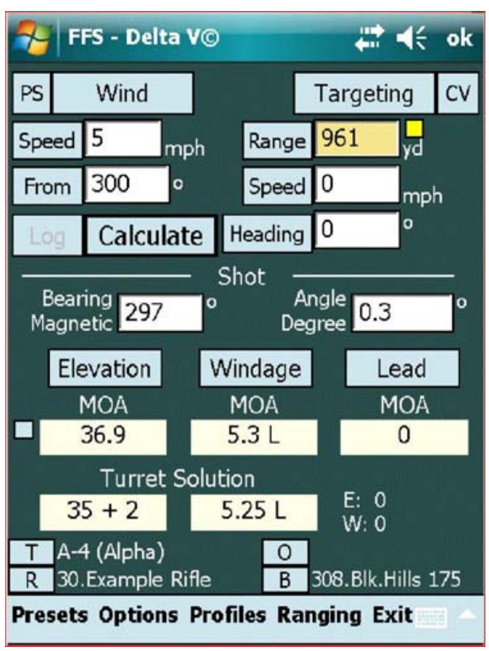
User Manual

Field Firing Solutions© Delta V© Software

Version 4.8

Real-Time Ballistic Solutions©



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Introduction

This ballistic software 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. The trajectory computation engine has been shown to be extraordinarily accurate even for ultra-long range applications assuming two conditions: 1) that the input values are valid, and 2) that the bullet selected is itself capable of traversing the transonic region in stable fashion. The basic output of the program is, of course, the specific information needed for a complete firing solution: elevation, windage, lead, or hold-off. Elevation is given in terms of an MOA or Mil adjustment and an actual turret scale equivalent is provided; 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 to accommodate the scope that has MOA turrets but a Mil reticle. Beyond the basic firing solution, the program provides an array of other data in the form of tables, both displayed and printable, and tools to refine input variables. In sum, the software provides very complete coverage of the subject of extreme long range shooting..

Instructional Videos

The program is not "complex", but is, as mentioned, complete with a number of tools useful to the long range and ultra-long range shooter. Some tools require a fair amount of time to learn but are necessary to generate precise data that will be input into the program. The precision of this data is important if the user expects to make hits on targets at range. This manual will aid in the user's understanding of not only the software but external ballistics in general. In addition to this manual, there are over 30 instructional videos on the Lex Talus website covering most aspects of the software. An attempt was made to break the topics into discrete parts to permit videos of ten to fifteen minutes in length and for the most part that objective was achieved although a couple of the videos are somewhat more lengthy. The user is urged to view each video to gain a comprehensive understanding of how to use the software. After completing the videos and reading this manual, the user should have an extremely good understanding of long range ballistics in general and this software in particular. You can find the videos at: http://www.lextalus.com/videos.html

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.x (all versions) being the preferred operating system. In addition, .NET Compact Framework 2.0 must be loaded on the PDA. In newer PDAs with Windows Mobile 6.x 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 modify the existing state of the software with the new data in subsequent computations. "Abort" means to reject any data in the form and return to the previous display without change to the computational environment. 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 into the computational environment. For example, the user can choose to use the "Calculator" (Main page: Options, Tools, Calculator). 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 available for use in the computations.

Three of the forms have a "Kill" option to close the form - those related to GPS, Kestrel® and Rangefinder functions. These three forms have to do with getting data from outside the PDA through serial ports to various pages of the program. “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 “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, Kestrel®, and rangefinder data without the user having to be directly in the GPS, Kestrel®, or rangefinder forms. These devices are 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 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” and selecting “Kill” stops all related processes and closes the form.

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. The software attempts to program available, but how any particular button is named by the manufacturer or whether it is available to the program to modify its function cannot be known in advance. It depends upon the particular device. The user is advised to experiment with available buttons on 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. If the manufacturer has allowed the buttons to remain programmable, you will have to figure out what each button does inasmuch as the position of the various buttons is not uniform among manufacturers.

Basic Operation

Getting Started

To use this program in its most basic form and without paying attention to the various tools and refinements available, but merely to compute a basic firing solution, 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), the current temperature and humidity.

2. Bullet data consisting of the 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 "Calculating a DK" 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 in the beginning. Just ensure that the ballistic coefficient is based upon the G1 drag function. Almost all, if not all, bullet manufacturers publish a 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 are 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 software.)

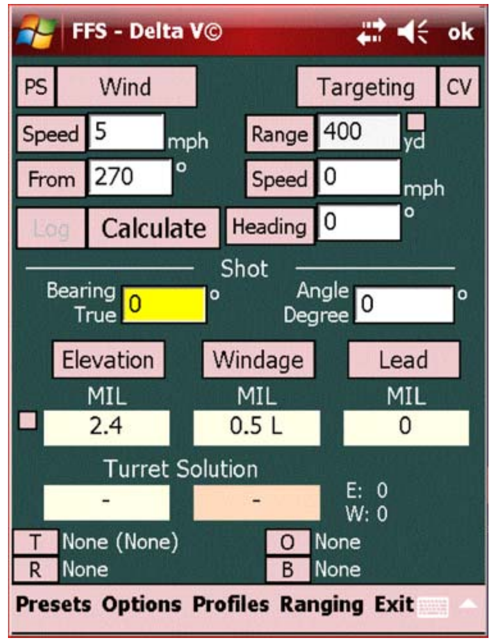
3. Scope data consisting of the scope height above the centerline of the bore and the range at which the scope is zeroed. To get the scope height, find a centrally located place on the scope and measure from the center line of the scope tube straight down to the centerline of the bore. It is not necessary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

After entry of the preset data, tap "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 latter values to calculate a Lead solution;

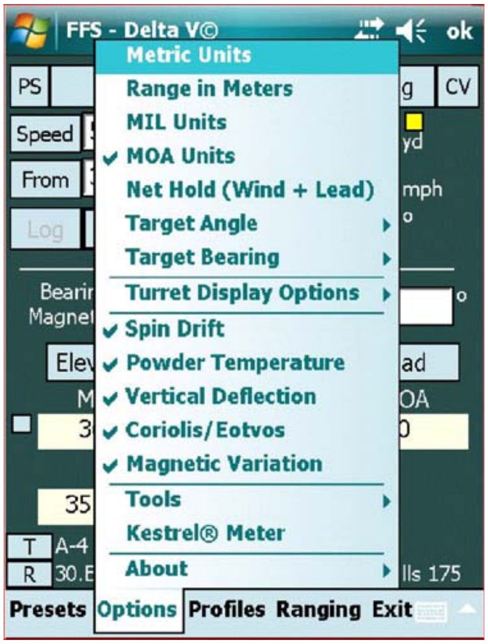
5. The wind speed and direction. Remember that wind is called from its source, i.e., where it is coming from, not where it's heading and is always relative to the direction of the target.. The program will compute the cross-wind component of the wind and use that to compute a windage correction value.



Following the entry of this data on the main page, tap 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 that input data. Dial the indicated elevation and windage, hold the lead, and shoot. If the target is within 500 yards, the solution will be close.

Preferences

Basic Options



Most user preferences are found by clicking the Options menu item. The user can choose to have the output in imperial units (the default), metric units, or imperial units except for range which will be shown in meters; MOA or Mil units; whether to show Lead for a moving target or to display the "Net Hold", the value combining both the windage and lead for a single resultant hold; whether to show the shot angle in terms of degrees, as the cosine[1] of the angle, or angular mil; and whether to show the bearing to the target in terms of degrees or angular mils. Angular mils are based upon the NATO standard of 6400 mils per revolution. Note that when an option is selected, it will be remembered by the program thereafter.

"Turret Display Options" - Two options, "Use Turret Windage on Tables" and "Positive Click Values" will be explained in the Turret Profile section of this manual. A third option is "Zero for Spin Drift". This option allows the user to zero spin drift at the zero range for that rifle. This option has application where the user decides to zero the rifle at an extended range where spin drift would become a factor.

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" button, to switch to the 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

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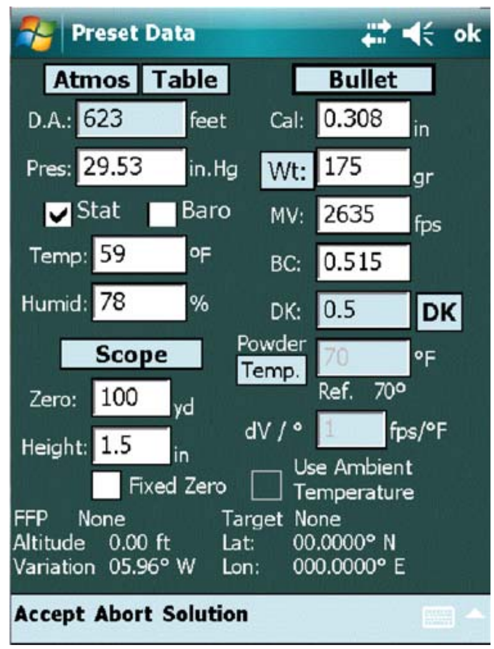
[1] Although self-explanatory, the option "Cosine" deserves a reminder of its limitations. While angles of fire can be expressed in terms of positive (upward) and negative (downward) degrees, a cosine can be expressed only as a positive; there are no negative cosines. Therefore, entering a cosine will 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.

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.

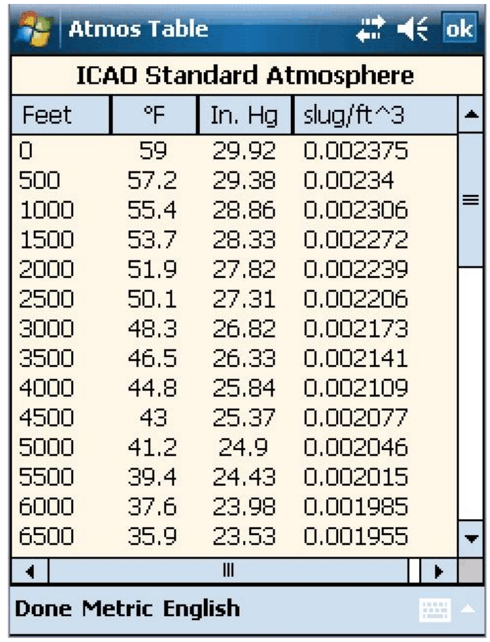
Station versus Barometric Pressure



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 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. When the Barometric pressure preference is checked, the user is asked for an equivalent sea-level pressure and current altitude. 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.

Note that there are two buttons at the top of the atmosphere data area; one will open a list of existing atmosphere profiles, the other will access a standard atmosphere table as shown to the right. This table is provided as a reference and shows the standard ICAO atmosphere in both imperial and metric values up to around 20,000 feet. Double tapping on an altitude will import the pressure and temperature back to the Presets page. The page will still show station pressure and not the altitude, however, because that is exactly what the standard pressures are, local station pressures. If the table showed Barometric pressure, all of the values would be 29.92 in.Hg (1013.25 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.



Feet	°F	In. Hg	slug/ft^3
0	59	29.92	0.002375
500	57.2	29.38	0.00234
1000	55.4	28.86	0.002306
1500	53.7	28.33	0.002272
2000	51.9	27.82	0.002239
2500	50.1	27.31	0.002206
3000	48.3	26.82	0.002173
3500	46.5	26.33	0.002141
4000	44.8	25.84	0.002109
4500	43	25.37	0.002077
5000	41.2	24.9	0.002046
5500	39.4	24.43	0.002015
6000	37.6	23.98	0.001985
6500	35.9	23.53	0.001955

Density Altitude

Looking again at the Presets graphic above, note that right above the Pressure input window is a "read only" window labeled "D.A.", or "Density Altitude". Density altitude is a single number that reflects the density of air based on its pressure, temperature and humidity and provides the equivalent altitude of air with that density as defined by the International Standard Atmosphere (ISA). The standard atmosphere charts shown in the preceding section are nothing more than a reflection of ISA atmospheres at the various elevations shown. Each altitude has a standard pressure and temperature and results in a defined air density for that altitude.

When the Station Pressure option is checked, the Density Altitude window will show the equivalent density altitude for the variables of pressure, temperature and humidity listed below it. This, in turn, will help the shooter understand how the air density is changing as conditions change and may help explain how bullet performance is being affected for the given conditions.

Because density altitude is a reflection of air density, it can be a handy single number data point to help a shooter judge what to expect for a trajectory for his given cartridge. While explaining how to use density altitude charts is beyond the scope of this manual, the user is encouraged to print out some density altitude charts (Elevation Table->Capture->Den.Alt.Table) for a given bullet profile, print out the density altitude charts (on the SD card in the \Documents folder) and use them as backup in the event of a PDA failure.

[Note: When using a Kestrel connected to the program, do not expect the Density Altitude as calculated by the Kestrel unit to necessarily agree with the program's calculation. The problem is that the Kestrel does not send the actual pressure, temperature and humidity to the program; rather, it sends *rounded off values*. For example, when the program calculates the pressure at sea level, it calculates it as 29.92115526565 in. Hg., and uses that value in its calculations but displays the rounded figure of 29.92. The use of rounded figure for calculation purposes will result in a slight error in density altitude. When using the Kestrel, pressure is rounded to two significant digits, temperature and humidity values are rounded to one significant digit, and then these values are sent to the program. The program will use the rounded values, but the resulting density altitude calculation will not match that of the Kestrel which is using values of greater precision internally.]

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.

For historical reasons, many shooters have scopes that have MOA turrets but a Mil reticle. This uncoordinated arrangement creates certain challenges for appropriate data display. Depending upon whether the shooter is going to dial or hold the wind such decision dictates whether the wind solution should be displayed in MOA or Mil units. The situation becomes slightly more complex when the target is moving. Will the shooter dial the wind and hold a lead or should both the wind and lead be held in which case the shooter may want a resultant hold off value that comprises the net hold after combining both wind and lead?

The program attacks the problem by first allowing the user to toggle the Lead units between Mil and MOA. Whichever is selected is deemed to be the units of the reticle. Upon selecting Lead units different from the Windage units, a units toggle button for Windage also appears thus allowing the user to 1) keep the units suitable for dialing the wind; or, 2) change the units to those of the reticle so that windage may be held. This solution works fine if the target is stationary. But when the target is moving and a cross wind is present, both the Windage and Lead will have hold off values. Again, two choices present themselves: 1) dial the wind and hold the lead; or, 2) combine both wind and lead values for a net hold off value. The user can either do the math mentally or choose the "Net Hold" option which converts the Lead button and data window to a "Net Hold" function and displays the net hold off value thereby accounting for both the wind and lead corrections. Where target speed is zero, the Net Hold window can be used to display only the wind hold off value.

Ballistic Solution Significant Digits

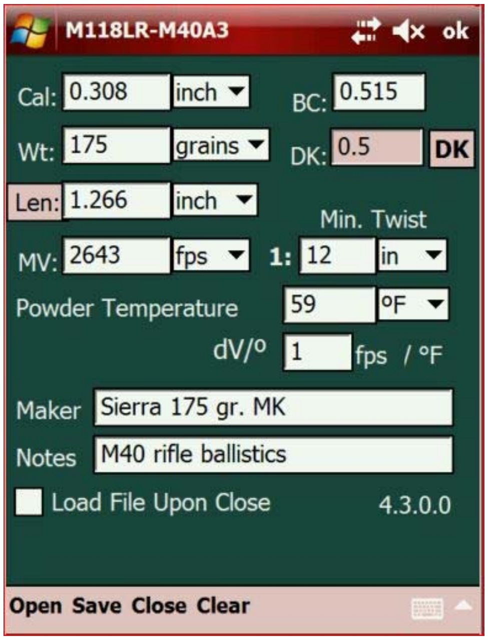
To the immediate left of the elevation solution window is a small unlabeled button whose function is to toggle between the one and two significant digits of the elevation and windage solutions. The reason for this option is that some shooters want the elevation solution to be expressed with one significant 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 8.05, the value is rounded up to 8.1 which means that the shooter will dial slightly more than needed. If, however, the 8.1 was rounded down from 8.149, the shooter would understand that solution was actually a little more than was dialed. In either case, knowledge of the actual solution is desired by some shooters and may influence his hold in a minor way.

However, the main reason for seeing a more precise value is to be able to understand the contributions of the various components of the trajectory. For instance, to see how much Coriolis and Eotvos effects contribute to the respective horizontal drift and vertical deflection of the bullet, remove spin drift and Vertical Deflection and see what's left. Enabling the more precise output will allow values for windage and elevation to be shown to the nearest hundredth Mil or MOA. Or, removing these components and leaving only spin drift will give a better picture of that component's value for a given barrel twist rate. Change the twist rate, bullet's muzzle velocity, or atmospheric values and see how each affects this component. Being able to see how these variables change can only enhance the user's understanding of how a particular trajectory results from the various contributions of the platform's specifications, bullet parameters, and condition of the atmosphere.

Basic Profiles

At the core of this software is the concept of the "profile" which is a text file that contains data that is logically related. These profiles and all the data they contain may be loaded by simply opening the file. There are a number of profiles that can be created, some essential, some merely convenient. As the user reads through this section, be aware that all profiles, once completed and saved, can be loaded automatically upon exit by checking the "Load File Upon Close" box to immediately use the stored data. The user should also be aware that merely changing the data in the profile does not change the data as saved or in memory. To make changes permanent, the data changes must first be saved. To use the changed data, the saved profile must be opened, i.e., loaded into memory.

A. 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 incorrect results. Of particular note is the "Min. Twist" data item. When building a Rifle Profile, the user will input the rifles actual twist. In the absence of a loaded 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.

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 "Calculating a DK" section of this manual.

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. The change of muzzle velocity is based upon the content of 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 temperature units will be the same as those used to express the powder temperature. The value that is used is a result of shooter 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 simply take apart a cartridge and measure the length with a set of calipers. 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 in which event spin drift will be the same for all twist rates. While not exact, it will be close. Example: a typical .308 Win. 175 gr. Sierra MK bullet leaving a barrel at 2600 fps with a 12" twist will experience spin drift of about 8 inches at 1000 yards. The same bullet leaving a 10" twist barrel will have around 12 inches of spin drift. The default spin drift function will calculate about 10 inches of drift. It is a reasonably close value.

B. The Turret Profile

1. The Simple Turret Profile

The purpose of the turret profile is to provide an elevation and windage that is correct for a given scope. To demonstrate the problem, assume that the calculated elevation required for a particular range and cartridge is 11.6 Mil (41 MOA). If the scope's click value is correct, the calculated value is dialed. If, however, the click value on a particular user's scope is not 0.1 Mil/click, but instead is 0.105 Mils per click, dialing 11.6 Mils solution 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, 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", i.e., 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.)

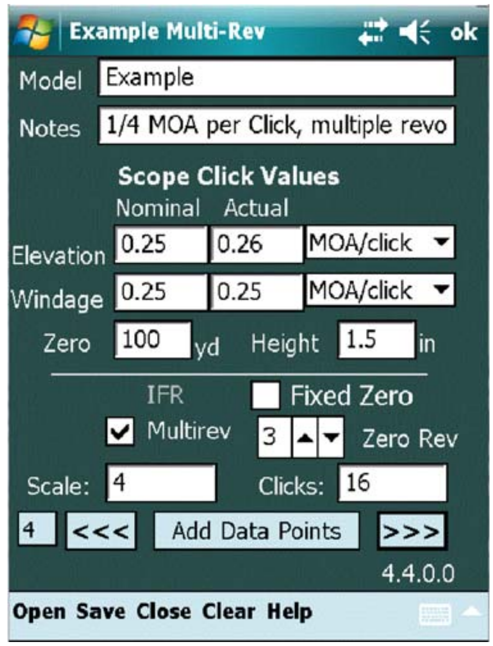
Multi-Rev type turret: Open the "Example Multi-Rev" turret file

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.

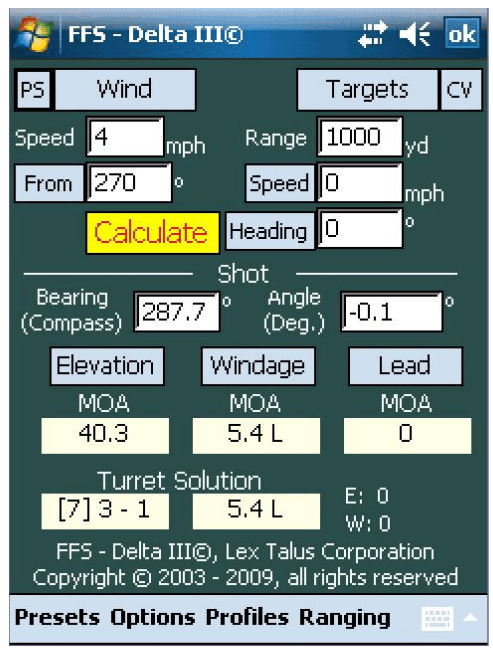
These numbers are entered in pairs, first the scale number and second the associated number of clicks. In the example at the right, the numbers 4 and 16 have just been entered and ready to be stored. Next it is necessary to add those data points to memory, so the user taps the "Add Data Points" bar. 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 taps "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.



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 be 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[2].



