that the wind speed and direction data areas on the main page have turned a slightly darker background color. This is a visual cue to the user that the Kestrel unit is connected and the port is open. The windage data can be updated by pressing the Enter button on the PDA control panel. Likewise, going to the Presets page the user will note that the Pressure,

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[11] The program uses the term "magnetic variation" to describe the local value that must added to or subtracted from the compass value to yield a "True" direction whereas the device documentation uses the term "declination". Declination has two components: the magnetic variation (the difference between true North and magnetic North from the current location) plus magnetic deviation (any local cause of magnetic deflection such as high tension wires, electronic equipment, or a magnetic source in the immediate vicinity. The software does not deal with magnetic deviation; the program gives the user, for any given position on Earth, the magnetic variation for that position. Hence the difference in terminology.

Temperature and Humidity data areas are the same darker background color, again to visually cue the user. Those data areas can also be updated by pushing the Enter button while in the Presets page.

This particular port is used to transmit requests to the Kestrel unit and receive the information in reply. When "Stop[ping]" the data and then re-"Start[ing]" the connection, allow a couple of seconds to permit the operating system to properly clear the port and open it. Don't get in a hurry as it will provoke a "port not accessible" error message. If that message appears, hit the "Reset" menu item a couple of times and try to open the connection again. If the message persists, check the Kestrel unit to make sure it is still on. It may have shut off automatically.

Continuous Operation

Looking back at the interface page, with the connection "Stop[ped]" or "Reset", the check box related to the "Continuous" drop down box becomes enabled. Checking the check box enables the "Continuous" drop down box allowing the user to choose various update time intervals. The default is two seconds and the user can choose an interval up to every 1 minute.

Two considerations when using the Continuous mode: first, as long as the requests for data from the Kestrel unit is continuously occurring, the battery is being drained on both units. Second, continuous operations interferes with other display areas, such as the Elevation Table. With each refresh of the data and new computation of the firing solution, the Elevation Table is redrawn and the data presented in its default format. So, if the user is looking at the time of flight column when the request for Kestrel data occurs, the user will see the TOF column disappear replaced with updated computations as if the the "Refreash" menu item had been pressed. The effect is basically the same: with each update of Kestrel data, the state of the data throughout the program's environment is "refreshed" and set back to default.

FAQ AND TROUBLESHOOTING

1. GPS and WM 5.0 and 6.0 Issues

When plugging a GPS into a serial port, on WM 2003 SE and before, the program will automatically search for and lock on the signal. Starting with WM 5.0, however, Microsoft included some GPS tools for the user and the tools may interfere with the automatic search feature. For WM 5.0 users, go to "Start", "Settings" and choose the "System" tab. The click on the GPS icon. On "Programs" and "Hardware" tab, choose "None" and on the "Access" tab check the "Manage GPS Automatically" box. Depending upon the quality of the GPS unit, it may take many minutes for the GPS to start working correctly.

2. Program malfunctions on startup

Sometimes a user will create a profile with data that the program can't read. Sometimes a user will omit data that the program expects to read from the profile. In these cases, particularly with erroneously constructed turret profiles (and particularly in the construction of the turret/click number pairs), the program may issue a error message and cease functioning. Worse, when the user starts the program again, the error persists making the program unusable.

First, if the program has trouble with a profile, suspect that it contains improper data or has become corrupt and stop using it. Create another profile from scratch. If you have problems or questions, contact support@precisionworkbench.com with your questions. You can attach the problem profile to the email for us to look at.

Second, understand that when the program closes it writes all current data to a file called "eSession" located in the Program Files/FFS-Delta III folder. Sometimes when an errant profile has been opened, should the program crash, the data is still saved including the name of the profile that was just opened. When the user runs the program again, the program looks in the eSession file and begins to load all of the saved data and may try to open the profile that caused the problem in the first place.

Therefore, if the program is malfunctioning and continues to malfunction upon startup, go to the Program Files/FFS-Delta III folder on the SD card and delete the eSession file. The program will then start using all default values.

3. Trouble building Turret Profiles

If you are having a problem building a turret profile on the PDA, open an example turret profile to see how it was built, particularly the turret number pairs. You can also change existing numbers to those representing your particular scope and then "Save As" a new scope profile. Examples have been provided for single (or double) turn, BDC, and multi-rev turrets.

If you have a two turn turret you should create it as you would a single turn turret. Most two turn turrets have cardinal numbers that simply continue using a two-tier numbering system. So, start with the number zero with zero clicks and continue sequentially with the numbering scheme matching each number with the total number of clicks it takes to get to the number from zero. (Example: for a 1/4 MOA per click turret with cardinal numbers every 2 MOA, the turret numbering will be 0, 2, 4, 6, etc. while the corresponding click values will be 0, 8, 16, 24, etc.)

