POLARSTAR

Fire Control Unit Instructions (REV 3.0+)

BATTERY

The Fire Control Unit can be powered from battery packs between 7.4v and 10.8v. This includes common airsoft battery packs as well as small (<300mAh) lithium polymer packs. 7.4v and 8.4v battery packs are recommended since there are no benefits to us ing a higher voltage. **Alkaline batteries (including 9V batteries) should not be used as they do not meet the minimum continuous current rating of at least 1A and will lead to malfunction.**

THE FCU WILL CONTINUE TO DRAW POWER FOR AS LONG AS THE BATTERY REMAINS CONNECTED.
ALWAYS DISCONNECT THE BATTERY AFTER USE TO PEREVENT THE BATTERY FROM DISCHARGING COMPLETELY.

PROGRAMMING - BASIC OVERVIEW

To enter programming mode, press inward on the programming button. The display will show the firmware revision (e.g. rE 3.0) and the programming indicator will turn on. When the programming indicator is on the trigger is disabled and the system is in programming mode. Press the programming button again to exit programming mode. Setting changes are automatically saved upon exiting. While in programming mode the various settings may be accessed by pushing the programming button left or right. The values are changed by pushing the button up or down.

The FCU may be returned to the factory defaults by holding in the programming button while plugging in the battery.

Firmware Revision (e.g. rE3.0) - This is not a user setting, but instead displays the firmware revision of the FCU. Pressing up or down on the programming button will display the upper or lower four (4) digits of the FCU shot counter. This value is displayed in hexadecimal format.

FCU Mode (FC) - As of revision 1.0 the FCU can control both dual solenoid (Fusion Engine & F2) and single solenoid (F1 & JACK) systems. This setting (FE or F1) determines which system the FCU is controlling and which system-specific settings are visible in the menu. Some settings are global and apply to both modes while others are specific to either the FE or F1 mode.

Rate of Fire (rF) - The ROF variable sets the cyclic rate of the system. The value on the display is the desired cyclic rate in Rounds per Second. If the FCU calculates that the set cyclic rate is too high to achieve based on other settings then it will automatically use the calculated maximum cyclic rate regardless of the number displayed.

Max Semi Auto ROF (Sr) - This setting controls the maximum semi auto rate of fire. Once a shot has been fired the FCU will ignore additional trigger pulls until the time in the Sr setting has elapsed. This is adjustable in 0.1ms increments from 10 shots per second (Sr 01) to as low as 1 shot every 9.9 seconds (Sr 99). Setting this to 0 turns off the timer and allows you to fire as fast as you can pull the trigger.

Selector Modes (S1 & S2) - The fire mode of each selector position is configured individually to allow the mapping of any fire mode to any selector position. S1 sets the mode of the semi-auto position and S2 sets the mode of the full auto position.

00: Full Auto
01: Semi Auto
02-09: 2-9 Round Burst

Anti-Stiction Timeout (iS) - The Anti-Stiction timeout is a countdown timer that enables the Anti-Stiction Pulse when the timer reaches zero. This is set in 10 second increments and is automatically reset after every shot.

Anti-Stiction Pulse (iP) - The Anti-Stiction pulse is added to the Poppet Dwell when the Anti-Stiction Timeout has elapsed. This is used to counter static friction ("stiction"). In many cases it is not needed and can be turned off by setting the iP to 00.

Poppet Dwell (dP) - The poppet dwell variable controls how long power is applied to the solenoid and allows adjustment of the gas volume released through the nozzle. The higher the value, the longer gas is allowed to flow. The dwell is set in 0.1ms increments. This is the only settings which directly affects performance on single solenoid systems such as the F1 and JACK. ***To learn how to set the dwell of the F1 or JACK, see Poppet Dwell (dP) in the Fine Tuning section below.***

Nozzle Dwell (dn) - The nozzle dwell variable controls how long power is applied to the nozzle solenoid, affecting the time that the nozzle is held rearward. The higher the value, the longer the nozzle is held to the rear, which allows tuning for slower feeding magazines. This setting is highly dependent on the magazine, BB and Hop-Up combination. In most cases, a dN setting of 8ms to 14ms is ideal. Setting this value too low will result in inconsistent feeding and potential jams. (This setting only applies to Fusion Engine mode.)

Return to Battery Delay (dr) - The RTB delay determines how long to wait for the nozzle to return forward while chambering the next round. Due to the design of the AEG magazine/Hop-Up, the actual delay time required varies each shot so the default value is set to a conservative 22ms. Although the dr value may be lowered for some setups, it should not be set below 17ms. (This setting only applies to Fusion Engine mode.)