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[2] 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 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

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:

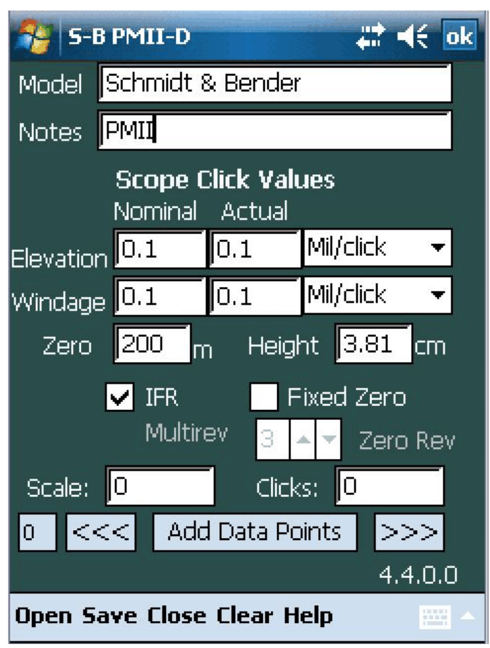
0	6	12	18	24	30	36	42	48	54	60	66	72	76	84	90

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 lower right.

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, certain 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.



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 dialed *down* a few clicks. On the following page are two graphics

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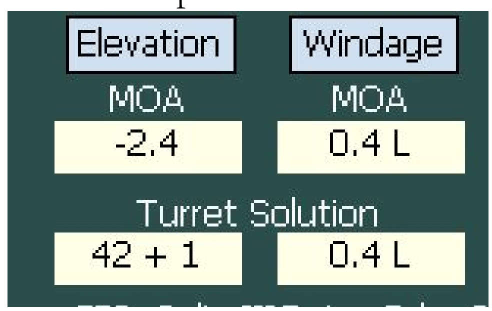
40.3 MOA. The program correctly showed the correct turret setting for a scope that had an actual click value of 0.26 MOA per click.

showing the result in a rifle shooting typical .308 Win. ammunition with a 175 gr. bullet. Note that in the case of the complete 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 discussion 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.

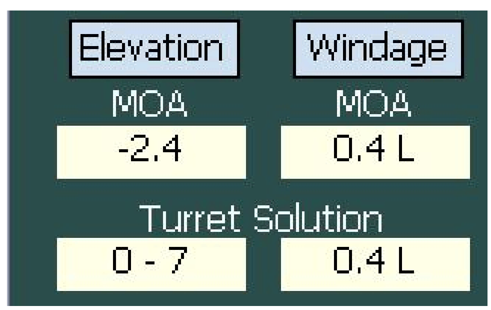
To the right is a turret profile for the Schmidt & Bender PMII which has an incomplete second revolution. The 'IFR" box is checked to denote that condition. As a result, when a negative setting needs to be made, the turret solution will denote this condition by showing zero and a negative number. See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

Complete Revolution



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



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.

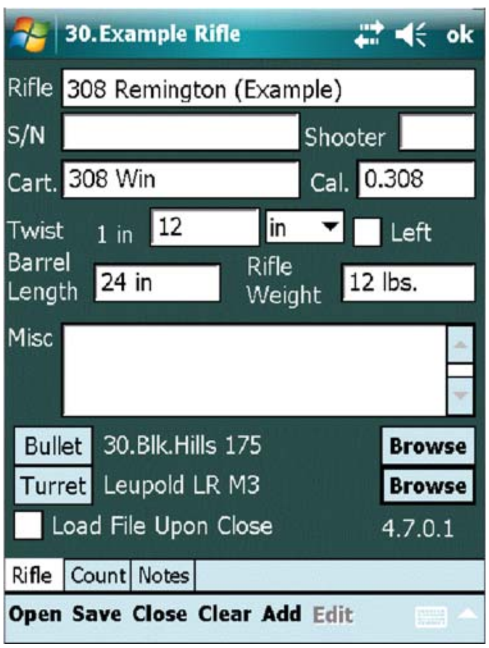
The program comes with example turrets so the user can open the example turret and move through the pairs to see how it is done. Do not be discouraged if the program produces an error when the new turret profile is used. Carefully check the data, particularly turret data pairs. Step through the pairs and make sure that they have been entered properly. If not, simply change the values and tap 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 Display 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.

C. The Rifle Profile

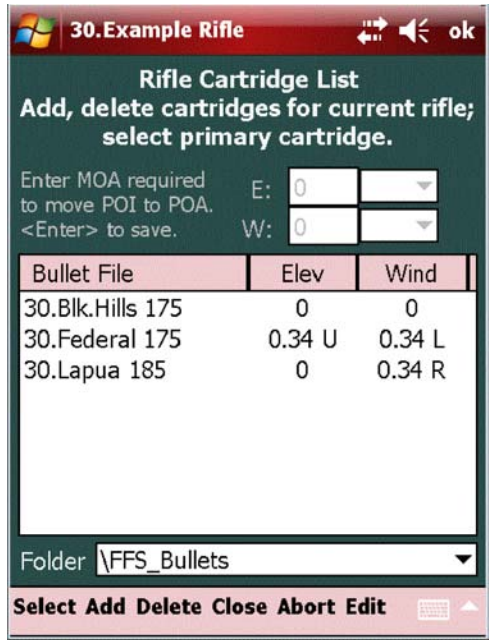


The rifle profile has three major functions: first, it is a location to associate a primary bullet profile, all related cartridges used by the rifle, and a turret profile which will be loaded at the same time a rifle profile is selected; second, it refines the twist data to exactly that of the rifle 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.

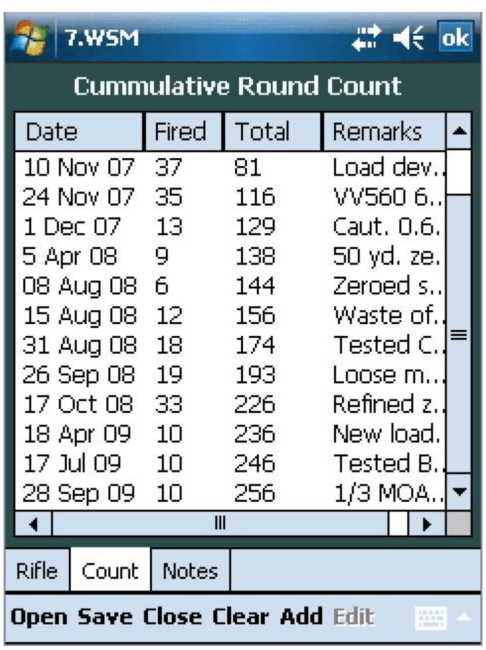
Of note is the "Shooter" text area where the user identifies the primary shooter or owner of the rifle. This data is loaded into the program to keep track of who is shooting for logging purposes. The shooter ID, usually initials or call sign, is shown on the main page. A small item, but helpful in detailed record keeping.

The "Add" menu is context sensitive. On the primary page, tapping the "Add" menu item opens a cartridge list where all cartridges that the rifle may shoot are to be listed. Because it is expected that the scope will be zeroed for the primary cartridge, the list of cartridges also can be associated with elevation and windage offsets so that the same scope zero can be used without modification for different cartridges.



When in this list, "Add" will open the FFS_Bullets folder where additional cartridges can be selected. The "Select" menu item selects whichever cartridge is highlighted for importation back to the main Rifle page as the default cartridge for the rifle. Not only will the cartridge be imported, but whatever offsets are listed will be imported as well and when the rifle profile is loaded, the default cartridge will also be loaded along with its offsets. Generally, it makes more sense for the default cartridge to have zero offsets meaning that the scope on the rifle is zeroed for that cartridge. However, the program is flexible enough to accommodate cartridges with offsets should the need arise.

The "Folder" link shown can be ignored at this point. For more information on how and when to make use of this rather powerful feature, see Advanced Directory Management in this manual.



Choosing the "Count" tab near the bottom of the main form brings up a form on which round count with appropriate notes can be kept. Below is a screen shot of an actual record for a rifle in use along with the detail of a particular entry. To edit an existing entry, double tap the entry. To add an entry, tap "Add" on the menu. The functionality of the menu item has changed due to the context.

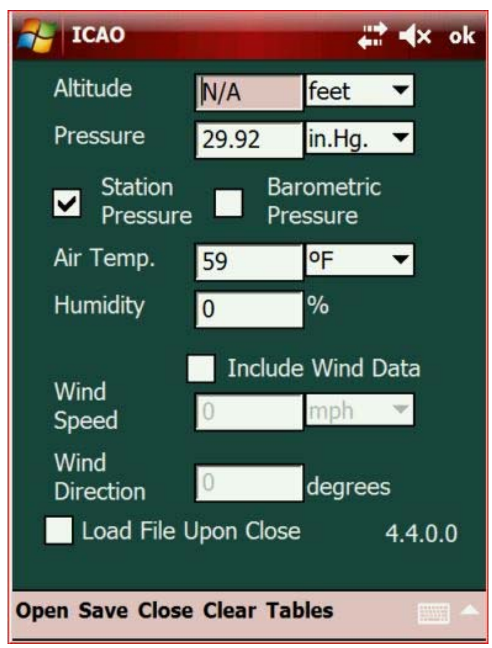
The third form available in the rifle profile can be accessed with the "Notes" tab. This is a place to include any information deemed related to the rifle system. The "Edit" menu item has a variety of editing functions. At the top of the page is a "Write" button which will allow the writing of the notes to a file which will, by default, contain the name of the rifle profile and be stored in the FFS_Rifle directory. The user is free, however, to name the file whatever he chooses and store it where he pleases. If the "Append" check box is checked, the existing notes will be appended to any existing text file specified. If the Append box is unchecked, the notes material will overwrite whatever is in an existing file.

If the user presses and holds the Write button for ½ second, the button functions as a "Read" button and will open an Open File Dialog list with all of the text files found. Thus, in this mode the user is allowed to import any text file into the Notes text window.

D. The Atmosphere Profile

The least important of the basic profiles is the Atmosphere Profiles. 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. This type of profile was included to quickly load a set of atmospheric conditions either standard for comparing the trajectory of different bullets or loads or to save the conditions that habitually are present at a particular range or location.

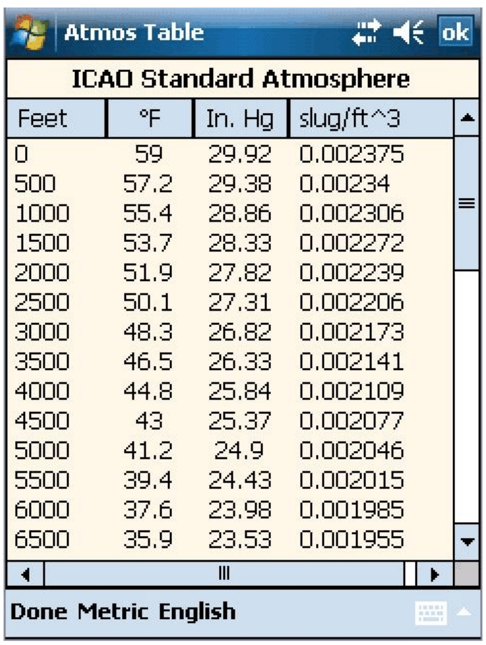
To build, edit or to simply inspect the content of an atmosphere profile, the user taps "Profiles" on the main menu, then "Atmosphere" then "Build/Edit". At this point the Atmosphere Profile form appears and looks like this except the various data window areas will be blank. The user can create an atmosphere 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 “Load”. 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.



Feet	°F	In. Hg	slug/ft^3
0	59	29.92	0.002375
500	57.2	29.38	0.00234
1000	55.4	28.86	0.002306
1500	53.7	28.33	0.002272
2000	51.9	27.82	0.002239
2500	50.1	27.31	0.002206
3000	48.3	26.82	0.002173
3500	46.5	26.33	0.002141
4000	44.8	25.84	0.002109
4500	43	25.37	0.002077
5000	41.2	24.9	0.002046
5500	39.4	24.43	0.002015
6000	37.6	23.98	0.001985
6500	35.9	23.53	0.001955

On the menu at the bottom is a “Tables” item. Tapping this item produces a Standard Atmosphere Table showing data in both imperial 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 because the table is showing the standard *station* pressure at the related altitude.

Basic Ballistic Solution Refinement

While inputting the essential data on the main and Presets page will yield a firing solution, the solution calculated will be suitable for only short range shooting not exceeding 500 meters. There are several tools added to the program to help refine the calculated firing solution suitable for long range use.

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 its left side pushing the bullet to the right as the bullet moves downrange. The result of this is what appears to be a drift of the bullet to the right. To have the software correct for this drift, tap the Options menu and check Spin Drift. The program will calculate this 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.

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.[3] In order to deal with this indirect effect of temperature change, an option was included that allows 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 Basic Profiles 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 the same as the ambient temperature. Alternatively, the "Use Ambient Temperature" box on the Presets page can be unchecked and the program will assume a powder temperature as supplied by the bullet profile or as input by the user. This is useful during experimentation where the user can keep the cartridges at a particular temperature and specify that powder temperature irrespective of what the air temperature is.

Vertical Deflection

Everyone knows that a cross-wind causes a horizontal deflection of the bullet

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[3] 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 team leader who works for the Western Australia Police and very careful student of exterior ballistics, has collected interesting experimental data indicating that changing barrel and receiver temperatures does not affect muzzle velocity, but that changing powder temperature does. Clearly, more work in this area is warranted.

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"[4]. 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 to 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 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 horizontal 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 a phenomenon known as the Eötvös effect.[5]

In small arms, the Coriolis/Eötvös effects are generally ignored. It is basically a time dependent issue and since small arms projectiles are actually in the air no more than 8 seconds for extremely long range shots, 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

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

[5] 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 reduction or increase in the force of gravity as felt by the bullet due to centripetal force. When the Coriolis effect option is chosen, the program also computes and applies both the Coriolis and Eötvös effects to the trajectory.

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 effect is similar in terms of degree of magnitude.

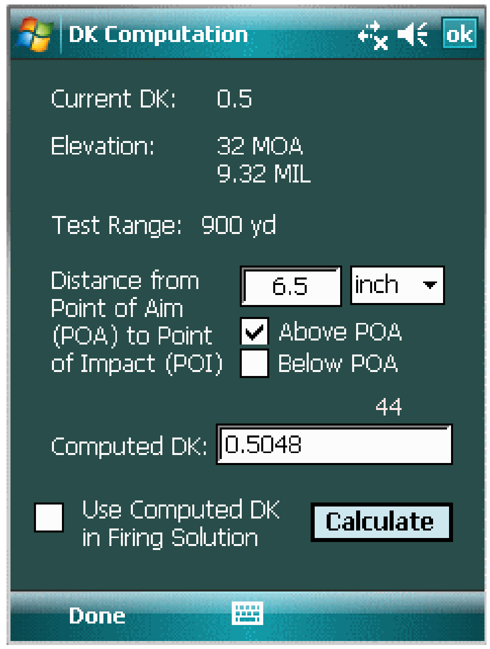
The downside to computing a Coriolis/Eötvös error is that the shooter must know his latitude due to the fact that this apparent movement of the bullet is directly influenced by where on the planet the shot is being taken. And he must know the bearing to the target to get a complete solution since the 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, Map and Rangefinder Ranging sections.)

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 either effect 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 generally be ignored.

Calculating a DK

Two shooters using the same rifle and ammunition in the identical conditions may have very different points of impact at range. Furthermore, 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 but only after the user has done the work to insure that the variables input into the program are correct.* 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.

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. 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.



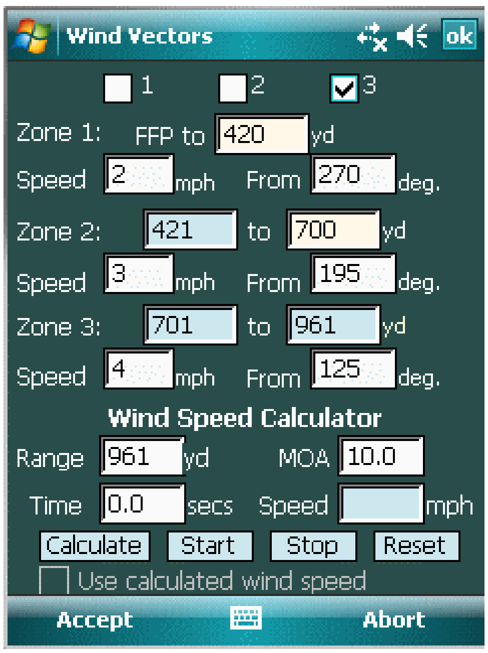
Closing Caveat

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. If you try to use DK to get agreement between the actual and calculated trajectories using erroneous muzzle velocities and/or 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.

Wind Zones

Immediately above the wind speed input window on the program's main page 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 show a "resultant wind vector", a single equivalent value for the total right or left deflection. As a visual cue that multiple wind zones are in effect, the Wind button will go dark in color. Any attempt to change the wind values, use a Kestrel to update conditions, update the Target Range Card, or select a different target will cause the multiple zone mode to terminate.

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

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->Tools->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.

The Projectile Metrics Button

To the immediate right of the Range text window on the main page is a small button whose job it is to display various velocity/range related projectile metrics to the shooter and therefore provide a quick way to see data related to the current range: the height and range of the Maximum Ordinate, the velocity of the projectile and its total drop, the energy and momentum of the projectile, the speed of sound, and the transonic boundaries as well as the maximum supersonic range, the maximum useable range, and the maximum possible range for the bullet. (The speed of sound is not a constant value, but changes directly with temperature.) These various data are informative and can quickly help make a decision whether a given shot has a high, medium or low hit probability.

Visual cues are given to the shooter when the range of any shot is 1) in the transonic region but still supersonic, 2) in the transonic region but subsonic, and 3) out of the transonic region and subsonic.. In the case of conditions 1 and 2, the background color of the Range text window (main program page) changes color as does the small subsonic information button, a yellow hue for condition 1, a red hue for condition 2. For conditions where the bullet is not in the transonic region and is subsonic, the window remains a red hue, but the button returns to the normal color.

Intermediate Tasks & Tools

Intermediate Refinements

Scope Calibration

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. The first important step the user must take is to calibrate his scope. Scope calibration involves measuring the reticle movement over a significant distance at a known range and then computing what the click value of the scope really is. This is necessary to correctly implement the calculated elevation and windage corrections produced by the software. The problem of an incorrect click value becomes a problem at range and compromises precision at long and ultra-long ranges.

First: create a chart of some kind, something that is around a foot wide and 72 inches high. There is nothing magical about these dimensions; the chart must be wide and high enough to track the reticle movement from the top of the chart down a significant distance. Make hash marks at regular intervals from top to bottom; these marks must thick enough to be visible through the scope at our measurement range. Alternatively, create the same foot wide, 72 inch high target but place 1 inch tape down the middle from top to bottom and place an aiming point at the very bottom.

Second: place the chart at around 100 yards. The term "around" does not imply that the distance can be approximate, but rather to signify that few ranges have surveyed distances from bench to target face and as long as the range is "around 100 yards or 100 meters" it will do. Place the chart at the target end of the range and take a little time to ensure that it is vertical particularly if you have the tape strip running down the middle. Make sure that tape strip is exactly vertical.

Third: back at the shooting bench, set up your rifle. Measure the distance between the face of the chart and the turret section of your scope. This distance must be very precise, the more precise the better but in no event more than plus/minus one foot. If the best you can do is plus/minus a yard, you really cannot perform the calibration because an accurate distance from the reticle to the target face is critical to a precise calculation. The difference between using 100 yards and 101 yards is enough to change the resulting click value computation. Some people use a steel tape; some use a laser range finder that can has an accuracy of plus/minus 1 foot; some actually survey the distance, set up markers, and create a permanent calibration space. Whatever method is used, it must provide a distance that is correct within 99.6% of actual. For purposes of the example here, it is assumed that the range distance is 101.5 yards.

Forth: make certain that you have zeroed out the parallax in the scope. Parallax results when the target image and the reticle image do not fall in the same plane in the scope. Parallax can be detected by getting behind the rifle, looking through the scope, and then moving one's head up and down, left and right, slightly without disturbing the rifle. If parallax has been properly eliminated through adjusting the objective lens focus, the target will not move with respect to the reticle. If parallax is present, the shooter will see movement of one image with respect to the other. Continue adjusting the objective focus until no relative movement is detected. This is important since the presence of parallax can provide errors in determining the precise position where the reticle starts and ends on the chart.

Fifth: now measure the distance the reticle travels over the face of the chart. If the rifle being used can clover leaf shots, then start by setting the scope at a 100 yard/meter zero and shoot at the bottom aiming dot - just to make sure the rifle is zeroed correctly. Assuming the shots center punch the aiming dot, dial the turret up 3 Mils (10 MOA) and fire a couple of shots while insuring your rifle is level with an anti-cant device. Dial up a second 3 Mil (10 MOA) and repeat. Do this until at least one rotation of the elevation has been dialed through, farther if there is additional room on the chart. When finished, if the scope has been mounted vertically, all the rounds should march straight up the tape.

Or forego shooting this process and use the chart itself to measure the amount of reticle travel. Place the rifle in some sort of firmly held vice or sand bagged position where dialing the scope will not disturb the rifle itself. Dial to the scope's zero or close thereto and place the horizontal reticle element right on the top hash mark on the chart. Make note of the turret setting. Then begin to dial the turret up 3 Mils (10 MOA) at a time. You will see the reticle move downward in the scope as you do this. At each interval, note where on the chart the reticle is. Be precise with this; these distances are going to measured with a tape measure to the nearest 1/8th of an inch after all data has been gathered. Be as careful and as precise as possible.