4. You insert the SD card into your PDA but the program doesn't run

a. Is .NET Compact Framework 2.0 installed? Although all versions of Windows Mobile 6.0 and later came with .NET Compact Framework 2.0 or better, some PDAs with Windows Mobile 5.0 didn't and this support software needs to be installed. So, download and install .NET Compact Framework. There is a link to it on the website in the Support area. Be sure to get any and all Service Packs.

b. If the foregoing does not solve the problem, it is possible that the operating system has become corrupt. First do a soft reset. If that fails, do a hard reset. Before taking this last action backup your data since a hard reset will reset the PDA to its original factory condition and all additional programs, files and data will be gone.

5. Why is my zero range not showing exactly zero for elevation?

Check your Options and see if you have "Vertical Deflection" selected. If so, with a cross-wind there will be a slight vertical deflection that will be shown at the zero range. Either reduce the cross-wind to zero or deselect the vertical deflection option and you should see "0" elevation at the zero range. If the error persists, check whether the "Coriolis/Eötvös" option is selected. A shot bearing other than North or South will produce a small vertical component. Deselect this option.

FUNCTIONAL OUTLINE

As an aid to quickly understanding the functionality of the Delta III software, the following presentation arranges the features in four data groups: User preferences, core inputs, refinements and support tools.

1. User Preferences
    a. English v. Metric (Options menu)

    b. English units, but Range in meters (Options menu)

    c. MIL v. MOA units (Options menu)

    d. Degrees v. Cosine (Options menu)

    e. Use Turret Windage (Options menu)

    f. Degrees v. Clock for wind direction (Main page)

    g. Station v. barometric pressure (Presets page)

2. Core Inputs - the five basic data sets
    a. Atmosphere
        i. Pressure, temperature, humidity (Presets page)

    b. Bullet
        i. Caliber, weight, muzzle velocity, ballistic coefficient (Presets page)

    c. Scope
        i. Zero, height above bore (Presents page)

    d. Target
        i. Range, angle, speed, heading (Main page)

    e. Wind
        i. Speed, origin (Main page)

3. Refinements
    a. Multiple wind zones (Wind page)

    b. Spin Drift (Options menu)

    c. Powder Temperature (Options menu)

    d. Cross-wind Vertical deflection (Options menu)

    e. Coriolis Acceleration (Options menu)

    f. Correcting for magnetic variation (Options menu)

4. Support Tools
    a. Wind
        i. Estimating wind at distance (Wind page)

    b. Target
        i. Target Table (Targets page)
            (1) Direct
            (2) Ranging using coordinates

    c. Elevation Table (Elevation page)
        i. Quick velocity reference
        ii. Vertical holds
        iii. Wind holds

    d. Windage Table (Windage page)
        i. Mil or MOA holds for extended values

    e. Field Zero (Options menu)

    f. Calculator (Options menu)

    g. DK calculator (Options menu)

    h. MV calculator (Options menu)

    i. Profiles (Profiles menu)

    - i. Atmosphere
    - ii. Bullet
    - iii. Offsets
    - iv. Rifle
    - v. Solution
    - vi. Turret

- j. Ranging (Ranging menu)
    - i. Direct - manually using rangefinder
    - ii. GPS
    - iii. Map
        - (1) Rangefinder - Coordinate calculation
    - iv. Reticle

- k. Miscellaneous
    - i. Profile Summary (Main page)
        - (1) Reference sections
    - ii. Bullet and Cartridge database (Profiles menu)
    - iii. Visual Cues
        - (1) Bearing (Coriolis)
        - (2) GPS button
        - (3) Muzzle Velocity - temperature adjusted (Presets)

FILE NAMING CONVENTIONS

A. Bullet Profiles

At a minimum bullet profiles will need a caliber, maker, weight, and some identifier indicating which rifle it is designed for or some other unique identifier to distinguish it from other loads using similar components. For instance, a bullet profile for Federal .308 Match will show different muzzle velocities depending upon which rifle the cartridge is going to be used in. Or there may be different loads using the same powder and bullet but using different primers and resulting in different muzzle velocities for the same rifle. Once convention would be something like: [caliber].[manufacturer]:[bullet weight].[rifle/unique identifier]

For Federal .308 Match the file name would look like:

30.FM:175.990

where the 30 is the caliber, the "FM" is for Federal Match, 175 is the bullet weight and the "990" could be the last few digits of the rifle's serial number for which this profile was designed. The muzzle velocity listed in the profile would be for rifle "990". Another .308 Win. might need a different profile if the muzzle velocity of Federal .308 Match in that rifle is different from that of rifle "990."

B. Rifle Profiles

These profiles include links to a bullet profile and a turret profile. In rifles that shoot various loads comprising different bullet weights, various bullets from different manufacturers or various powder weights, primers or cases. If you plan to shoot the same rifle using different loads, you must have a profile for each load and the profile name must give some clue as to which load is being linked to. One format could be to use the same file name as the bullet profile that is being linked to. Or the same information could be used just in a different sequence. For the rifle above, the profile name could be "990.FM:175". Whatever format is adopted, being able to quickly tell what rifle and bullet combination is included in the file.