Closed Bolt Mode (Cb) - Closed Bolt Mode allows simulation of a closed bolt mechanism by firing the round first, then cycling the nozzle. This allows for even faster trigger response and more consistent seating in the Hop-Up at the expense of dry-firing the first shot on a new magazine. (This setting only applies to Fusion Engine mode.)

FINE TUNING (FUSION ENGINE & F2)

It is a common misconception that there are particular settings which are recommended for optimum performance. In actuality rifles will normally require difference settings to perform at their best. Even if the settings work great on one gun, they may not work well on another since every gun can behave differently depending on what components it is configured with. Incorrect settings can cause problems such as the gun not feeding/firing, jamming or terrible accuracy. Therefore you should always turn your rifle based on how that particular rifle responds.

Before making any adjustments to the FCU make sure that your rifle is set up exactly how you intend to field it. This means that you will have the same barrel group, magazines and BB's. You'll want to have the correct nozzle and adjust the pressure so that that rifle is shooting at the required muzzle energy with the same BB's you will be fielding it with. This is important since changing any one of these variables can make a difference in how the gun behaves and the FCU would need to be adjusted accordingly.

For example, with a Fusion Engine or F2, changing the pressure will change how quickly the components of the engine move. If you decrease the pressure to reduce your muzzle velocity, the nozzle will retract slower so you may need to increase your nozzle dwell to ensure BB's feed reliably. If you decide to shoot a heavier BB then there will be more weight for the magazine spring to push up against and more weight for the nozzle to move forward into the chamber so you may need to adjust both your nozzle dwell and return to battery delay.

To better understand how each dwell setting you adjust in the FCU affects the function of the engine, you first need to understand what happens inside of it when you squeeze the trigger. In FE Mode (FCFE) there are four main dwell settings that affect performance. The order of these dwells is the same with Closed Bolt off (cbof) and Closed Bolt on (cbon). The major difference between the two modes is the location of the start point in the cycle. The order of the dwells in a firing cycle with cbof are as follows: **dn, dr, dP, rF** in full auto the cycle repeats: **dn, dr, dP, rF; dn, dr, dP, rF; dn, dr, dP, rF**.

The Fusion Engine and F2 are strictly a closed bolt systems so the nozzle is always biased forward regardless of cb being on or off. The cb setting is simply to change the firing sequence. The default setting is cbof which means when the trigger is pulled the nozzle cycles first to chamber a round and then the poppet will fire. With cbon the poppet will fire first and then the nozzle cycles to chamber the next round. With cbon it replicates the action of a closed bolt firearm whereas with cbof it replicates the action of an AEG. The benefit of having closed bolt on is that you will get a faster trigger response and, when shooting semi auto, it guarantees the nozzle is forward and sealed before the shot is fired regardless of other settings. This promotes improved accuracy so it is an ideal choice for Sniper/DMR applications. The only downside is that if the chamber is empty, such as when you run the magazine dry, the first shot after loading a new magazine will be a dry fire since it must fire first before the nozzle will cycle to chamber the next round.

Now, moving on to the four main dwells that affect the engine's performance. Here we will explain what each dwell does and how you can go about adjusting it to fine tune the rifle. One thing to point out is that the default settings should work with any rifle since they are set conservatively. It is not required that the engine be tuned just to use it but only if you want to get the most out of the engine. Tuning mainly comes down to adjusting the engine to match the feed rate of the magazines and how quickly they can push the BB's up into the chamber. The faster your rifle can feed BB's, the faster you can push the engine.

Each dwell has a recommended setting and some dwells have a minimum recommended setting regardless of all other factors e.g. BB's, magazines, gun brand etc. The dn and dr dwells are in millisecond (1/1,000th of a second) increments while the dP is in 1/10th of a millisecond (1/10,000th of a second) increments.

When you want to tune the FCU, the order that you adjust the settings needs to be considered. It is recommended that you start with the FCU at the factory settings.

Nozzle Dwell (dn) - The first setting to address is the dn setting which determines how long the nozzle is held back. Load all the magazines that you intend to use with the brand and weight BB's you intend to shoot. Select one magazine and use just that magazine for the first portion of the test. Insert the magazine into the gun and shoot about ten shots on semi and ten on full auto. If the gun feeds every single round lower the dn by 2 and repeat. Continue until the gun begins to miss feed, when it starts to miss feed increase the dn by 1 until it feeds every single round again. Burn through the whole magazine using semi and auto and confirm zero miss feeds. If there are miss feeds reload the magazine and shoot again, if there are still miss feeds increase the dn by 1 reload and shoot again until you can get through the entire magazine from full to empty without experiencing a feeding issue.