Sixth: at this point, the data gathering is done. Bring the chart back to the shooting bench and for those that measured the reticle movement on the chart, take a tape measure and measure the distances from the top of the chart to each interval. Make pencil hash marks for each place the reticle landed as you moved through each interval and note not only the total increasing distance each point was from the beginning point, but make note of the distance between each interval. If the turret is uniform in its click value, then the distances between each interval will be the same over the whole distance measured. Record the total distance covered from the top of the chart to the last hash mark on the chart.

For those who shot the chart, do the same measurements and record the distance from the bottom aiming point to each group and measure the distances between each group.

Seventh: calculate the click value based upon the actual reticle movement across the face of the chart. There are three inputs: 1) the precise range from turret to chart face (range); 2) the distance from the top (or bottom) of the chart to the last hash mark (or bullet group) at the bottom (or top) (this we will call the "chart distance"); and, the number of turret clicks it took to cover the chart distance (clicks). These values are input in the software at Options->Tools->Scope Calibration. This work area will precisely calculate the actual click value for the scope being measured.

Calculating Muzzle Velocity by the POI Method

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 using the shorter range for small calibers and the longer ranges for large calibers. 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.

The 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 the bullet used in the cartridge and its ballistic coefficient, weight, and have a published muzzle velocity value so that the Presets page can be filled in. Set a target as described above and set the elevation as calculated by the program. Assuming that the weight and BC are reasonably correct, any deviation from the trajectory will result predominantly 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 actual muzzle velocity necessary to have placed the bullet where it did. Of course, to deal with the normal dispersion of shots fired, multiple shoots will be taken and the measurement will be from the center of the group. This will yield an average velocity which is all a chronograph provides. Update the bullet profile with this velocity and ambient temperature.

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, found at Options->Tools->Calculate BC enables a user to refine 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.

Using a Chronograph

This workspace is quite simple: the user will obtain two velocities using a chronograph, the first at or near the muzzle depending upon the chronograph used. 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 at each location, subtracts the two to get the range over which the bullet has slowed, and using this range and the two velocities obtained can 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.

POI Method

This workspace uses the impact point of the bullet to determine its ballistic coefficient. There are some assumptions at work to do this: first, it is assumed that the shooter has obtained a good and accurate zero. Second, it is assumed that the shooter has obtained an accurate muzzle velocity. If these assumptions are grounded in fact, then it is likely that at range what error is noted between the calculated elevation and the actual elevation is due to an errant ballistic coefficient. The term "at range" as used here means a range sufficient for the trajectory to develop and be affected by the ballistic coefficient of the bullet but not so far as to allow other forces and effects to alter the trajectory. For purposes of the program, the requisite range is actually based upon the velocity of the bullet. A desirable velocity range would be above the speed of sound but far enough for the bullet to have slowed substantially, somewhere between 1350 fps and 1650 fps (410 m/s and 500 m/s.)[6] This method avoids the drawbacks inherent in the chronograph method of obtaining muzzle and downrange velocities but suffers from the assumption that any deviation between point of aim and point of impact is due to the usage of an incorrect ballistic coefficient. Therefore, the shooter must be alert to other possible causes which may

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[6] The lower velocity is just above the start of the transonic region and guarantees that every bullet used in long range shooting will be stable at this point. This velocity can be lowered to just above the supersonic velocity if the bullet being used is known stable into the transonic region.

be responsible for or at least contribute to this difference, such as up or down drafts, fluctuating or errant muzzle velocity, poor understanding of the actual range involved, cross-wind vertical deflection, mirage and its effect on target acquisition. The shooter must evaluate conditions, distances, and the accuracy of his input data in order for him to have confidence in the resulting ballistic coefficient calculation. If everything going in is good data, the result should be a good, dependable and useable BC value.

Comparison of the Two Methods

The best method is to use the muzzle velocity and downrange velocity of a single bullet. However, obtaining this kind of data tends to be expensive. Either the shooter must obtain Doppler data (which is excellent for BC analysis) or invest in expensive equipment such that the velocity of the same bullet can be measured at both the muzzle and at some significant downrange location.

Since generally most shooters do not have access to either Doppler data nor a setup which would provide muzzle and downrange velocities of the same bullet, he is left with measuring the muzzle velocity first (generally with a chronograph) and then moving the chronograph to a location downrange and obtaining a velocity from a second bullet there. However, for each bullet sent over the chronograph at range, it is not known what the muzzle velocity of that particular bullet is. The shooter is left with performing the BC analysis with an average muzzle velocity, an average downrange velocity, leading to an average BC. All in all, this is an unsatisfactory approach but is perhaps better then nothing.

Slightly improved is the POI method. At least the shooter is dealing with the same bullet from muzzle to target. The drawbacks are that at increasing range the number of extraneous effects can multiply and have an effect upon trajectory. Nevertheless, if the shooter can place a single bullet on a distant target with a high degree of confidence that the round was well aimed and landed properly without the intrusion of errant wind swirls, bullet wobbles, or the myriad of other effects that can distort a trajectory, then that single bullet point of impact can be used to calculate a decent ballistic coefficient. So, like so many things in long range shooting, it takes some skill and reasonably good sense to evaluate conditions, the shot, and the results. But potentially this approach represents an efficient and effective means of calculating a ballistic coefficient that makes sense for use in this software.

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. The software uses a database created by the National Geospatial-Intelligence Agency for its World Magnetic Model to calculate magnetic variation for any place on Earth.

The program needs to know where it is or at least what location the computed firing solutions relate to. 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 obtain the current location via a GPS device 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 "Magnetic" 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 main page will show a tilde ("~")[7] and the Presets page will show all zeros for current FFP, 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 make many other good calculations if it knows the location of the firing position.

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[7] Wherever a data from a profile is shown, when the related profile has not been loaded a "~" will be printed instead. When the software is first started or reset to default values, the user will see tildes next to the [T]arget, [R]ifle, [B]ullet, and [O]ffset buttons on the main page and elsewhere.

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

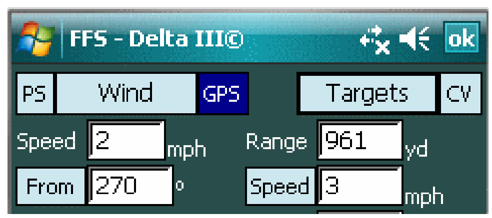
The purpose of the Map Ranging page is to input firing positions (FFPs) and target locations in the form of location coordinates for saving and use on the Targets list and Target Card. FFP location can be obtained one of two ways: 1) from a map; 2) from a GPS. In the first case, it is necessary to input 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 becomes 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. These parameters can be entered by hand or by opening an existing Direct target file which contain just the range, bearing and angle of a target. 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. 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. If the rangefinder is attached to the PDA, each ranging will input the range, azimuth and angle of the target. The program will then calculate the coordinates of each ranged target and the user can easily save this set of coordinates as a target file. These target files will immediately become accessible on the Targets list such that engaging multiple targets 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. See topic "Rangefinder Ranging" below.

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; or the PDA may itself provide GPS capability from an internal GPS chip. 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 of 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 the system color of the other buttons 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.



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; 4) the GPS Ranging form; and, 5) the Target Range Card. 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.

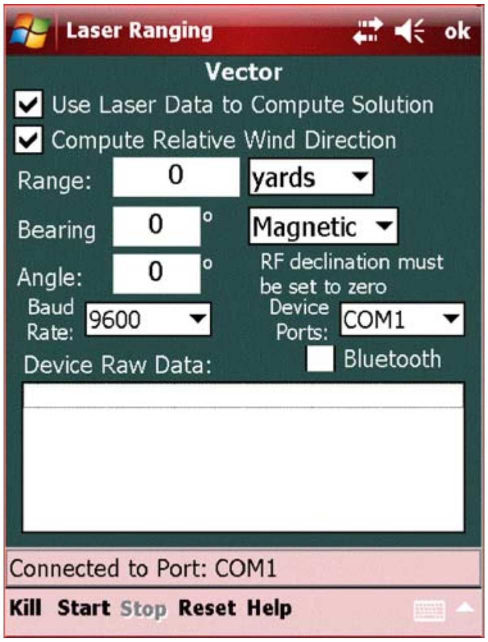
Associated with the GPS Ranging page is a button located on the Local Time line. Pressing this button will synchronize the PDA time to the satellite time.

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 screen backlight may power down, but 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. Range finder Ranging

Obviously a shooter can range a target by using a rangefinder and then input the range into the program. This isn't what is meant by "Rangefinder Ranging". Clicking on the menu item Ranging, selecting Rangefinder and then selecting a particular rangefinder, the user will see the form to the right, this one pertaining to the Vector IV. This form is to enable and open a serial port to bring in ranging data exported by the rangefinder. The range finders listed are those that have the facility to export the ranging data via a serial cable which can be plugged into the PDA. Tapping the "Start" in the menu opens the PDA serial port and assuming that a Vector IV rangefinder is attached to the PDA via the serial cable, each time the range button is pressed on the range finder, the range, bearing and angle will be transmitted to the PDA and displayed in the data boxes. The raw data feed will be displayed as well so the user can inspect the raw data for problems.[8]



There are a limited number of ports on a PDA and those that are available are

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[8] While range finder manufacturers list the baud rate in the specifications of their products, sometimes these specifications change and sometimes the specifications are erroneous for any particular device. For example, the Vector 1500 prior to 2004 had a specified baud rate of 1200; from approximately 2004 on, the baud rate was increased to 9600. Therefore, if user has trouble in getting error free communication with the device, experiment with the baud rate setting. Although the Vector IV has always been spec'd at 9600 baud, we have found at least one which outputs its data at 1200 baud.

listed in the drop down list. Double click on a port, click "Start" and then press the ranging button on the connected rangefinder. If the range finder is connected to the port which is open, the data will be displayed. If it isn't, close the port and try another. If no port works, suspect that no signal is being generated by the range finder or that the adaptor cable is failing to transmit the signal properly to the appropriate pins of the PDA connector.

When the serial port is opened, the "Kill" menu item changes to "Close" which is a visual cue that the form can be closed without killing the serial connection. If the form is "Close[d]" the serial port remains open and each time a range is taken, the data is received by the program and used in various places as discussed below. In addition, a button immediately adjacent to the "Targets" button becomes visible on the main page. This is a visual cue and reminder that the rangefinder serial port is open. It is also a shortcut back to the Laser Ranging page. Instead of tapping the Ranging menu, Rangefinders and then Vector IV, simply click the "RF" button on the main page for immediate access to the to Laser Ranging page.

Once the serial port is open, the data generated by each ranging will be channeled to: 1) the main page for instant firing solution computation; 2) the Lead Computation form[9] for use in rapidly obtaining target fixes to compute target speed and heading; 3) the Direct Ranging page where the range, bearing and angle data will be displayed for saving in a direct target file; 4) the Map Ranging page for purposes of using the range, bearing and angle to compute the coordinates of the ranged target; 5) the Target Range Card where a target list from a current firing position can be quickly created by simply ranging targets in sequence, each target entry showing a range, bearing, vertical hold, and windage information for each target. (See the Target Range Card topic for complete information.); and, of course, 6) the Laser Ranging page to monitor the incoming data for troubleshooting purposes.

The routing of the range finder data to the Map Ranging page is especially useful. If the user has the current coordinates set as the current FFP, going to the

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[9] On the main page there is a Speed button associated with Target speed. Generally pressing this button toggles the speed units. Pressing and holding the button for a half-second will bring up a timer form for manually timing the target's movement to calculate target speed. However, when a serial port for a rangefinder connection is open, the button's function changes. Pressing and holding the button brings up a form on which the lead of a moving target can be automatically computed through two fixes from the rangefinder. The user presses the rangefinder button once to get the range, bearing and angle of the target in position 1, waits a period of time and then takes a second fix of the target. The program computes the speed and direction (relative to the shooter) of the target which can be "Accepted" back to the main page where a firing solution will be computed for that target.

Map Ranging page will fill the FFP location with the current data. Ranging a target with a connected rangefinder will fill in the Range, Bearing and Angle windows on the form. Checking the Target Coordinates box will cause the Calculate button to calculate the target's coordinates based upon the current location and the ranging data. The user can then quickly save the target coordinates in a target file for later use on the Targets List.

On the Target Ranging Card the data is handled similarly. If the FFP is set, each ranging causes the automatic calculation of the target's coordinates and upon saving the target group, each file is saved as a Position target file and is included in a target group file for quick loading later.

<u>Use Laser Data to Compute a Solution</u>

By default when the program starts, this check box is checked and each time the range finder ranges a target a solution is computed. However, when ranging targets that are beyond the practical range of the rifle or when the objective is merely to range targets for purposes other than engaging with the rifle, this box may be un-checked in which case the range finder data is still distributed throughout the program, but no solution calculated. In addition, when the this box is unchecked the "RF" button on the main page turns a dark blue as a visual cue that firing solutions are not being computed. As an additional reminder the solutions windows show only "----" instead of a numeric value. Therefore, when using the program to plot target locations on the Map Ranging page, uncheck the box, open the laser port, close the Laser Ranging page and open the Map Ranging page. With the "Compute Target Coordinates" box checked and a current FFP location, each ranging will automatically calculate the ranged target's coordinates.

<u>Compute Relative Wind Direction</u>

The range finder interface page has a check box labeled "Compute Relative Wind Direction" which is selected by default. When selected, the user will see the wind direction on the main page change as targets are lased in order to reflect an accurate relative wind direction for each lased target given its particular bearing. Unchecking the box will cause the windage direction to remain constant during target ranging.

<u>Limited Function Rangefinders</u>

Some PLRF rangefinders, as an example, do not have an internal compass or inclinometer and thus does not output a bearing to the target or a target angle. There are other rangefinder brands of similar limited functionality. Upon selecting such rangefinder, the data inputs which cannot be supplied by the rangefinder will be grayed out on the interface page and these values must then be input by hand.

E. 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.[10] 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]".

Next to the Target data window is a button which brings up a Size of Objects editor. This editor permits the reading of lists containing the known size of various objects which may be encountered in the file. The editor also permits the editing of existing lists and the creation of new lists.

Editing an Existing List - make the required changes or additions and then press the "Save" menu item. All changes are saved to the existing file.

Making a New List - make changes to an existing list and then click on the "SaveAs" menu item. A file naming text window appears at the top of the screen. Tap <Enter> to save the file. (Tapping <Enter> on an empty screen aborts the process.) To create a brand new list, click on "New" and add the desired data. Then finish with "SaveAs" and enter the name of the file. Upon the creation of the new list, the drop down menu is updated and the new file will immediately appear on the list.

Getting Size Data - the user can import a size number back to the Reticle Ranging form by 1) highlighting the desired number and 2) clicking "Close". At that point the Size Lists form closes and the selected number appears in the Target size window. The user must then ensure that the units (inches, feet, yards, centimeters, or meters) for the imported value are correct. Only the number may be highlighted; do not include any additional text such as units.

[10] The form can also be used as a training aid in that it allows input of any two unknowns for calculation of the third. Thus a target of known size and at a known distance can be input so the shooter can see what the target of the calculated Mil size looks like in the scope.

Intermediate Profiles

A. The Offset Profile

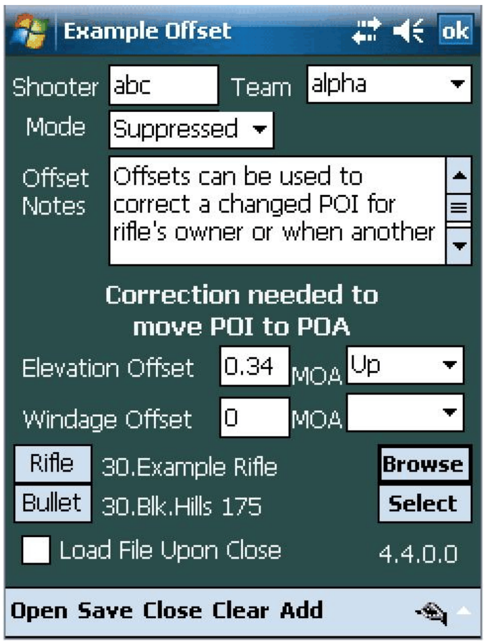
The offset profile is linked to a particular rifle, a default cartridge, and its own cartridge list similar to the rifle profile. The cartridges listed in the offset profile need not be the same cartridges associated with the rifle profile. This is a powerful feature which provides a method to compensate for a shift in bullet point of impact due to 1) a change of ammunition; 2) a change of shooting position or rifle configuration (such as adding or removing a suppressor); or, 3) a change of shooter. In fact, *any* change in the rifle, scope, cartridge, or shooter that causes a point of impact (POI) shift can be corrected by use of an offset profile. When a modification that changes the POI 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 offset profile may have the same or different cartridges listed than those listed in the related rifle profile. This design decision was implemented to give the most flexibility to the user.

The implication of the offset profile is that each user should have his own offset profile for each rifle he shoots in each position if a change of position causes changes in POI. 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.

To use the offset profile, enter the initials or other description, a team if applicable, and mode. Note that the mode comes with a list of possible descriptors as a convenience, but the user can simply type in his own as necessary; same with the Team list. Add any offset notes.

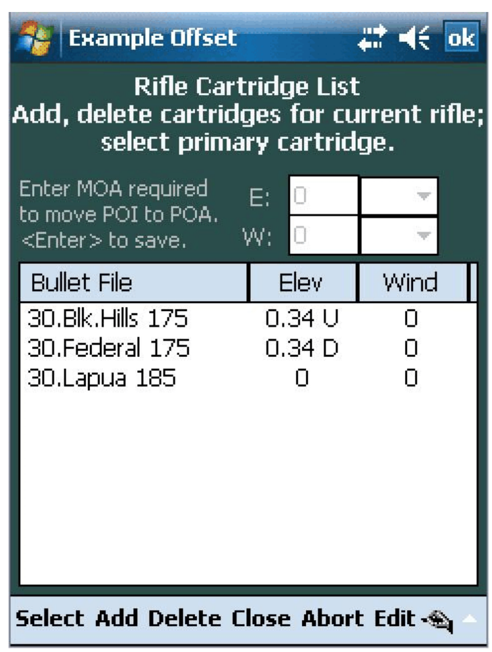
Next, browse for a rifle that this offset will relate to. When selecting a rifle, whatever bullet is the default bullet for the rifle profile will also be initially listed as the default bullet for the offset file. Note the "Add" item in the menu. This is a context sensitive item: when pressed on the main page it means "add cartridges to a list" and will call the cartridge list shown below. When pressed on the cartridge list form, it will open the FFS_Bullets folder so the user can add cartridges to the list.

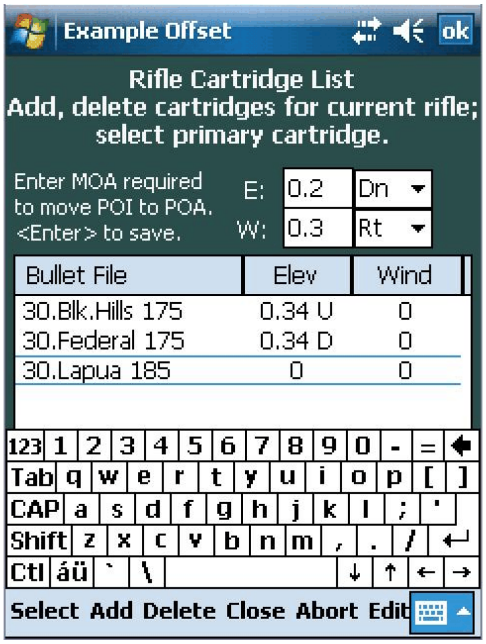
It is not necessary that every offset profile have a list of cartridges; it can relate to the default cartridge only, although that is a fairly narrow application of this tool. If the user does not create a cartridge list, the user can enter the elevation and windage offsets directly on this form. Enter the correction as well as direction (up, down, left, right) for the offset and the profile is complete for that particular bullet.



The true power of this feature, however, is seen when a cartridge list is created. The offset profile was made from the 30.Remington example rifle that ships with the software. Shooter, Team, Mode and Notes were added. Because the example rifle comes with a default cartridge and a cartridge list, the same records are added to the offset profile. However, the Black Hills cartridge has no offset in the rifle profile and so initially the elevation offset will be listed as "0.0". Press the "Add" menu and the form below appears.

The offset values have been changed in this example from the values initially there from selecting the example rifle. These values were changed to show the POI correction when a suppressor is mounted on the example rifle. To "Add" more cartridges, simply press the "Add" menu item and chose any cartridge of choice. One other note: if MOA are the default units, the units shown in the these forms will be MOA; if Mil units, Mils units will be used.

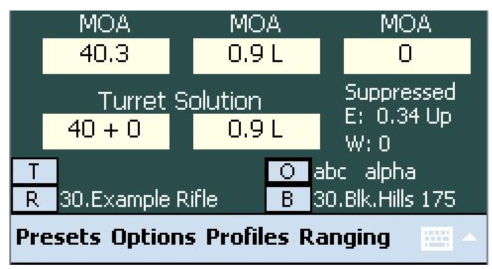




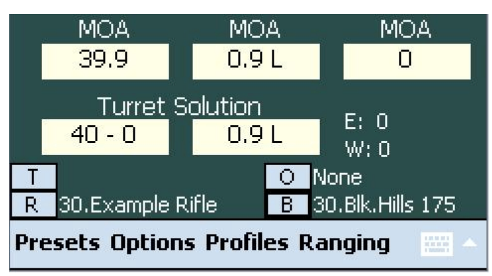
The way the offset values are changed is to 1) highlight the cartridge of choice; 2) click the "Edit" item in the menu and choose "Offsets". At that point, the offset part of the form at the top becomes active, the existing values associated with that cartridge are loaded in the appropriate boxes and are ready for editing.

As shown here, the values were initially 0.0 for both elevation and windage. After tapping the "Offsets" choice the values 0.0 were imported to the edit section and that section is activated. In this example, the values 0.2 Dn and 0.3 Rt have been added. To accept these changes, tap the enter key on the soft keyboard, generally shown by this symbol: ↩ . Continue in this way until all of the offsets have been entered for all of the cartridges chosen. If there is a cartridge on the list that is not wanted, highlight the cartridge, tap the "Delete" (now "Remove") menu item and the cartridge will be removed.

Upon "Close" the changes made will await a "Save" of the changed file by the user. If the user wants to abandon the changes, simply tap the "Abort" menu item and the form will close with any change being discarded.



To the extent that a change to the offsets of the default cartridge was made, these changes will now appear on the main form. In fact, when there is a cartridge list, the only way to change the offsets of the default cartridge is by going to the list and making the changes there.



Upon loading the offset file, the effect of the offsets on the computed solutions will be noted on the main page. This is the main page showing the loading of this file.

Pressing the "B" button will bring up the cartridge list for the offset file, not the rifle file. The reason why is obvious: we are interested in the offsets for all cartridges on the rifle as suppressed. To clear the offsets, click on the "Profiles" menu item, then select "Offsets" and "Clear Offsets" with the result being as shown. At that point, the cartridge list returns to the list associated with the rifle profile, in this case the "30.Example Rifle". (You will see the change in the MOA solution although the turret solution remains unchanged. This is a function of the turret itself which, in this case, is a 1 MOA/click turret so in this case the turret solution is the same. This will not be the case for either 0.1 Mil/click or 1/4 MOA/click scopes.) Or, a more efficient way to clear the offset is to tap the "O" button, tap and hold on the loaded offset file and choose "Clear" on the resulting context menu.

The offsets concept is flexible and applicable to a variety of problems. It is anticipated that this feature can be adapted to many, many issues that lead to a consistent change in POI. The offset profile may offer a solution for those issues.

B. 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.

C. Targeting Profiles

Targeting profiles are simply FFP, Position Target and Direct Target files. The FFP and Position Target Profiles have similar data as the Map Ranging form and the files are interchangeable, the difference being that the profile form allows for the entry of notes and comments. Thus, the FFP and Position Target Profiles can have more extensive data associated with them than a similar file created in the Map Ranging file. Both files, however, can be brought up and read in either form. The Direct Target Profile takes the user to a form very similar to the Direct Target Ranging form and identical in content. And, as with all profiles, after creating a Targeting Profile, the user can elect to save the data and/or load the data into the program upon closing the form ("Accept") or abandon the data with or without saving it first.

Quick Access Data Buttons

In order to manage teams of shooters or multiple firearms, quick access to relevant data files is desirable not only to load a particular file but to inspect or edit these files in a summary fashion. To facilitate this access, keys or buttons are located on the main page at the bottom which take the user immediately to lists of offsets, rifles, the bullet database and the target list. The other buttons list the current data related to the currently loaded data file(s). Thus, if an offset file is loaded and is current, the shooters identity, the shooting position, and the elevation and windage offset is shown on the main page in order to apprise the team leader of all pertinent data. The rifle button lists the current rifle; the bullet button lists the current bullet; and, as mentioned, the target button list the current target.

A. Offsets List

The program supposes that in a rifle team there will be a number of offset files for team members shooting their own rifles with various cartridges and team members shooting other members rifles. Pressing the "O" button produces a list of offset profiles which can be filtered by shooter and team. Each offset file lists the file name and the rifle which it links to. As with all lists, highlighting any particular file allows use of the "Edit" menu item. Tap the edit item or press the far right hardware key and the highlighted file will be opened in a edit form such that the data can be modified or inspected. Tapping the far left button closes the edit form and brings the user back to the list.

When the offset button is first pressed, the list is automatically filtered for the rifle currently in use. Thus the list shows all offset files that pertain to that particular type of rifle. To see more offset files, press the "All Rifles" button at the bottom of the form.

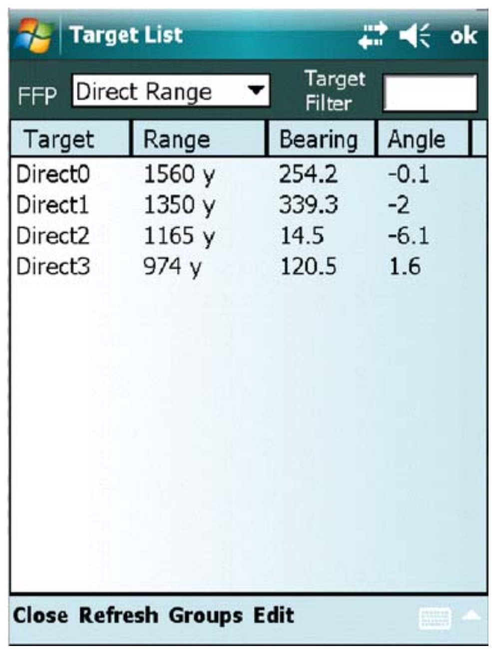
B. Rifles List

When the Rifle List button is pressed, all rifle profiles are shown whether the rifle files are linked to offset files or not. At the top of the list are filters that will filter the list of rifles by individual shooter and/or team. If the team leader wants to see what rifles are available in any particular team, he simply looks at the team drop down list and selects the team of interest. The team names are taken from the offset files, so clearly each shooter and his rifle should be represented by an offset file even if the file shows no offsets. Note also that when the rifles are filtered by any criteria each offset file is read and the data, including the position, is placed on the list. This data helps the team leader determine the content and relevance of any particular file listed.

Note that the user can choose a file to edit from the list. When the list is filtered by shooter or team, only rifles linked in offset files are listed and therefore it becomes possible to edit either the rifle profile or the associated offset file. The program tries to determine which offset file is being referenced and brings that offset file into the edit form. The data can be inspected and/or changed and the file re-saved or selected.

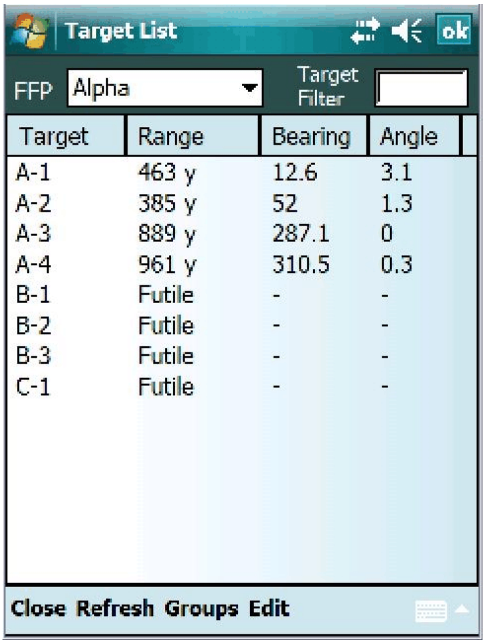
C. Targets List

Clicking on the "T" button (lower left corner of the main page) will produce a list of targets, assuming that the user has created such targets. There are two types of targets that will show up on this list: those created by Direct Ranging which contain only range, bearing, and angle and Position target files which contain coordinates and an altitude of a specific location. These types of files can be created in the Map Ranging page and in the Target Ranging Card.



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 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 are 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.



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 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 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.

Quick Editing of FFP and Target Profiles

At the bottom of the screen is an "Edit" menu item. When the targets are of the Direct Range type, only target files may be edited. When an FFP has been selected, submenu items "FFP Files" and "Target Files" are both active. Clicking on the FFP File will export the current FFP to the editing form. Clicking on Target File will export the highlighted target to the editing form. After editing is complete, save the changed file and close the form to return to the target list form. If a file has been changed and saved, the list will be refreshed to show the content of the edited file.

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.

Exiting the List

This form does not have an "Accept", "Abort" or "Done" menu item. Exit by tapping the "Close" in the menu or by tapping "OK" at the top of the form.

D. Bullet Files

The bullets button at the bottom of the main page produces all cartridges that the user has associated with the rifle or offset profile currently selected and in memory. This is a particularly powerful feature of the software since the two lists need not be the same. An interesting application for having two distinct list is the rifle that is suppressed enabled. Without a suppressor, the rifle will perform one way with a particular cartridge acting as the default cartridge for purposes of the scope's zero and a list of other cartridges that may be chosen along with their respective elevation and windage offsets. Upon mounting the suppressor, two common things happen: 1) there may be a shift in point of impact for all cartridges; and, 2) there may be a muzzle velocity change for each cartridge. The solution would be to create two sets of bullet profiles for this rifle, unsuppressed and suppressed, with the relevant muzzle velocity, temperatures, etc., for each. Assume that the normal mode of operation is unsuppressed. In that case the unsuppressed set of cartridges will be placed in the rifle's profile; the other will be placed in a suppressed offset profile which will list not only the suppressed set of bullet profiles but any offsets required when the suppressor is mounted. Placing the suppressor on the rifle then requires only a few program clicks to choose the offset file from the list. Thereafter, all available cartridges for the rifle will be those associated with the rifle suppressed and pressing the bullet button will bring up the suppressed bullet list.

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, 6.5 seconds have elapsed and the calculator declares that the smoke is traveling at 3 mph perpendicular to his line of sight. 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 tap the "Start" and "Stop" buttons while he is trying to watch the smoke through his scope? Well, he doesn't have to. The timer on Wind Vectors screen is tied to the button cluster hardware on the front of the PDA, specifically the "Enter" button. The first push of the Enter button 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.

Target Fix & Speed at Range

A similar work area exists for obtaining the speed of a target at range as exists for obtaining wind speed at range. On the main page in the Target section is a "Speed" button that normally toggles the speed units. By holding the button down for longer than about one-half second, upon release a target speed timer appears. As for the wind speed timer, the "Enter" button will start and stop the timer and by observing the target through the scope, the target's speed across the reticle can be timed and ascertained assuming that the shooter has the target's range. To use the computed speed, simply "Accept" the result and it will be imported back to the main page where a firing solution will be computed.

Note that, like wind, only movement of the target perpendicular to the target's bearing can be measured so the user must indicate whether the target is moving towards the right (90 degrees) or left (270 degrees). Any part of the movement either towards or away from the shooter is ignored.

When a range finder is attached to the PDA, the "Speed" button functions in a similar way except that upon holding and releasing the button a target fixing page is shown. Because the shooter has the ability to exactly range the target with the range finder, he has the ability to take two "fixes" of the target's position at two distinct points in time. The shooter therefore ranges the target which places the first fix on the form and starts the timer. The shooter then takes the second fix. The range, bearing and angle is input into the program as the second fix data, the timer is stopped, and the program accurately computes the target's speed, bearing (relative to the shooter) and angle. Upon accepting this computation, these data items are imported back to the main page where a firing solution is computed.

As a backup in case of a failure of the range finder, it is possible to perform these fixing tasks manually by inputting the range, bearing and angle data by hand, starting and stopping the timer by hand and hitting the calculate button. While "possible" this mode of target speed calculation is not particularly feasible; better to use the target timer manually or, if keeping the range finder connected is required for some reason making the manual time unavailable, use the wind timer.

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 in 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 the 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 his preferences. To obtain the data contained in the table, select Capture->Current Table. All data in the table will be written to a CSV file which the user can find in the \Documents directory on the card. Copy this file to a desktop computer for opening in a spreadsheet and thereafter editing the columns, presentation, format and the rest. Please note that the turret column data can be interpreted by the spreadsheet program as a date. In order to avoid this, instead of merely opening the file in the spreadsheet, import it and during the import process specify that particular column as a text column.

If the user wants to make several field cards for the same bullet profile but with changing atmospheric values, simply create the file as instructed above but leave the data file in \Documents, exit the Elevation Table, make changes to the Presets page, re-enter the Elevation Table and tap on the Current Table menu item again. The new trajectory data will be appended to the original file. The user may repeat this sequence until all of the various conditions for that cartridge have been exhausted. At that point, move the file to the desktop computer, open it in a spreadsheet program and the user will see individual trajectory blocks for each condition saved.

It is possible to create extended Density Altitude Tables for a given cartridge as well. Clicking on the Capture->Den. Alt. Tables item will take the user to a form where he can specify the altitude range of interest and specify the size of the step or interval. It is recommended that 500 or 1000 feet (200 or 500 meters) be used, but it is possible to enter any value. If the user wanted a study of changes from 500 to 750 meters at 10 meter steps, he would select the lower and upper boundaries and then enter 10 in the Step window, then "Accept". A rather lengthy file with 25 separate tables would be found in the \Documents directory ready for further editing in a spreadsheet.

It should be noted that the Abridged density altitude tables can reflect elevation in terms of the user's turret, i.e., the elevation that must be dialed given the click value error of the user's turret, as well as the impact upon elevation calculation due to powder temperature changes as altitude increases. If the user has loaded a particular turret file into the program, the various elevation columns in the table will reflect elevation settings for that turret; therefore, if the user wants "pure" elevation calculations unaffected by a particular turret he merely has to clear the turret (Profiles->Turret-> Unload). Similarly, if the "Powder Temperature" option is selected, as the density altitude increases, the standard temperature decreases which may affect muzzle velocity and hence downrange performance. To obtain a table with a constant muzzle velocity, simply turn off the "Powder Temperature" option.

Density Altitude tables can be a good backup in the event that program functionality is lost and the user is encouraged to learn more about the uses of this type of table on his own.

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.

The second column shows holds that assume that a windage value has been dialed and as the wind changes speed, the shooter can hold either left or right the amount shown. The fourth or last column assumes that the windage is not dialed, but held and the amount to hold is shown, starting at zero (where only the spin drift and Coriolis deflections, if any, are shown.) The third column shows the Net Hold, particularly useful for a moving target and a variable wind. This column assumes that no windage has been dialed and the net value of adding the wind correction and the lead value is shown. This value also incorporates the spin drift and Coriolis deflections.

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.

Creating Printed Data Tables

Printed data tables are a poor substitute for real-time ballistic solutions based upon conditions existing at the time the shot is taken. Nevertheless, while they may be a poor substitute, they are very much better than nothing. As a precaution against loss of access to the software, foreseeable due to the loss of battery power for the device upon which the software runs for example, the user can create a number of useful tables, print them out, and have them for emergency purposes. It should be recognized, however, that printed tables contain static information and adjustments must be made mentally for any condition that is different from that upon which the table is based. Further, tables generally do not contain every possible solution so interpolation is frequently required.

There are five areas in the program in which the user can organize the data to create a printed table or chart:

a. The Elevation table (Elevation button, main page) can be captured to create a useful come-up card. The data on the table will be the same data as shown on the Elevation table itself and therefore be based upon the atmospheric conditions, bullet parameters, and table parameters upon which the electronic table is based. This table is created by tapping the Elevation button->Capture->Current Table.

b. Density Altitude tables can be created which will have basically the same information as on the Elevation table but at a range of density altitudes as specified by the user. The user taps the Elevation button->Capture-> Den. Alt. Tables to access the interface to specify the range of altitudes of interest.

c. A Wind/Range table showing windage values over a range of wind speeds and target ranges can be created. To create this table, tap the Windage button (main page), then the Table menu item. Input the starting and ending values of both wind speed and target range as well as the increment (the Step) that the data is to be calculated. Windage values will be calculated for each wind speed and range requested. (Note: these windage values are "pure" in the sense that they are reflective of the deflection from wind only and do not include Coriolis or spin drift deflections even if those elements are options included by the user in the normal firing solution calculation.)

d. A reticle ranging table is available for creation which correlates target size and reticle measurement to obtain the range to target. This table is created by tapping Ranging->Reticle->Table and specifying the range of target heights and reticle measurements of interest.

e. A Density Altitude Chart showing density altitude over a user specified elevation range for a user defined temperature range and at a specific humidity. This chart differs from the density altitude table created a part of the Elevation table in that this chart does not related to the trajectory of any projectile. This chart is created by tapping Presets and then tapping the "Table" button at the top-left of the Presets page. On the standard atmosphere table, tap the "DA-Chart" on the menu and input the desired elevation and temperature ranges.

Each table created will be found in the \Documents folder on the SD card and each will be in the format of a "CSV" file (Comma Separated Values). This is a text file that can be directly read by most spreadsheets which will organize the data items in rows and columns to create the table. The resulting table will not be pretty; CSV files cannot specify how the data is to look, how it is to be formatted in the cell, or what color or font should be used. It is just the plain, basic, numbers laid out as a rudimentary table. But the hard work of gathering perhaps hundreds of solutions has been done and what remains is making the data look nice and readable. This step will depend upon the skill the user has developed with spreadsheets.

In order to permit a single file to contain multiple tables varying in the range of the input values or based upon different atmospheric conditions or even different bullets, etc., the program will append a new table to the data already in an existing file. For example, if the user wanted to create windage tables for different density altitudes, but all covering the same range of values, he would go into the Presets page and choose atmospheric conditions that would yield a particular density altitude, Accept, and then open the table interface page in the Windage section. He would input the wind and range parameters, create the table, and then go back to Presents to input the next density altitude condition. This would be repeated until the entire range of density altitudes had resulting tables. When he opens the single "Windage Table.csv" file in a spreadsheet program, he would find all of the tables he had built, one for each density altitude he specified. He would then work with the spreadsheet program to format, color, and arrange these tables to his satisfaction, print them out, and have them as emergency reference material in the event the ballistic software was unavailable. If the user wanted to save the data file and not permit further appending, he would simply change the name or move it out of the \Documents folder.

To the right is an example of the DA-Chart.csv after it has been opened in Microsoft's Excel, formatted, and given color. This spreadsheet can be printed and laminated as required by the user.

Density Altitude Chart									
Humidity: 50%									
hPa	Elev. (m)	DA							
898.7	1000	700	892	1081	1269	1456	1645	1836	2031
877.2	1200	949	1140	1328	1515	1702	1890	2080	2276
856	1400	1198	1387	1575	1761	1947	2135	2325	2520
835.2	1600	1446	1635	1821	2007	2192	2379	2569	2764
814.9	1800	1694	1882	2067	2252	2437	2623	2813	3007
795	2000	1942	2129	2314	2497	2682	2867	3056	3251
775.4	2200	2190	2375	2559	2742	2926	3111	3300	3494
756.3	2400	2437	2622	2805	2987	3170	3355	3543	3737
737.5	2600	2684	2868	3050	3232	3414	3598	3786	3980
719.1	2800	2931	3114	3295	3476	3657	3841	4029	4223
701.1	3000	3177	3359	3540	3720	3901	4084	4271	4465
683.4	3200	3424	3605	3784	3964	4144	4326	4514	4708
666.1	3400	3670	3850	4028	4207	4387	4569	4756	4950
649.2	3600	3915	4094	4272	4450	4629	4811	4998	5192
632.6	3800	4161	4339	4516	4693	4872	5053	5239	5434
616.4	4000	4406	4583	4759	4936	5114	5295	5481	5675
600.5	4200	4651	4827	5003	5178	5356	5536	5722	5917
584.9	4400	4895	5071	5246	5421	5597	5778	5963	6158
569.7	4600	5139	5314	5488	5663	5839	6019	6204	6399
554.8	4800	5383	5557	5731	5904	6080	6259	6445	6641
540.2	5000	5627	5800	5973	6146	6321	6500	6686	6881
	C	0	5	10	15	20	25	30	35

Advanced Tools

The Target Range Card

Clicking on the "Targeting" button at the top of the main page brings up the Target Range Card, probably the most powerful and meaningful display of data in the program, outside of the main page. This data presentation combines the functionality of the Target List, Elevation Table, Windage Table, Map, Direct, GPS, and Laser Ranging functions, into a single location to rapidly create and catalog multiple targets from a single firing position, presenting the firing solution data in the form of elevation hold-offs and relative windage values for each target such that the shooter can rapidly acquire any of the listed targets without dialing the firing solution. Second, the created target list can be edited, modified, and saved as individual targets and, more appropriately, a target group all from this work area. In addition, each of the individual targets created, as well as the related FFP, is also accessible from the Target List and are editable in the various locations in the program for editing target and FFP profiles.

Review of Target File Types

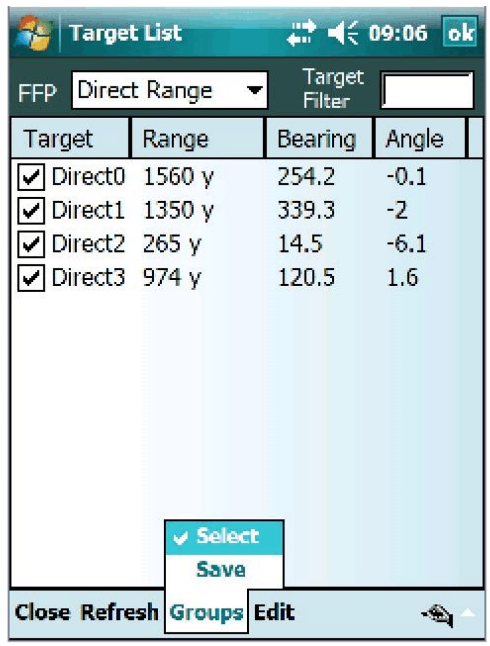
The program allows for the creation of two types of target related files: the "Direct" ranging file and the "Position" or "Location" file. The direct ranging file is a simple file as it merely comprises a range, bearing and angle. It is not connected to any particular location on Earth and is compatible with any loaded FFP. This type of file is included in the program to enable the creation of target files in circumstances where the current FFP coordinates are not known. In the absence of FFP coordinates, it is not possible to calculate target coordinates and therefore it is not possible to create location or position target files. These simple range-only files can be loaded under any circumstance since doing so only means the loading of a range, bearing and angle to the main page of the software.

The second type of file is the "Position" or "Location" file; it consists of the latitude, longitude and altitude of a specific location on Earth. In order to use a position file it is necessary to pair the target position with a shooting position, an FFP file which contains the latitude, longitude and altitude of a firing position. Once the coordinates of the FFP and target are known, the range, bearing and angle of the shot can be calculated. Obviously, position target files have no real meaning in obtaining a firing solution in the absence of an FFP location since it always takes two map positions to calculate the range, bearing and angle components that form the basis for computing a firing solution. Consequently, while it is possible to load an FFP file in the absence of a target file, the reverse is not true. Loading a Position target file by itself has no meaning to the program since it not possible to do anything with a target location by itself.

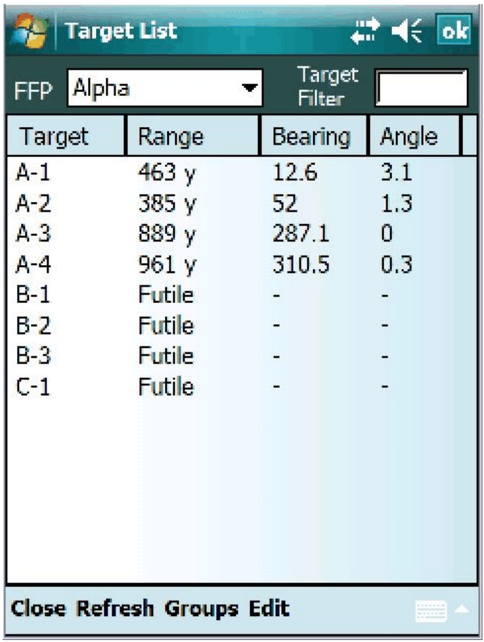
With this review, the user can see why the Direct ranging file can be used with or without loading an FFP file, but to use a Position file an FFP **must** be loaded. Not only that, the FFP and Position files must be within a meaningful range of one another to be useful in the program. Therefore on the Target Range Card, where an FFP is changed which places the existing targets beyond the maximum possible range of the loaded cartridge, the target list will be cleared since the targets are not meaningful to that FFP. (Discussed later: the program will make an effort to find a target group that is meaningful to that FFP and display those targets.)

Creating Target Groups from Existing Target Profiles

The purpose of the Target Range Card is to form target groups that relate to a specific FFP which can then be saved as a target group and loaded as a group for subsequent use. These target groups can, of course, be created on the card itself. But they may also be created from existing target/FFP profiles from the Target List. To accomplish this, open the Target List by tapping the "T" button at the bottom left of the main display and note that the menu has a "Groups" item. First, it is necessary to "Select" the targets the user wants to group and upon clicking the "Select" sub-menu item, boxes appear on the list enabling the user to choose which targets are going to part of the group. Groups will be comprised of either Direct targets or Position targets, but it is not possible to mix the two. After the targets are selected, the "Save" sub-menu item becomes enabled and tapping on Save leads to a file dialog which allows the user to name the new group file and save it. The process is the same whether Direct or Position group files are being created.



Be aware that when making Position target groups, the related FFP is also saved as part of the group. This insures that when loading a group, a correct FFP is also loaded. However, it is possible to include a target in more than one group. The only limitation is that the target must be within the maximum possible range of a given cartridge from the associated FFP. If the user attempts to create a group file and to add a target beyond this distance, the attempt will be ignored and the file will not be added. The program will assume that the user simply made a mistake and refuse to include the target in with the group.

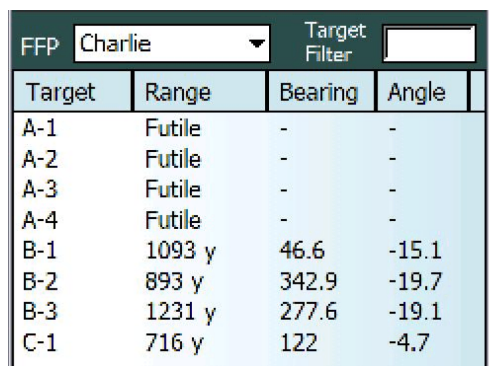


Target	Range	Bearing	Angle
A-1	463 y	12.6	3.1
A-2	385 y	52	1.3
A-3	889 y	287.1	0
A-4	961 y	310.5	0.3
B-1	Futile	-	-
B-2	Futile	-	-
B-3	Futile	-	-
C-1	Futile	-	-

Looking at the list of position targets on the list, the filter has been removed so that the ranges from Alpha to all of the targets is shown. Note that the range from Alpha to some of the other targets is deemed "Futile" by the program because these targets are beyond the maximum possible range of the cartridge that is currently loaded; there is no reason why the program should compute an actual range for these targets and therefore doesn't.

Now look at the target lists for Bravo and Charlie FFPs, again with the filter removed. Charlie is an FFP that is a short distance from Bravo so targets associated with Bravo and Charlie may be accessed from either FFP. And, it would be possible for the user to create target groups

Target	Range	Bearing	Angle
A-1	Futile	-	-
A-2	Futile	-	-
A-3	Futile	-	-
A-4	Futile	-	-
B-1	1235 y	48.1	-14.8
B-2	945 y	351.9	-20.7
B-3	1142 y	282.4	-22.4
C-1	794 y	112.8	-6.6



Target	Range	Bearing	Angle
A-1	Futile	-	-
A-2	Futile	-	-
A-3	Futile	-	-
A-4	Futile	-	-
B-1	1093 y	46.6	-15.1
B-2	893 y	342.9	-19.7
B-3	1231 y	277.6	-19.1
C-1	716 y	122	-4.7

which included any of those targets in a Bravo and/or Charlie group file. For demonstration purposes, the program comes with Alpha, Bravo and Charlie group files. Alpha contains targets A-1 through A-4; Bravo, B-1 through B-3 and Charlie contains B-2, B-3, and C-1.

As a naming convention for Position target groups, it is helpful if the group file is named after the FFP. The reason why is, as will be seen in the discussion of the functioning of the Target Range Card itself, when FFPs are changed, the program searches for a target group with the name of the FFP and loads it assuming that the user will want targets shown that are within range of the selected FFP.

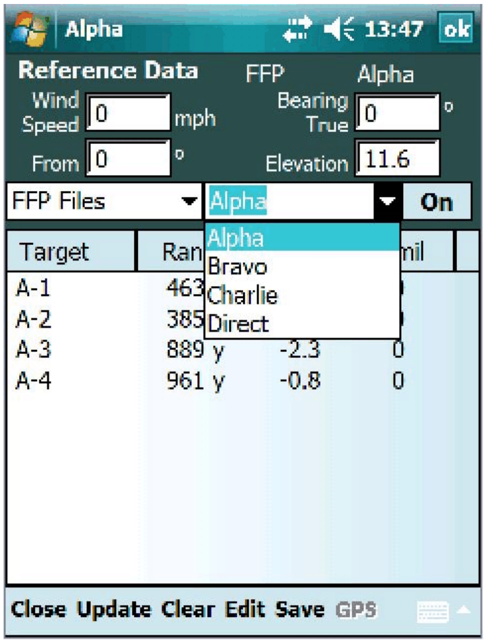
<u>Using the Target Range Card</u>

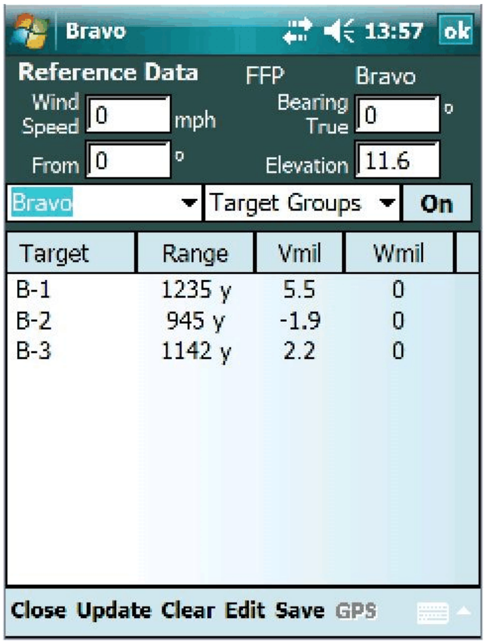
Tapping the "Targeting" button on the main program page brings up the

Target Range Card. If the user has created group files, each group file will be listed in the drop-down "Target Groups" list. Tapping on one of the group files will load the file into the list view area. Group files may consist of either Direct or Position targets. As already mentioned, the Position groups contain not only target positions but the related FFP as well. When loading a group of Direct target files, therefore, no change is made to the current FFP, even if that is "~", i.e., no FFP loaded. However, when loading a group of target position files, the FFP that is contained in the file is also loaded .

A. Loading a group file

The program comes with four group files: Direct, Alpha, Bravo and Charlie. A group file is loaded by dropping the Target Groups list and tapping on one of the available groups in the list. The graphic shows the list and what the form would look like with Alpha loaded. Note at the top of the form the FFP is shown as Alpha and targets A-1 through A-4 are displayed on the list view. These targets were added to the group file in the Target List as explained above. Note also that the name of the form at the very top has changed to the name of the group file in order to help the user know at any time what file is loaded, particularly if the file name is not that of the FFP.



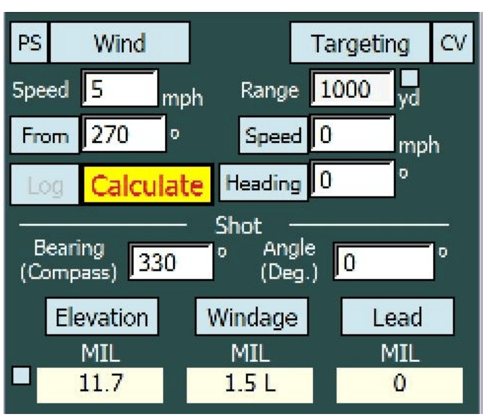


An FFP may be changed in much the same way except the catalog of available FFPs are in the "FFP Files" drop-down list. In this case, there are three FFP files: Alpha, Bravo and Charlie. The FFP list shows those three. If an FFP is selected which is in conflict with the listed targets, that is if the FFP is mismatched to the targets and the resulting distances between the two exceed the maximum possible range of the loaded cartridge, the targets are removed from the list and the program tries on its own to find a group file containing suitable targets. Show in the graphic is the consequence of selecting the Bravo FFP. Note the change of name at the very top and the change of FFP. When the FFP Bravo was selected, the program went through the available group files to determine whether there was one named after this FFP and upon finding one, opened it and loaded the files it found.

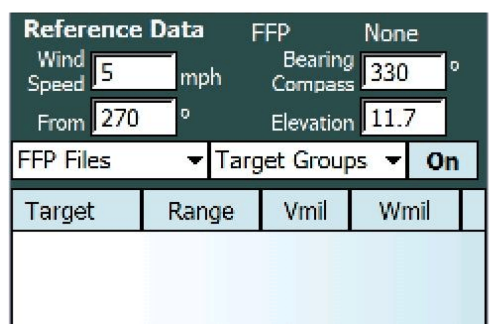
B. What is "Reference Data"?

When the Target Range Card is first invoked, the main page has certain parameters set for wind speed, wind direction, shot bearing, range to target, and the required elevation needed for that target at that range. These are the initial "reference data" and are used to compute relative windage values and vertical holds for the loaded targets. In other words, if wind direction is from the immediate left (270 degrees or 9 o'clock) for a target with a bearing of 330 degrees, when we change targets to one at 0 degrees, the relative wind has now shifted to the rear 30 degrees, the same amount that the bearing changed to acquire the new target. Now the wind is coming from 240 degrees relative to the shooter. If there are multiple targets each at a different bearing, obviously each target will have its own wind value since the wind relative to that target will coming from a different direction relative to the shooter and hence have a different windage correction. In order to make each of these calculations, it is necessary to know in the first instance what the wind direction was relative to a specific target bearing, then as the bearing changes, the relative wind for the new bearing can be computed and known.

Initially, the reference data will be taken from the main page. This may or may not be helpful, but as mentioned reference data is required for the calculations that are made in this page. Below are four graphics showing the initial main page settings, the result of importing that data into the Target Range Card, the changes that result from designating an FFP, and finally the result of designating one of the listed targets as the reference. Note, it is not necessary that an FFP be designated before loading a group of targets. In this case, the designation was made to show the effects of such designation to better understand what the form is doing and why.

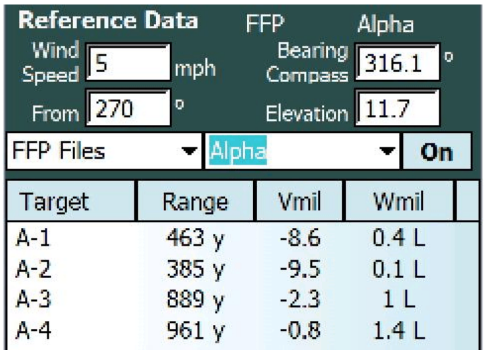


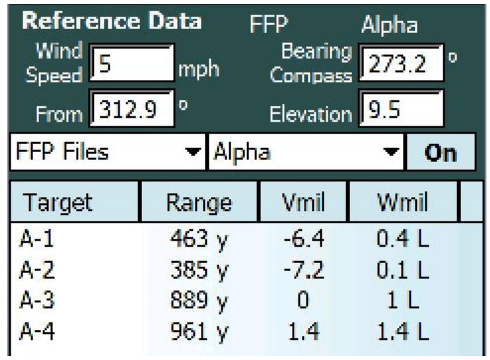
First, the main form shows the wind speed and direction, target range and target bearing. Although the bearing windows shows a compass bearing, because no FFP is loaded, the magnetic variation is 0 degrees, so the compass and true bearings are the same value.



Note that on the Target Range Card each reference data item is imported exactly as it is represented on the main page: wind is 5 mph from 270 degrees and a target at 1000 yards at a bearing of 330 degrees which requires 11.7 Mils elevation correction.

In the next graphic, the Alpha group file has been loaded. If the coordinates of FFP Alpha were inspected, it would be seen that its location is somewhere in the Sierra Mountain Range in California where the magnetic variation is 13.9 degrees East. Therefore, when this FFP was loaded, the bearing was changed to 316.1 degrees, not because there was an actual change of bearing, but the compass bearing was adjusted to account for the change of magnetic variation at the site of the FFP.

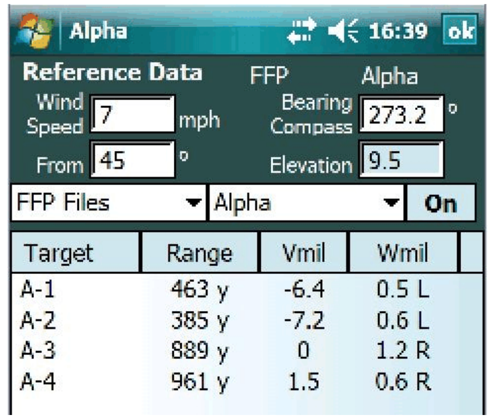




Note that the vertical holds for targets A-1 through A-4 are based upon the reference range of 1000 yards. Because the reference range is farther than any of the target ranges, all of the holds are negative meaning all of the holds must be below the target since the current zero has elevated the barrel too high.

In the right graphic above, target A-3 has been double-tapped making it the reference target, not the unnamed target at 1000 yards. The elevation for A-3 has now become zero because, as the reference target, the scope is dialed for that range, in this case 889 yards. All of the other targets now show vertical offsets based upon A-3 being the zero target. Notice that the reference elevation has changed from 11.7 for 1000 yards to 9.5 representing the elevation required for 889 yards. Note also that the relative wind has changed because the bearing to the target has changed. The A-3 bearing is 273.2 degrees. This change of target bearing has caused a change in the reference wind direction to 312.9 degrees. Since none of the wind values have *actually* changed, the windage values for each target have remained the same. Each windage value is based upon the original wind direction and speed relative to the bearing of each target.

C. Changing Reference Data

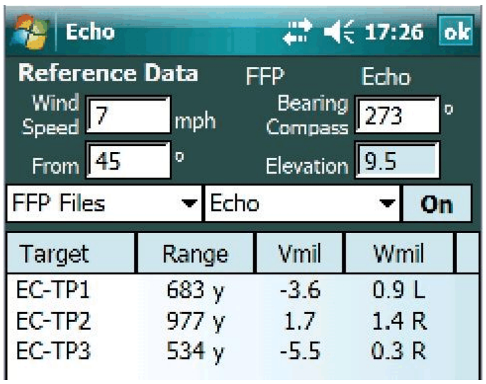


The reference data can be easily changed by simply changing the values in the text windows and hitting the "Update" menu item. Changing wind conditions would require a change of the reference wind, so based upon the data as is shown in the above graphics, if it is assumed that target A-3 is still the reference target but that the wind has changed from 312.9 degrees to 45 degrees and has increased in speed to 7 mph, those values would be entered and then the program "Updated". The result is shown. In this case, none of the options have been checked so there is no change in elevation, but the cross-wind component of the wind can result in a vertical deflection which would cause changes in the hold values as well.

D. Creating a Target Card

It is certainly probable that a group file for a shooting location will not exist upon arrival to a firing position. The data, however, can be created with nothing more than a GPS and range finder. For this example, it is assumed that the user has the software deployed in a Trimble Nomad or similar hand held computer. Upon arrival at the firing position, the GPS is activated from the software by going to Ranging->GPS and hitting the Start menu item. Data from the built-in GPS receiver immediately begins to stream in and after a short while the data stabilizes and the horizontal and vertical degree of precision (HDOP and VDOP) reach levels of 3 or better indicating that the data is sufficiently accurate for use by the program. Looking at the Target Range Card, the user sees a grayed out "GPS" item. When the GPS data is sufficiently accurate, the GPS function is enabled allowing the user to tap GPS and get a current fix. Immediately the user is prompted for a name for the FFP file that will be saved representing the current location and upon saving those coordinates are loaded into the program as the working FFP and will be reflected at the top of the form.

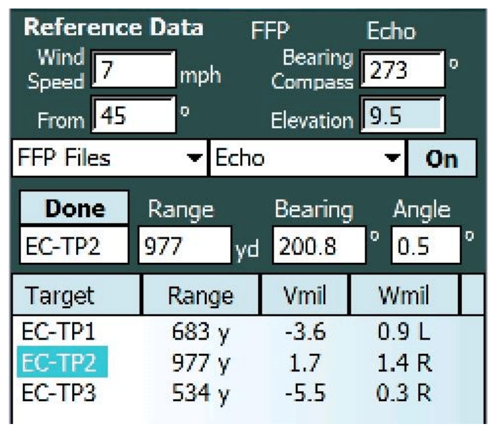
The user has attached the range finder to the PDA via the DB9 connector, has gone to Ranging->Rangefinder->[Range finder ID], opened the proper COM port and is ready to receive data from the range finder. Having established the current FFP coordinates, he begins to range targets. Because with each ranging, the resulting data will be transmitted to the Target Range Card in a separate line, he hits the "On" button to toggle it to "Off". This prevents the data from being displayed on the page and is ignored until such time as the user presses the button back to "On". When the shooter has surveyed the area and is ready to record targets, he taps the "On" button and begins to range specific targets. Each is given a name starting with the first two letters of the FFP followed by "TP" and a sequential number. The "TP"stands for Target Position and is a reminder that the target files being created are position files, not Direct (range, bearing and angle) files. (It is possible to use the range finder to create Direct files when the coordinates of the FFP are unknown, in which case the files are named "RO" (range only) followed by a sequential number.)



At the conclusion of this work, the user has a Target Range Card that looks like this. In this case, the FFP was called "Echo" and saved as such using the "Save" menu item. Note that upon saving, the group file is added to the Target Groups drop-down list. Checking the Target List, the user will find that each file, the FFP file and a group file called "Echo" has been added to the FFS_Targeting directory.

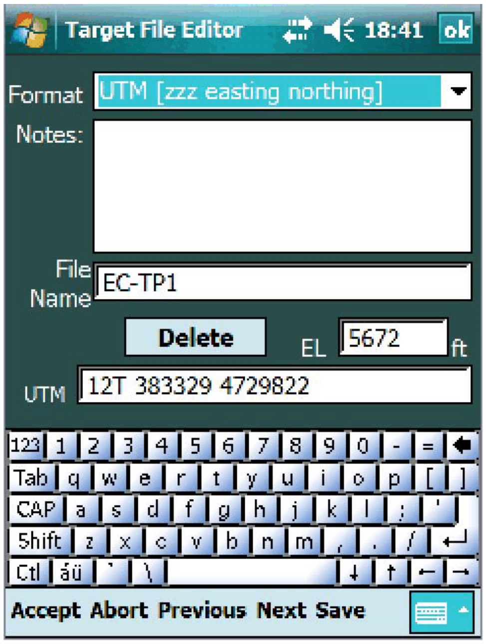
E. Editing and Saving the Target Card

Individual target files and FFP files can be edited in this work area. The first editing function to review is the "tap and hold" method of editing an individual entry on the card list. Just tap and hold the stylus on a target entry and then choose "Edit". The result is shown. This edit feature is limited to changing a name, range, bearing or angle of a particular target. After the edit is completed, tap the "Done" button and the changes are reflected in the list. Note, however, that any edit must be Saved to become a permanent change.



By tapping and holding in a clear area on the list, the context menu that emerges allows the user to add targets either by creating a target in the edit section as shown above or by adding an existing file (discussed in depth below.) Again, the adding of an entry does not make the change permanent. The changes must be saved and if the user leaves the Target Range Card form or tries to clear the form without saving the changes, he is prompted to save the data at that time.

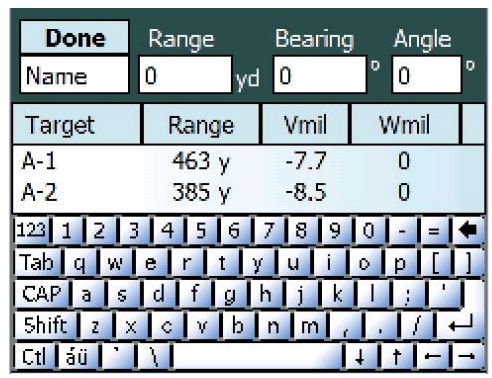
The second and more extensive way to save the FFP and target files is to use the "Edit" item on the main menu. This edit feature allows the editing of the actual data in the file, namely the coordinates and altitude. In addition, it is possible to add notes to the file and change the target's name. (A similar edit form exists for the FFP

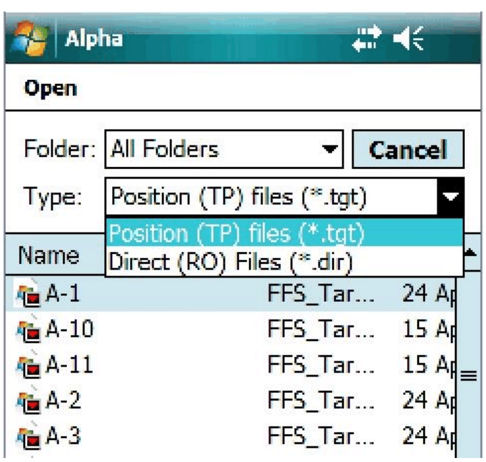


and allows editing of similar types of data.) Each file in the group is there and is accessed through the "Previous" and "Next" items in the menu such that all of the files can be paged through and changed one at a time. At the conclusion of making the desired changes, the files are saved by tapping the Save menu item. The "Edit Entry" is similar but is limited to the single file which has been selected.

F. Adding and Deleting Files

Tapping the empty area of the target list brings up a context menu with "Add Entry" and "Add File" enabled while the other menu items are grayed out. Selecting "Add Entry" opens the manual entry edit area as already discussed. It is possible to add any number of locations to a group manually in this manner. If an FFP is loaded, these files will be added as Position files; if the FFP is "~", the files added will be the simple Direct (RO) files.





The second way to manually add a target is by adding an existing target file. If no FFP is loaded, only Direct (RO) files can be added; if an FFP has been specified, the user can add either type of file. To add a file, tap and hold on a blank section of the file list to trigger the context menu, then select "Add File". At that point, an Open File dialog will appear. The user may choose which type of file to list in the dialog by tapping the file type drop down list and then choosing either the Position (TP) or Direct (RO) type to display; tap the file of interest and it is opened and added to the existing file list. Here the drop down menu is shown along with additional targets A-10 and A-11. Tapping the "Direct (RO) Files (*.dir)" type would show all Direct target files on the PDA.

It is important to understand that if a Direct (RO) file is selected for addition to a list of Position files, the range only file data will be converted into Position data; in other words, upon adding the file, its range, bearing and angle data will be extracted and the coordinates for a target at that location from the current FFP will be computed and held in a data structure that will be saved should the user desire to do so. At that point, a new Position file will be created on Save which may have the same name as the Direct (RO) file, but will have the ".tgt" extension and will be a Position (TP) type of file.

The main menu also has "Delete" functions as a sub-item in the "Edit" menu. "Delete" means to permanently destroy a file which is to be contrasted with the "Remove" function in the context menu. "Remove" means to take the selected file out of the current list of targets but the file itself, assuming such a file existed in the first place, is left alone. "Delete", however, means to destroy the file itself permanently.

The program allows the user to "Delete" FFP files, Group files and Target files. The delete target files function exposes both the Direct (RO) and Position (TP) files to the user for selection and does so in a manner similar to the Add File process. The Delete File dialog has a drop down list so the user can choose to view Direct or Position files for deletion candidates.

G. Clearing the Target Range Card

The Clearing function is separated into clearing the FFP, clearing the targets, and clearing both. When the FFP is cleared, the program is put into a state where it is not tied to any location on Earth. In that condition, when attaching a range finder and obtaining ranging data through the serial port, the target entries will be named "RO" plus a consecutive number. These will be saved as simple Direct files holding a range, bearing and angle only.

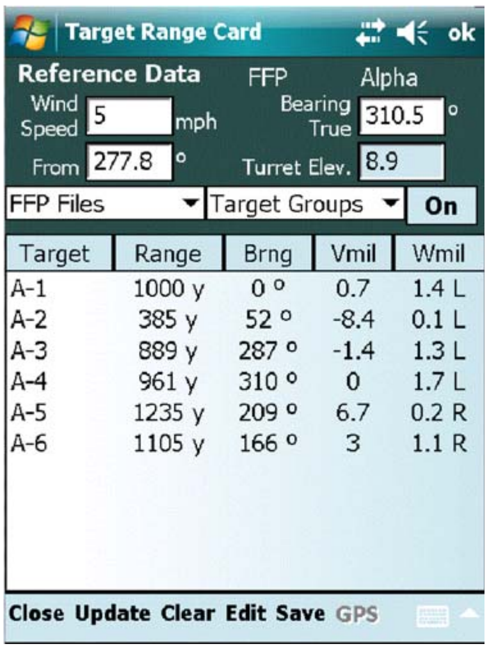
When an FFP is loaded and when a target is double tapped to become the reference target, the target and FFP names are transmitted to the program in general. Upon closing the Target Range Card, the user will see the target and FFP name next to the Target List button. In addition, the target and FFP names will appear in the Map Ranging form, the Target and FFP editing forms, and the Presets form. Upon clearing one or both, the program signifies the absence of a named entity with a "~" character in the place formerly occupied by a file name.

H. Matching Elevation and Windage Units to the Reticle

If a coordinated scope is being used, i.e. a scope that has Mil reticle and Mil turrets or an MOA reticle and MOA turrets, the units shown on the V and W columns will reflect the proper units. However, where an uncoordinated scope is used, the user will have to set the units to those of the reticle. He will do this by setting the proper reticle units by clicking the Lead button on the main page. The Lead units inform the program what units are being used in the reticle and setting Lead will cause the same units to be used in the V column. Once the Lead button is clicked, the Windage button will become visible and allow the user to select the reticle units (if he intends to hold windage) or the turret units (if he intends to dial windage.)

I. Sorting Targets

The graphic below shows a list of targets in alphabetical order and reflects the way the targets were originally organized and saved in the Alpha group file.



Target	Range	Brng	Vmil	Wmil
A-1	1000 y	0 °	0.7	1.4 L
A-2	385 y	52 °	-8.4	0.1 L
A-3	889 y	287 °	-1.4	1.3 L
A-4	961 y	310 °	0	1.7 L
A-5	1235 y	209 °	6.7	0.2 R
A-6	1105 y	166 °	3	1.1 R

These targets can be sorted by name, range, bearing, vertical hold or windage hold. Targets can be ordered alphabetically; Range, Vmil, and Wmil can be arranged in either ascending or descending order. The Bearing column will arrange the targets from left to right (or vice versa) using the reference bearing as the line of demarcation.

If the user wants, for example, to organize the targets nearest to farthest, he taps on the Range (or, in most cases, the Vmil) header and the result is this:

Target	Range	Brng	Vmil	Wmil
A-2	385 y	52 °	-8.4	0.1 L
A-3	889 y	287 °	-1.4	1.3 L
A-4	961 y	310 °	0	1.7 L
A-1	1000 y	0 °	0.7	1.4 L
A-6	1105 y	166 °	3	1.1 R
A-5	1235 y	209 °	6.7	0.2 R

Tapping on the Bearing header will arrange left to right across the field of view using the reference bearing as the central median. Here, target A-4 is the reference target. Tapping the Bearing header arranges the targets as shown. Note that the reference target is at bearing 310°. The farthest target to the left is A-6 at 166° and moving across the field of fire from the left targets A-5, A-3, A-1 and A-2 at the far right will be encountered sequentially. Tapping the Bearing header again will reverse the order of the targets from right to left.

Target	Range	Brng	Vmil	Wmil
A-6	1105 y	166 °	3	1.1 R
A-5	1235 y	209 °	6.7	0.2 R
A-3	889 y	287 °	-1.4	1.3 L
A-4	961 y	310 °	0	1.7 L
A-1	1000 y	0 °	0.7	1.4 L
A-2	385 y	52 °	-8.4	0.1 L

After the user organizes the data to his satisfaction, he must tap the Save menu item so that the targets will be saved in the group file in the order shown. The next time this file is loaded, it will be loaded in the order as saved.

J. Using the Capture Function

The content of the Target Range Card 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 of the range card. The user is free to modify the data presented, organizing it in ways that best fit his preferences. To obtain the data contained in the range card, select Edit->Capture. All data on the card will be written to a CSV file which the user can find in the \Documents directory on the SD card. Copy this file to a desktop computer for opening in a spreadsheet and thereafter editing the columns, presentation, format and the rest.

If the user wants to make several range cards for the same bullet profile but with changing atmospheric values, simply create the file as instructed above but leave the data file in \Documents, exit to the Presets, make changes to the atmospheric variables, Accept the changes, and Capture the data again. The new card data will be appended to the original file. The user may repeat this sequence until all of the various conditions for that cartridge have been exhausted. At that point, move the file to the desktop computer, open it in a spreadsheet program and the user will see individual blocks for each condition saved.

LOS Metrics

The purpose of this work area is to enable a user to know where the bullet is with respect the his line of sight (LOS) to the target all the way from muzzle to target. As the bullet leaves the muzzle it is well below the LOS of the shooter who is looking through the scope. From that point the bullet has a path that moves upward and at some location down range will cross the LOS and continue in its arc to the target. Far down range, the bullet will again cross the LOS. A well placed shot means that this second intersection of the LOS is precisely at the vertical plane of the target. In that event, the bullet will strike the target exactly at the point of aim.

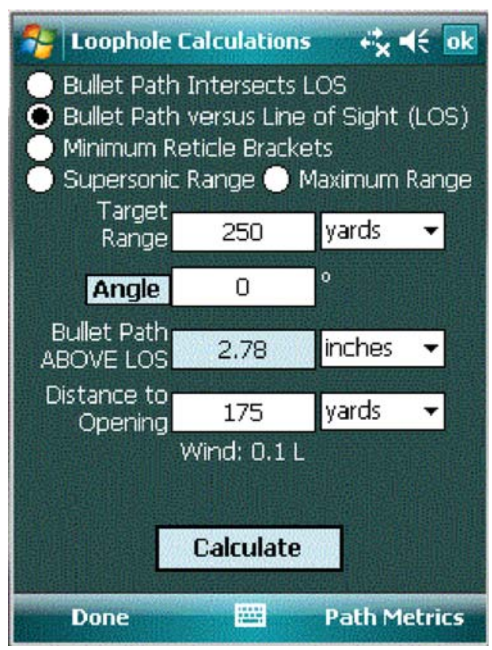
Knowing the location of the bullet with respect to the LOS can solve a host of problems. One example relates to shooting through an opening to get to a target beyond. In order to shoot through an opening, the problem to be solved is to locate the path of the bullet with respect to the LOS in order to determine whether the bullet has room to pass through the opening at the vertical plane where the opening is situated. This will, of course, depend directly upon the distance between the muzzle of the rifle, the down range location of the opening, its size, and the bullet's trajectory with respect to the LOS of the shooter looking through the opening at the target. This is a generalized problem. The "opening" can be the space under a bridge, a clearing in the trees, or a hole in the wall. Whenever a shooter needs to ascertain the location of the bullet at some point along the LOS for any reason, this is the workspace to use.

Mode 1 - locating the first intersection with the LOS

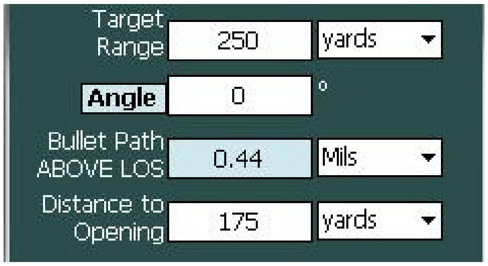
When the bullet crosses the LOS initially, the bullet's axis is nearly coincident with the LOS which would mean that the opening for this shot need not be much larger than the diameter of the bullet. This is a theoretical minimum since such a small opening would have extreme limitations on the field of view beyond its plane so as to render its use impractical at least. Nevertheless, knowing the distance from the muzzle at which the bullet crosses the LOS is valuable information since it guarantees that a shot can be taken through any opening of any practical size. Therefore, when the opening calculation form first opens, it automatically calculates and displays this distance based upon the currently loaded bullet, scope variables (scope zero and scope height) and atmospheric variables. (After this form is first opened, the state of the form will persist from use to use such that if the user was working with a particular mode, upon return the work in that mode can continue.)

Mode 2 - locating the bullet's path with respect to the LOS

Tapping the second radio button enables a data entry box for the input of a distance between the muzzle and the opening. The resulting calculation is the path of the bullet at that distance. A negative value indicates that the bullet is below the LOS; a positive value, above. This value should tell the shooter whether the opening he is looking through has sufficient height to accommodate the bullet at the calculated distance above or below the LOS. The shooter can adjust his distance from the opening until the bullet is sufficiently close to the LOS to allow it to pass through the opening without interference. Moving toward the opening will cause the bullet to move downward from its current location; moving further back will cause the bullet to move upward.



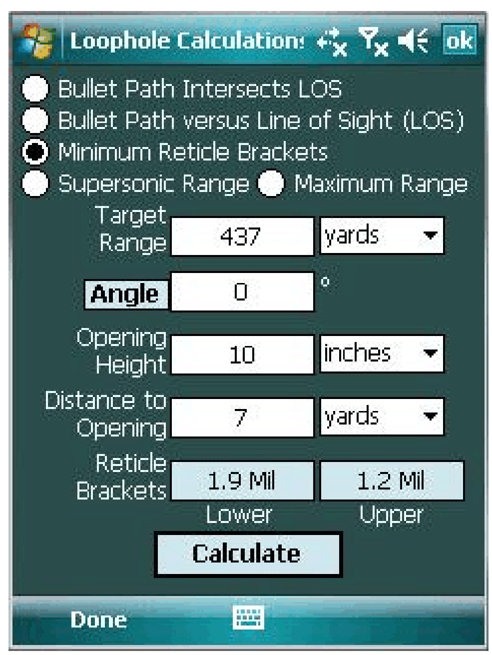
An interesting application of these concepts is the problem of shooting through a chain linked fence. The openings in the typical chain linked fence is just slightly under 2 inches square. Adding a reasonable buffer and the actual area to shoot through is more like 1.5 inches square. For example, assume a target at 250 yards and a chain-linked fence at 175 yards. For a typical .308 Win. cartridge, at 175 yards the bullet would be 2.78 inches above the line of sight given a 250 yard target. <u>Caveat</u>: For a variety of reasons, the program does not deal with cross-wind vertical deflection, Coriolis, or Eotvos effects on the loophole page. Therefore, when the opening is at range, be aware that there may be a small vertical and horizontal deflections that may have to be accounted for. Note windage value at opening. This assumes ambient wind effects from muzzle; this value may have to be modified mentally to the extent that some part of the distance is shielded from the wind.



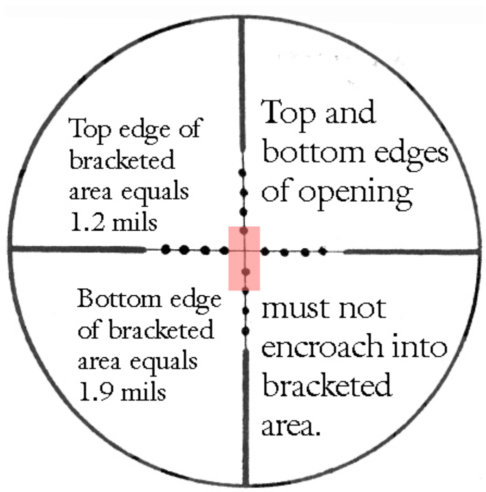
Tapping the units drop-down menu and choosing Mils gives a value of 0.44 Mils above the LOS. The shooter would therefore make certain that reticle point at 0.44 Mil would be centered in one of the link openings at the time the rifle is fired. Presumably the bullet would encounter the fence at the opening, travel through and on to the target.

Mode 3 - minimum bracketed reticle values

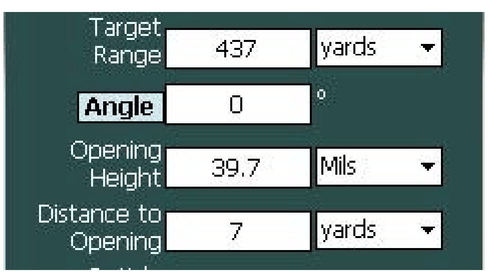
Pressing the third button enables a data window to input the height of a particular opening and a second data window to input the distance between the muzzle and the opening. The resulting calculation tells the shooter the minimum reticle values to hold off the bottom and top of the opening in order to avoid having the bullet hit the opening structure. The portion of the reticle that is between these two values must be kept clear of opening's boundaries since allowing the boundary to encroach into this area risks having the bullet impact the opening's structure. The values, given in either mils or MOA, are calculated to give a buffer of one caliber from the bottom and top of the opening. Of course, actually seeing the top and bottom may be a problem since the shooter may be too close for the scope to allow the opening itself to come into sharp focus, so these boundaries may be blurred. Nevertheless, the calculation will help the shooter be able to see, even if somewhat imprecisely, whether he is holding too high or too low such that he risks striking the structure. As long as the edges of the opening are outside of the bracketed area, his bullet should be able to travel through the opening without being compromised.



The user will note from the above example that the opening itself may be indicated in inches, centimeters, Mils or MOA units. These last two are impractical for *specifying* an opening's size but may be helpful in understanding the size of the opening in terms of reticle and where, using only the reticle, it would be safe to engage a target with assurance that the bullet will pass through. For example, the image shows the reticle brackets for a typical .308 Winchester cartridge, a 100 yard zero and a scope height of 1.5 inches. Here an opening of 10 inches has been specified with a distance from muzzle to opening of 7 yards. The bracketed area for the scope is calculated at 1.9 to 1.2 Mils which means that neither the bottom or top edges of the opening should encroach those limits in the scope. (Note that upper bracket is actually a buffer equal to one caliber at this distance. While the reticle could conceivably be placed right up against the top edge of the opening without a problem, the program was created using the opening height less a distance equal to two calibers so that there could be a one caliber buffer both top and bottom.)

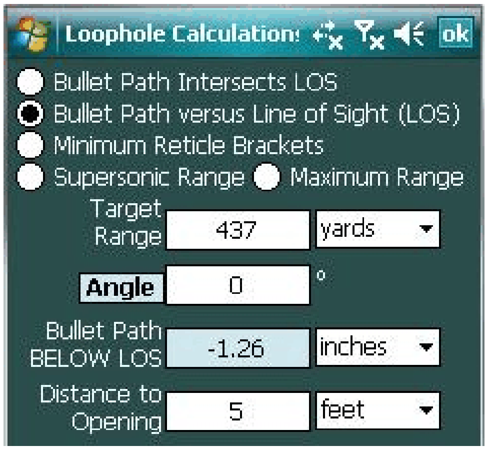


The bracketed "No-Go" limits are shown in red in the left graphic. **This is the area which encompasses the possible bullet paths through the opening at the current distance.** As the shooter moves down in the opening looking at targets near the bottom of the opening, the bottom edge of the opening will be coming up into the scope. The bottom edge must not encroach into the red area. If it does, the bullet will almost assuredly strike the bottom of the opening. The same is true for the top of the opening and keeping it out of the red area. If the top of the opening touches or invades the red area, the shooter risks placing the bullet at or above the top edge of the opening. The bottom line is this: Keep the bracketed area clear and the bullet will move through the opening on to the target.



The graphic immediately left shows the same information as shown above except that the units have been changed to Mils. This gives a perspective to the shooter that the window opening at this distance is 39.7 Mils in height; the bracketed values are simply telling the shooter that he must stay away from the bottom and top 1.9 and 1.2 Mils respectively of the opening. Note that this number represents the included angle formed by the muzzle at the vertex of the two lines extending from the muzzle to the top and bottom of the opening. As the shooter moves closer to the opening, this included angle increases dramatically. At some point, the values given for both the opening size and the reticle brackets become unusable. For instance, if the distance to the opening was only 5 feet, the included angle would be quite large and the calculation would produce a result that would be meaningless on a practical basis, as shown to the right. The 10 inch opening has become 166.7 Mils in height and the bracketed values have become 20.9and 5.1 Mils. Because most scopes do not have reticles that subtend

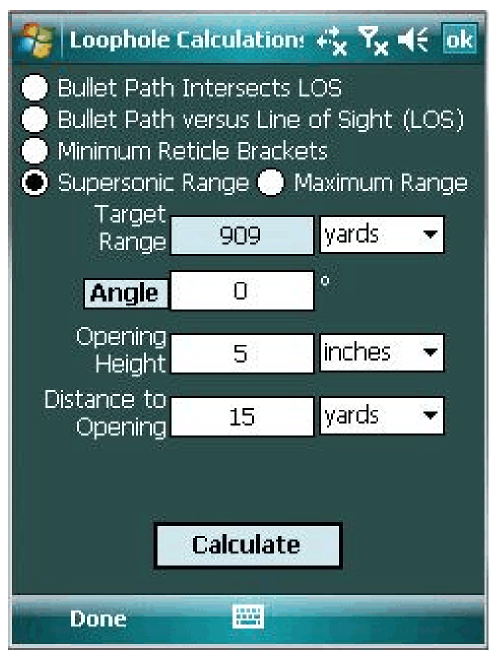
21 Mils, knowing that the minimum distance the shooter must keep from the bottom of the opening is 21 Mils is not information that can be readily used.



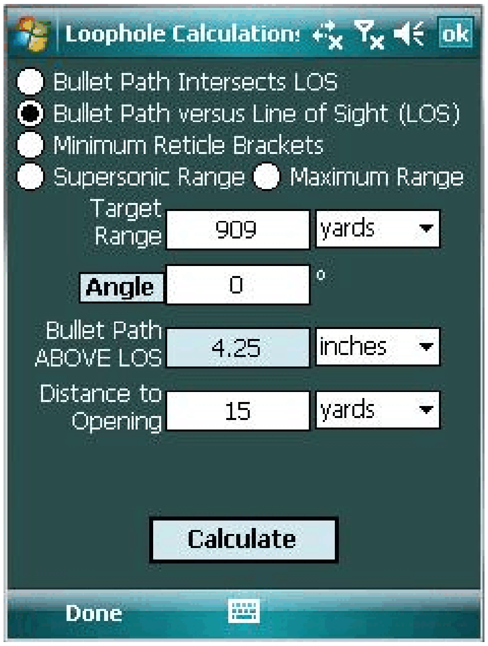
However, it is possible to figure out where the bullet is with respect to the LOS at a distance of 5 feet by using Mode 2; the solution is shown at the left. At a distance of 5 feet from an opening, it can be seen that the bullet is 1.26 inches below the LOS at the opening itself. What can be done is for the shooter to look beyond the opening and at the field of view where he can choose a landmark that optically appears to be 1.3 inches above the bottom of the opening. When viewing the field of view through his scope, he will know immediately when he is in danger of encroaching upon the bracketed area when the intersection of the reticle elements are at or below this landmark. At that point, the bullet path is now within 1.3 inches of the bottom of the opening and the bullet will potentially strike the structure surrounding the opening. The shooter holds fire and waits for a target that is located at a point above the landmark.

Mode 4 - maximum supersonic range

Pressing the Supersonic Range radio button places the work area in Mode 4. In this mode, the reticle (and target) is assumed to be at the lowest possible position in the opening; the calculation yields the maximum possible range in which a target can be engaged under that circumstance while the bullet is still supersonic. Note that again the opening is assumed to be the measured height less two bullet diameters. Basically the program is calculating the range potential given a bullet path equal to the opening height, less the one diameter buffer, at the opening distance from the muzzle.



The graphic at the right show the maximum range available to a shooter firing through a 5" opening from a distance of 15 yards. What this means is that with the reticle off the bottom of the opening by one caliber, there is 5 inches, less two calibers, of space above the reticle for the bullet to transit. The solution tells the user what maximum range is possible with such a path.

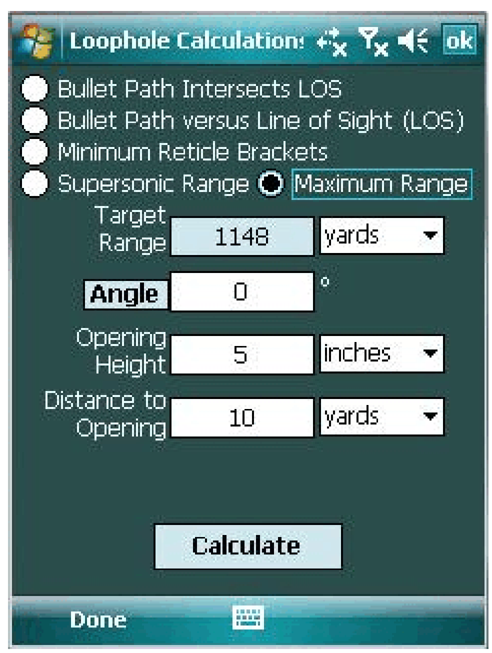


It is possible to check the results by going to Mode 2. At the left is the result. Note that according to the program at 15 yards the bullet is 4.25 inches above the line of sight when zeroed for a target at 909 yards. Adding two bullet diameters, the total height is 4.866 inches, slightly below the space available of 5 inches. This happens due the following: the range computed in Mode4 is based upon the range that can be engaged *by the scope being used at the time.* In other words, scopes must be dialed in whole clicks so elevation can only be dialed that is represented by the nearest whole click without exceeding the limitation imposed by the opening itself. So, when the range is computed in Mode 4, it is that range that can actually be dialed by the scope. If the scope was to be advanced one more click, the elevation would likely place the bullet path too close to the upper edge of the opening. By checking Mode 2, the user can confirm that at the maximum computed range the bullet will in fact successfully transit the opening without encountering an edge or the wall.

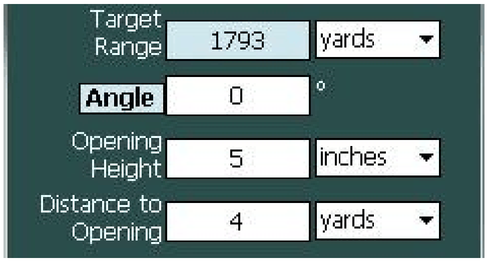
If the range that can be accessed through the opening is greater than the supersonic range of the bullet, a notice to that effect will appear and the range will be limited to the range where the bullet is still supersonic.

Mode 5 - maximum useful range

If the user is not constrained by supersonic range considerations and wishes to know what the actual range is that can be accessed through a particular opening, he will choose Mode 5. As the shooter moves closer to an opening, the accessible range increases. By moving the reticle lower in the opening, room is created at the top for a higher path which means that the shooter can engage target further out. Mode 5 will show the maximum range unconstrained by the fact that the bullet may have gone subsonic. The graphic at the right shows the same shooting conditions as Mode 4 except that the shooter has moved 5 yards closer to the opening. At this distance the shooter can access 1148 yards of range beyond the opening. It is possible to move closer to the point that potential range available to the

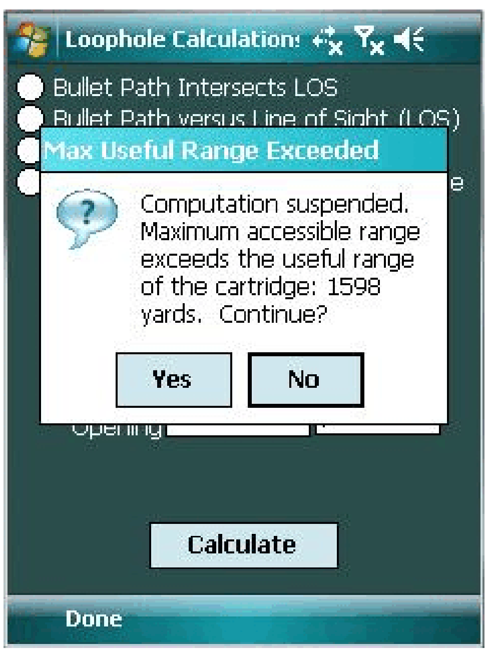


shooter exceeds the reasonable or useful range of the cartridge.



In the example at the left, the shooter has moved to a position 4 yards from the opening and has calculated the range available to him. The program tells the shooter that he can acquire targets beyond the useful range of the cartridge, in this case approximately 1600 yards is deemed to be beyond the useful range of the .308 Win. cartridge. Nevertheless, the program gives the user the option of continuing with the computation to determine what the actual accessible range is. By selecting "No", the range will be shown as 1598 yards. On the other hand, if the user chooses "Yes" the program will compute the actual range which can be accessed through the 5 inch hole from a distance of 4 yards, notwithstanding the fact that the information may not be particularly useful.

Using either Modes 4 or 5, the shooter is given important information about his ability to acquire targets beyond the opening through which he is shooting. For any given opening size and distance to the opening, he can verify that the locations of expected targets are within the range zone which his setup will enable him to cover. For any given range, he can verify the safe areas to hold through a Mode 3 analysis as he determines where the bracketed "no-go" areas are in his scope. And, of course, he can verify the actual bullet path for various ranges to ensure a successful transit of the opening by the bullet.



Limitation Warning

It bears repeating that while it is possible to obtain bullet position with respect to LOS out to the maximum possible range of the bullet, the user should know that these calculations ignore 1) cross-wind vertical deflection, 2) Coriolis and 3) Eotvos effects. Therefore, these calculations are meant for practical distances where these small corrections will not be meaningful.

Path Metrics

The data which can be obtained from this work area gives the shooter important information about the trajectory.

Mode 1 - Maximum Ordinate

The highest point along the trajectory is called the "Maximum Ordinate" and tells the shooter how far above the line of sight the bullet is expected to travel at its maximum point along the trajectory. This information may be important if the shooter is trying to shoot either under or over an obstacle. To be of value, the shooter must know both the maximum height of the bullet and the range at which it occurs. Examples of where this information might be indispensable are numerous: shooting under a bridge at a target beyond; shooting over high-power electrical power lines to name just two. In addition, the maximum ordinate my help the shooter understand what winds might be involved in deflecting the bullet on the way to the target. If, for example, the shooter is located in an area that has a surface topography that shields him from the wind, he can determine whether the trajectory may elevate the bullet out of the protected area and into the wind stream causing a substantial wind deflection, estimate the deflection and modify his point of aim accordingly.[11]

Mode 2 - Danger Space

This information tells the shooter, for a target of a given height, how precise the ranging must be to make a hit. If, for example, the danger space for a given target at a nominal 1000 meters is 996 meters to 1006 meters, this indicates that if the target is closer than 996 meters the bullet is likely to pass over the top of the target; and if the target is farther away than 1006 meters, the bullet is likely to miss the target low. The danger space for that target is 10 meters deep: if the target is located within that 10 meter span, it will get hit. The danger space information is helpful in evaluating whether to take a shot which depends upon highly accurate ranging information.

Mode 3 - Point Blank Zero

While generally the concept of a point blank zero is associated with hunting where the shooter may be required to acquire a target rapidly, it nevertheless has application under some circumstances in precision shooting. Where, for one example, multiple hostile targets are advancing and there is a need simply to quickly hit multiple targets as a strategy to slow down the advance, PBZ can help the shooter know that with a center of mass hold, the bullet will strike somewhere on the target as long as the

[11] Because the Maximum Ordinate is a handy number to know, it is also readily available from the main page in the Projectile Metrics data window accessible via the small button located immediately to the right of the target range text entry box.

target is within the maximum PBZ range. Even targets beyond the maximum PBZ range can be successfully engaged with hold-offs and knowing the PBZ maximum range will help the shooter with sufficiently accurate hold-offs.

Advanced Directory Management

For some users with numerous target, rifle, bullet profiles, it becomes desirable to create subdirectories to hold related groups of profiles. In prior versions of the software, this was made nearly impossible due to limitations of the operating system in allowing access to directories or folders below the first level using the default Open/Save dialog box. The most recently release version, however, has replaced the default Open/Save dialog box with a custom designed dialog that allows the user to navigate to and see all existing files and subfolders in a particular folder. This new dialog also allows users to see the file extensions on each file (something the default dialog obscures.)

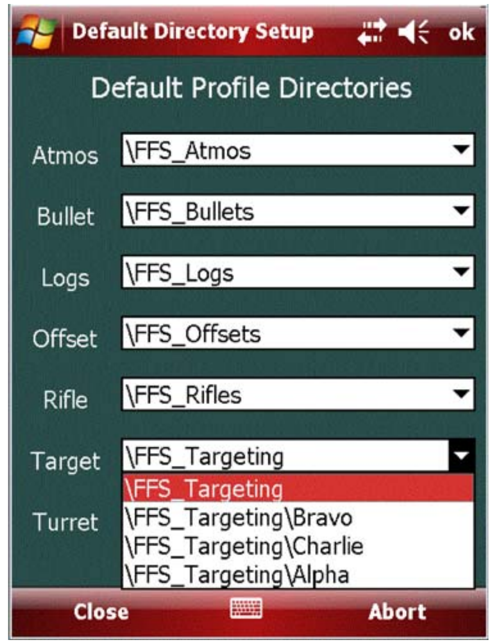
A. Default Paths

To the extent that the user needs to create subdirectories in the standard profile directories that come with the program, there is a need to be able to view and select which folders will be deemed "default" data paths. To view this tool, go to the Presets page and click on "Defaults" in the menu. Initially the default directories are displayed and if the users has not create subdirectories in any of the default directories, those will be the only directories available. However, assume that the user has segregated target files into logical groups. Perhaps the user wants to create subdirectories in FFS_Targeting that will hold targeting files related certain specific areas where the user habitually frequents. For purposes of the manual, the example targeting files Alpha, Bravo, and Charlie, have had subdirectories created with all Alpha related files moved into the Alpha subdirectory, Bravo into the Bravo subdirectory and so forth. The direct targeting files have been left in the original directory, FFS_Targeting.

Note that since the various related files have been moved into logically named subdirectories, only the direct targeting files now show on the target list. In the drop-down FFP list, only "Direct Range" FFPs appear and only corresponding direct targets are listed. This happens because the program "sees" only the .ffp, .tgt, and .grp files that are presently in FFS_Targeting. The other targeting files have been moved into subdirectories so as not to be seen when they are not relevant.

Going to the default paths form, (Presets->Defaults), and tapping on the Targeting drop-down list, the three subdirectories that were created can now be seen.

If subdirectory "Alpha" is chosen, the target list now shows only Alpha FFPs, targets, and, in the Target Range Card, groups.



The reason why this is the case is that as far as the program is concerned, the new default path to all targeting files is FFS_Targeting\Alpha and the program will look only there for targeting files. If Alpha happens to be the location where the shooter is going be accessing targets, this is very convenient since he will not be presented with non-relevant targets.

The user can, of course, update the targets in the Alpha area by saving additional Alpha related target in the Alpha subdirectory and those new targets will come to be listed in the Target List.

While the user can change the default path to other profiles, not all changes make sense. Unless there is a compelling reason to segregate atmosphere profiles, for example, there isn't much reason to add subdirectories. Nevertheless, if the need arises, the software can accommodate the need.

B. How to Create New Subfolders

New folders in profile directories can be created in two ways. The first is to create the folder while the card is in the PDA. To do that, tap the Start icon (upper left hand corner of the PDA screen, choose Programs and then tap on the File Explorer program. This program gives the user access to the file system of the PDA. By navigating Up the file hierarchy, the user will come to the root directory which will list various directories including the Storage Card or SD Card directory. Tap on the directory opens the file system of the software's SD card. If the user wanted to create a subdirectory in FFS_Targeting, the user would tap the that folder and then tap and hold on an empty space. A context menu would appear which the menu item "New Folder". Tapping that will create a new subfolder which the user will then name.

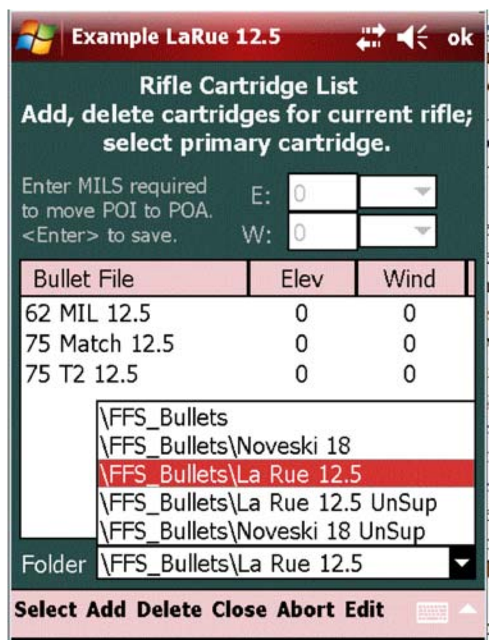
The second way is to remove the SD card and insert it into a desktop or laptop computer that has an SD drive. Using Windows Explorer, the sequence is the same. Find the SD drive, click on it to view the various directories on the card. Find the

"FFS_Targeting", click on it and use the available menus to create a new folder - or right click on an empty space and choose "New Folder" followed by renaming the folder as desired.

The same process is used to create subfolders in the other profile directories. WARNING: care must be taken not to delete files during this process. In addition, there is no reason to create subfolders in the non-profile directories and it is best not to clutter up those system files with non-useable folders.

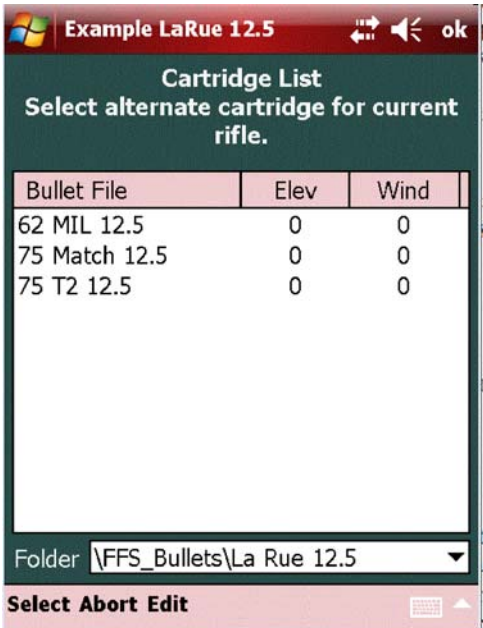
C. The Special Case of Bullet Profiles

Bullet profiles can proliferate and, given the fact that different rifles with different barrel lengths and configurations use the same cartridge, trying to manage bullet profiles through a naming convention only can become a challenge. In order to deal with this simple fact, a feature was added to the rifle profile which allows the user to list cartridges that go with a particular rifle and indicate where to find these particular bullet profiles. This can solve the vexing problem of multiple profiles with slightly changed names in the same directory.



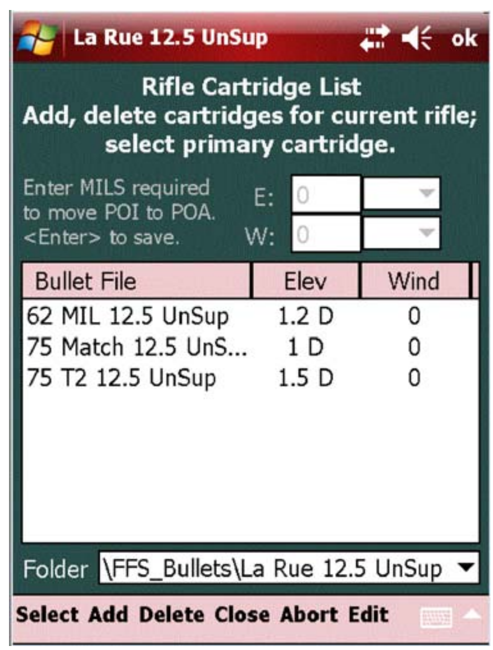
The software comes with two example rifles to exemplify this technique. Assume that the user has two AR-type rifles, one a La Rue with a 12.5 in barrel and one a Noveske with an 18 inch barrel. Both are in caliber .223 (or 5.56) and therefore both can shoot the same ammunition. However, with the two different barrel lengths the same cartridge will have a different muzzle velocity in each rifle. To deal with this problem, two subdirectories were created in the FFS_Bullets directory, a La Rue 12.5 directory and a Noveske 18 directory. The bullet profiles for each rifle were put into their respective directory. (Note: for purposes of this demonstration, the bullet files retained names that indicated the rifle's barrel length. This was done so that the user in getting comfortable with this feature could look at the bullet profiles and know that he had access the correct subdirectory. In practice, it is possible to name similar cartridge files with the same name so that the cartridge list will look the same for each rifle. The difference will be where the profile is being drawn from.)

Once the subdirectories are created and the bullet profiles segregated, it is time to create the rifle profile. The main page of the rifle profile is the same, but the cartridge list page has a directory path added. Here is the cartridge list page from the rifle profile of the La Rue 12.5 rifle. Again, the bullet profiles were all taken from the “La Rue 12.5" subdirectory in the FFS_Bullets directory. Note that in the “Folder” drop-down list the \FFS_Bullets\La Rue 12.5 folder was chosen. Once these cartridges were added and the proper source folder specified, the form is closed and the profile saved.



On the main page, the “R” button is pressed and the list of current rifles appears which include the La Rue and Noveske rifles. Choosing the La Rue loads that profile, the cartridge list associated with that profile and the turret profile associated with that rifle. Then pressing the “B” button, the list of cartridges associated with that rifle is displayed. Loading the rifle profile also loaded the path to the cartridges that the rifle will use. We can see that because the cartridges are all named “12.5" demonstrating that the correct subfolder has been opened and is the source of the cartridges. If the “62 Mil 12.5" cartridge is double tapped, it loads and will have the proper muzzle velocity for the 12.5" barreled La Rue. Observe also that near the bottom of the form there is a reference to the directory which is the source of the bullet profiles. This is to assure the shooter that the correct folder is being accessed.

The reader may have noticed that there are two other subfolders in FFS_Bullets: the La Rue 12.5 UnSup and the Noveske 18 UnSup. The various bullet profiles created for the La Rue and Noveske have muzzle velocity data relating to their normally suppressed condition. When the suppressor is removed, two potentialities may occur. First, there may be a change in muzzle velocity. Second, there may be a change in the point of impact. To deal with these, two Offest profiles were created and their respective cartridge lists will 1) draw from their respective subdirectory so that any change in muzzle velocity can loaded when the cartridge is loaded; and, 2) each cartridge is given an offset to bring the point of impact back to the point of aim. This saves the operator from having to adjust the scope’s zero. Here is the cartridge list



from the La Rue 12.5 Offset profile, called the "La Rue 12.5 UnSup". These related offset profiles can be access by tapping the "O" button on the main page. The reader will also see a "La Rue 12.5 CCB" offset file which contains offset for the cold, clean bore shot(s). Tap and holding on the La Rue 12.5 UnSup entry will bring up a context menu. Choosing "Edit" will open the offset profile in the profile editor and tapping "Add" will open the cartridge list. Here the cartridges are already added. Note that the names confirm that the cartridges were drawn from the correct subfolder and the folder path correctly lists the path to that folder.

Because rifle profiles come with a path to their respective cartridges, it is not necessary to change anything in the default paths form. If a rifle profile does not have a cartridge list of if the number of rifles/cartridges are not so numerous to warrant segregation, then the profile will use the default FFS_Bullets to find its cartridges and no further folder additions are required. In fact, the entire use of subfolders and the changing of default paths is optional. The program does not require this level of complexity to function.

Export/Import of Targeting Files

Targeting files can be exported and imported by going to Profiles->Targeting->Export/Import. The export function is rather limited in that it converts targeting files into a .wpt file which is usable by OziExplorer GPS software and Google Earth. For Google Earth use, simply start Google Earth and then drag and drop the .wpt files onto the Earth. It will slew to the location and show the various files at their respective coordinate locations.

To use the tool, first, go to the Setup page to identify the paths to the files to export and where these exported files are to be placed. Do a similar identification for import locations. In both cases it is likely that the export source and import destination will be FFS_Targeting, but it is possible to specify other folders if desired.

Back on the main Export/Import page, tap the Export (or Import) button and find the files to operate on via the Open File dialog. Once chosen, the file will immediately be converted and a message will be displayed concerning the new exported file. When all of the files have been exported, use the File Explorer to open the folder where the exported files are located. At this point, the files are ready to be copied, moved, or otherwise used in other applications which can open and read .wpt files. Importing is a similar process.

Using the Expression Calculator

Version 4.8.1.4 introduced an advanced calculator, one that could store user defined formulas using up to two variables and that could parse expressions. Where the expression is comprised of numbers only, the "x" and "y" variable text input areas do not have meaning or functionality. The arithmetic expression will be parsed and the result will be given in the answer text area. The value of using an expression parser instead of the simple calculator is that the entire expression remains on the screen so the user can see and modify, if necessary, the expression before it is evaluated. And once evaluated the expression remains on the screen so that the user can make modifications if the result does not make sense. For example, 5 + 10 / 5 will produce 7 and not 3 as some might suppose. The reason has to do with the precedence of operations. In this case, the calculator sees the 5 dividing only the 10 and not the sum of 5 + 10. It is best to use parentheses to clarify the expression: (5 + 10) / 5. This will resolve to the answer 3, i.e., 15/5 = 3. Thus the user can edit the expression instead of having to enter the expression from scratch.

In addition, the calculator can evaluate equations with up to two variables. Example: the hypotenuse of a right triangle can be found by taking the square root of the sum of the squares of the other two sides. So if the user were to type into the expression text area "sqrt(a^2 + b^2)" as a general statement, the user would see the variables "a" and "b" immediately appear next to the two variable input text areas. There is where the user gives the values for "a" and "b". If, for example, "a" is assigned the value of 3 and "b" is assigned a value of 4, pressing the "=" key will produce the answer of 5. The formula remains in the expression area so the user can make changes or introduce new variable values.

The variable text areas are themselves capable of handling expressions. The variable "a" could be "7.3 * sqrt (7)". Tapping the "Eval" button while the cursor remains in the "a" text area will show what the "a" arithmetic expression evaluates to, in this case 19.3139... It is not necessary to evaluate the variable expression prior to use in the equation, but it is a way to see whether the evaluation makes sense or whether perhaps a mistake was made. Since the evaluated variable expression replaces the original expression, in the event of an apparent error, the user will have to re-type the expression.

A. Storing User Defined Formulas

At the far right of the Expression text area is a drop-down arrow. The software comes with some example formulas so the user can see how to access the formulas that the user might make for himself. The formulas themselves are taken from a text file that can be edited by the user. The existing formulas can be deleted and replaced by formulas that are useful to the user. To access this text file, tap the "Help" menu item and then select "Edit Formulas". For the first time user, read the text in this file as it explains how to edit the file. Note that lines that start with the semi-colon symbol are ignored by the calculator. These lines are for explaining the purpose or use of a formula or other matter the user wants to memorialize. After the explanation has be read and understood, the user is free to delete the explanation.

Next are the formulas themselves followed by a short explanation that starts with a semi-colon. When the calculator program read through this text file, any formulas that it finds will be copied to the drop-down menu and the explanation that follows will be place immediately below the formula to help the user to remember what the variables are and what units they should be in (if required.) One of the formulas is to compute the cross-wind component of an angling wind. The formula is cross-wind = wind velocity * sin(wind angle relative to shooter), or "w * sin(a)" will produce the cross-wind component. So, assuming a 7 mph wind from the shooter's 1 o'clock, the formula is w * sin(a) and the variables are w = 7, a = 30 degrees (1 o'clock is 30 degrees, 2 o'clock is 60 degrees, and 3 o'clock is 90 degrees.) Putting those values into the two variable text areas and tapping "=" will yield 3.5 mph in the answer text area. If the wind speed was 7 m/s or 7 fps, then the answer would be 3.5 m/s or 3.5 fps.

There is not a lot of room for the one line explanation of the formula, but in the text file the user can add as much detail as required. Just make sure that the all explanatory text begins with a ";".

Miscellaneous Tools & Topics

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.

Be aware that the benefit of a fixed zero 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.

The Log Button

The log function allows a user to record all pertinent data concerning a shot with a single click of the "Log" button. The button is by default inactive to avoid hitting it inadvertently and logging unwanted data. To activate the Log button, go to the Options->Tools menu and choose "Log Enable". The Log key, previously grayed out, becomes active.

Pressing the button will record the date and time, the current location in Lat/Lon, UTM or MGRS coordinates (depending upon your preference as revealed on the Map Ranging page), the pertinent atmospheric conditions and the calculated elevation and windage among other data items. The log entry also keeps a running count of each shot fired. The size of the log is limited only by the memory of the PDA.

The log file can be edited and can be saved under another name. This is a "txt" file and may be opened in Notepad on the desktop computer for easier editing or may be edited on the PDA by just tapping on the file. The program has a Log Editor (Options menu, Tools, then choose "Log Editor" and open the "CurrentLogData" file) which may be used as well. All current log data is recorded to a default file called "CurrentLogData" and if the program doesn't find a file by that name it will create one. Each log entry has a line for remarks so the user can add comments or documentation for any particular shot taken at some later time.

When the Log button is enabled, it is possible to call up the Log Editor by simply tapping and holding the Log Button for one-half second. When the editing is complete, be sure to Save the changes and close.

By default the log entries are in reverse chronological order, the last event is at the top of the file. Using the Edit menu item it is possible to change the default to have the last entry place at the end of the file by unchecking the "Reverse Chron". In addition, if the user has been keeping a log in one order, using the but wishes to change the default, tapping the "Reverse Entries" Edit menu item will reverse all current entries. Once the entries are in the order desired, tap the "Save" menu item to save the file.

The PS Button

The PS button 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, conversion factors and convenient menu access to the calculator.

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, length, and geometry. 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 enough information 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.

Unit Conversion

The PS Button also serves to bring up an interactive Unit Conversion page. To call up the unit converter, press and hold the PS Button for one-half second. Of course, various unit conversion formulas and well as formulas of general interest are found on tabs in the PS page. The user therefore has a number of tools available to solve most problems given the PS page, the unit converter and the field calculator.

Bullet Database

The last item on the “Profiles” menu is the Bullet Database. This is generally informational and based upon publicly available data. The database 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 tap on the Maker header and the Diameter header, and tap the “Load Selected Bullet Data” button. Only Berger bullets of the .308 caliber variety will be shown.

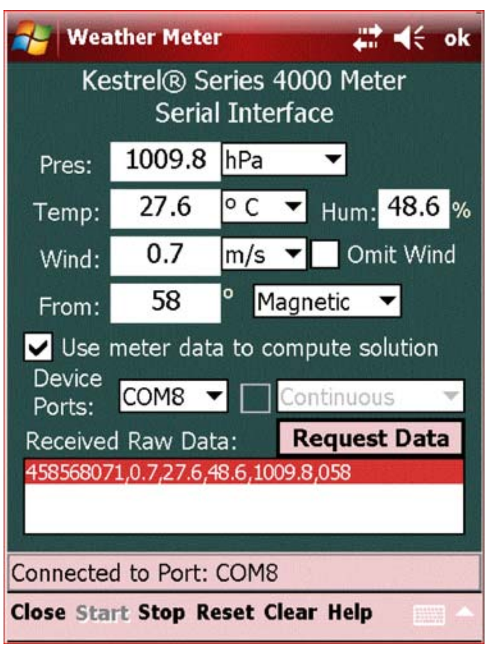
The data in the Bullet Database can be automatically inserted in a Bullet Profile merely by double-clicking on the “Maker” for the bullet of interest. The database will automatically close and the data will be inserted in the profile ready to be completed by the shooter and saved.

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 tap 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.

Kestrel® 4000 Series Interface

Kestrel® weather meters offers Bluetooth communication with its 4000 series. A 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.[12]

To access the Kestrel Interface, tap on the "Kestrel® Meter" entry on the Options list. To use the interface, the user must first pair the meter with the PDA (see Kestrel instructions) which may require setting a specific Com port for the communication. 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's 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 is being received. If the user doesn't know which port this is, just drop the list, select one and then tap 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 identified, then it can be determined whether the software itself will turn the Bluetooth on and off or

[12] 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.

whether the user must handle that operation.

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. 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 58 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 "Magnetic". 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.[13]

Once the connection has been established, the user can update the values on the interface page by either tapping 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.

[13] The program uses the term "magnetic variation" to describe the local value that must be 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.

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, Temperature and Humidity data areas are the same darker background color to visually cue the user. Those data areas can also be updated by pushing the Enter button while in the Presets page. The same is true on the Target Range Card as it relates to the wind speed and direction data items.[14]

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, tap 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.

Updating Delta V Software

A. Versions 4.7 and Earlier

Each of these program has a unique "fingerprint" which manifests itself through

[14] Not shown on the Kestrel graphics is the addition of a "Omit Wind" check box in version 4.8.1.5. Checking this box will allow the Kestrel data to refresh the pressure, temperature, and humidity but will not affect the wind value or direction in the main program.

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 software is installed on the SD card via an updating/installer program that runs on a Windows desktop computer and automates the updating process. At the conclusion of running the updating program, 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.

B. Version 4.8

With version 4.8 an effort was made to make the update process much easier. For version 4.8 installed software the update process consists of merely checking the website's Delta V page and noting the current update version number. A link is provided on that page to download the instructions for update and the instructions contain a link to a download site. Download the current version and install in accordance with the instructions. The program identifiers mentioned in the preceding paragraph are still important and may be crucial is something happens to the license on the card. Therefore, it is a good idea for the user to create the program identifier text file and save it as a backup on some other computer.

Appendix 1

Troubleshooting

Setup and Troubleshooting for the Trimble Nomad but Generally Applicable to Other PDAs as Well

The first thing you must do with a new Nomad is to "calibrate" the battery. This will take the better part of a day. Once calibrated, insert the Delta card into the SD drive which is located under the black cap at the top of the unit. Remove the black cap with the Phillips end of the stylus by turning each screw ½ turn counter-clockwise. The screws will pop up signaling that the top may be lifted off. The SD drive slot will be located on the left of the now exposed cavity.

Pairing a Kestrel

1. Turn the Kestrel on. Go to the setup menu and click on the second line, Bluetooth. Turn on the Bluetooth transmitter then click "Info" and make note of the four digit PIN number. Leave the Kestrel on.
2. Turn on the Nomad. Click Start->Settings->Connections->Bluetooth. Tap on the "Add new device." The Nomad will search for Bluetooth devices in the area and find the Kestrel. Highlight the Kestrel entry and hit Next on the menu. Enter the PIN and click Next.
3. Once the connection has been made you will be taken back to the first page where there are five tabs at the bottom of the page. Click on "COM Ports" and tap "New Outgoing Port". Select a port (port 8 or 9) and note this port; you will need to know it when you first connect the Kestrel to the program.
4. Start the Delta program; tap Options->Kestrel Meter. Once the Kestrel interface page appears, set the Com Port to that designated during the Bluetooth setup. Once set, tap on "Start" in the menu and the connection should be made. This should take a few seconds.
5. Be sure to set the units on the interface to those you have set for the Kestrel device. The data sent by the Kestrel does not include units so the Delta program will not know whether the pressure is in.Hg. or hPA or whether temperature is degrees Celsius or Fahrenheit.

Problems with Setting Outgoing Com Ports

After you have assigned a Bluetooth device to an outgoing com port and decide to change that com port to another device, you may find that you are unable to do so and each time you try you get an error message: "The COM port could not be created.

Please check your settings and try again." The problem is not the settings; the problem is that you can't delete an existing assignment and even if you delete the device from the devices list, it still does not free up the port for reassignment. This is a bug in the 6.0 operating system in Trimble Nomad devices. This bug was fixed in version 6.1.

There are two ways to solve the problem. The first is to do a hard reset. When you do a hard reset, all of the entries in the system's registry are deleted and the registry is rebuilt as if new. The Bluetooth com port assignments are recorded in the registry so rebuilding the registry deletes these assignments and makes the com ports available once again. After the hard reset, when the computer comes back on line you will see that you have no trouble assigning the com ports as you wish.

The second approach avoids the hard reset and attacks the problem directly by going into the registry and deleting the subkeys that are blocking the reassignment. This is for advanced computer users so if you didn't understand the preceding sentence, you probably are better off doing the hard reset.

If you can handle making registry changes, then you will need to acquire a windows mobile registry editor. You connect your Nomad to your desktop computer and run the windows mobile registry editor from the desktop. This program will display the registry on the Nomad and allow you to inspect individual entries. Open the following key in the HKEY_LOCAL_MACHINE hive:

Software\Microsoft\Bluetooth\Serial\Ports\

You should see one or two subkeys with cryptic names like "0000000d88ace93e". Delete all of the subkeys. These keys are created when you make an assignment of a com port to a specific device and are blocking you from assigning new devices to the port.

With the keys deleted, you should have no trouble assigning the com ports are you see fit.

<u>Connecting with the Internal GPS</u>

First you need to set up the operating system to use the internal GPS of the Nomad most efficiently. To do this, turn on the Nomad, tap on the Start menu in the upper left-hand corner, then tap Settings->System->GPS. On the GPS page you will see four tabs: Program, Hardware, Access, A-GPS. Enter these settings: Program - Com3; Hardware - Com2, 9600 Baud; Access - Uncheck the "Manage GPS automatically"; A-

GPS - Uncheck “Enable Assisted GPS”. In later versions of the operating system, sometimes checking the “Manage GPS automatically” proved helpful, so try it both ways.

Generally, if the Nomad is in its original default state, starting the GPS in the program results in the immediate transfer of data. Go to Ranging->GPS and tap Start in the menu. If you tap the Devices tab you will see the data being transmitted by the GPS.

The Nomad comes with a program called SatViewer that when opened for some reason redirects the signal to a location that the Delta program can’t find. If you have opened the SatViewer program, you will probably need to reset the Nomad unit back to default status. To do that:

1. Exit the Delta software.
2. Press and hold the Nomad power button. When you see the “5 Second!” warning, release the power button and tap the “Shutdown” button. After shutdown, wait for 10 minutes.
3. Power up the Nomad by pressing the power button. At this point, all internal settings for the Nomad should be returned to default and the Delta software should easily connect to the GPS.

In the event that the Nomad is still unable to connect to its GPS receiver, or if it is connected but is not receiving Satellite information, then it is necessary to reset the GPS chip itself to its default settings.

To reset the GPS chip back to its default state, shutdown the computer and remove the battery from the device for about 5 minutes. This will cut off the power to the GPS chip, which will cause it to reset back to its default state. Removing the battery is an essential step, as performing the Shutdown step does not affect the GPS chip itself.

To ensure that there is no risk for data loss, always close all active programs and properly shutdown the computer before removing the battery.

Transferring Files Between Nomads

One of the conveniences of the software is the ability to share profiles with others. Transferring a file between two Nomads in the field is relatively simple.

1. The Receiving Nomad must
    a. Tap Start->Settings->Connections->Beams and check the “Receive all incoming beams” box. Hit OK.
    b. Tap Bluetooth-Mode tab and check “Turn on Bluetooth” and “Make this

device visible”. Tap OK.

2. To make it easier to identity the Receiving Nomad, tap the System tab, then About->Device ID tab. Change the Device Name to something descriptive. Tab OK, X and you should be back to the main screen.
3. On the Sending Nomad, tap and hold on the file to send. On the appearing context menu tap “Beam File”. The Nomad will search for local Bluetooth devices and list same which hopefully will include the Receiving Nomad. Tap on the Receiving Nomad and the file will be sent.
4. On the Receiving Nomad, the file will be found in the \My Documents folder of the PDA. Tap and hold on the file, hit “Cut” (or “Copy”) and move to the location on the Delta card that the file will go. Tap and hold in the selected directory and “Paste”.

<u>Odd Program Behavior</u>

The program saves its state when you shut it down so that when you start the program later it can pick up exactly where you left off. All of the settings and data will be reloaded. Sometimes the program memory space will get corrupted for one reason or another and when that happens, merely cycling the program on and off will not help; when the program is turned off, this corrupt state is saved and when the program is started again, the corrupt state is reloaded.

To rid the program of a corrupt data item:

1. Go to Options->Tools and click on the Reset Program menu item. At this point, the file that keeps track of the program state is cleared.
2. With the program still running, press and hold the Nomad power button. When you see the “5 Second!” warning, release the power button and tap the “Shutdown” button. After shutdown, wait for 10 minutes.
3. Remove the Delta SD card from the Nomad.
4. Power up the Nomad by pressing the power button. At this point, the memory space of the Nomad is clear of any residual program data. Reinsert the Delta card. It will start with its original default values.
5. Carefully reload the profiles you were using. Pay close attention to the program’s operation after each profile is loaded. If after loading a particular profile you begin to see odd behavior again, you can suspect that the profile in question contains some bad data that is causing the problem. Open that profile in its editor, check each data item, and re-save. If the problem persists, contact Support.

Appendix 2

Videos - Title Listing

The following is a list of videos found on the Lex Talus website at [www.lextalus.com/videos.html.](http://www.lextalus.com/videos.html) View the videos in conjunction with this manual.

Delta V© Instructional Videos

1. Get Started - What's on the SD card
2. Get Started - Setting up the GPS
3. Get Started - Setting up the Kestrel
4. Get Started - The Start menu
5. Intro. - Basic Data Input
6. Intro. - PS, Wind Buttons
7. Intro. - Targeting, CV, Proj. Metrics
8. Intro. - Target Speed, Shot Logs
9. Intro. - Elevation, Windage, Lead
10. Intro. - Presets Page
11. Intro. - T, R, O, B List Buttons
12. Profiles - Bullets
13. Profiles - Turrets
14. Profiles - Rifles
15. Profiles - Offsets
16. Profiles - Targeting
17. Options - Turret Display
18. Tools - Scope Calibration
19. Tools - MV Calculation
20. Tools - BC Calculation
21. Tools - DK Computation
22. Tools - Field Zero
23. Tools - LOS Metrics
24. Tools - Path Metrics
25. Ranging - Range Finder
26. Ranging -Direct, GPS, Map, Reticle
27. Target Range Card
28. Adv. Directory Management - Part 1
29. Adv. Directory Management - Part 2
30. Export - Import of Targeting Files
31. Troubleshooting
32. Updating Delta V ver. 4.7 and Earlier
33. Updating Delta V ver. 4.8 and Later
34. Calculator (4.8.1.4 and later)
35. TwistCalc (4.8.1.4 and later)