Now, start working your way through the rest of your magazines to ensure you have no feeding issues with any of them. Again, shoot from full to empty as the magazines spring tension can change depending on how much ammo the magazine is pushing up. One magazine might not feed as well as another so, if you experience a miss feed with any other magazine, that magazine feeds slower and you should repeat the first test and adjust the dn to work with that magazine until it feeds properly. Once you can shoot any of your magazines without a miss feed, take note of your dn setting because this is the lowest you can take it at this pressure, using this nozzle, with these magazines and these BB's. If you are not going for the fastest rate of fire possible you will probably want to increase the dn by 1 or 2 to guarantee perfect feeding during use.

Poppet Dwell (dP) - The dP setting determines how long power it applied to the solenoid which opens the poppet valve. The poppet valve is the valve that releases air to fire the BB. If this setting is too low the gun will not fire the first shot after sitting for a short period of time and if it is lower still the gun may not fire at all. Some guns will need the dP to be adjusted with significant changes in operating pressure, climate and/or geography. For example, it will most likely require a higher dP when operating in colder climates than in warmer climates.

(continued on reverse side)

NOTES:

POLARSTAR

5 GARFIELD WAY, NEWARK, DE 19713
P: 302-449-4866 F: 302-368-5502

POLARSTARAIRSOFT.COM

CS@POLARSTARAIRSOFT.COM

You will go about adjusting the dwell differently for the Fusion Engine than you will for the F2, F1 and JACK. The poppet valve on the Fusion Engine is able to produce a much higher volume of air than other systems. Because of this, changes to the dwell will not have a noticeable affect on velocity unless you are using an extremely long barrel. Therefore you will mainly be adjusting the dwell to ensure the system fires on the first shot rather than changing the air volume. To adjust air volume on the Fusion Engine you will need to do it manually using either the optional low flow poppets we offer or adjusting the stroke of the poppet valve with shims.

(Fusion Engine) - To set the dwell on a Fusion Engine, start at the default dP25 and reduce the dP setting by 2 and let the gun sit for 5 minutes. Fire the gun twice on semi and confirm that the poppet valve fires air down the barrel for both shots. Continue to reduce the dP by 2 and letting the gun sit for 5 minutes until the first trigger pull does not fire air down the nozzle/barrel. Increase the dP by 2 and this now the lowest you can take the dP at this pressure and general climate and geography.

The valves in the F2, F1 and JACK open and close very quickly and to not produce as much air volume. Therefore you are able to fine tune the how much air volume is released by simply adjusting how long the valve is open without requiring the use of different valves or shims like a Fusion Engine.

(F2, F1 and JACK) - To set the dwell on these systems, you would first set your dP to the maximum setting of 99 and then adjust your air pressure until you are shooting at the desired velocity with the BB weight you will be using. Then start reducing the dP by 5 at a time until you see the velocity decrease or become noticeably inconsistent. This is a sign that you are under voluming the barrel so that air flow is being shut off before the BB reaches the end of the barrel. Increase the dP by 1 at a time until the velocity and shot consistency returns to where it originally was and then set the dP 2 higher than that point to account for any variance in the respond time of the solenoid.

Rate of Fire (rF) - Adjusting the rate of fire will only change the delay in-between each firing cycle and does not affect trigger response. Even if you have it set to 1 round a second, the system will still fire instantly when the trigger is pulled. The set rate of fire will only take affect on automatic and burst modes. It will not affect semi automatic.

The rF setting on firmware rE1.0 and higher will adjust the cyclic rate (rate of fire) of the system in actual rounds per second. Therefore, if the rF is set to 18, the engine will produce 18 shots per second providing the other delays and dwells could be accomplish in that amount of time. For example, if you were to set the rF to 30 rounds a second yet the dn, dr and dp were set high enough that only 23 rounds a second were possible, the engine will only produce 23 rounds a second until the dwell/delay on those other settings were reduced. Therefore by optimizing those settings you will be able to achieve the highest rate of fire possible with this particular set of variables.

Return to Battery Delay (dr) - The dr controls the time between releasing the nozzle to return forward and firing the poppet valve. The nozzle takes a minimum of 9 milliseconds at 100 psi to return all the way forward without a BB in front of it. With the solenoid de-energize time of 2.5 milliseconds the nozzle requires at least 11.5 milliseconds (with no BB in front of it) to return all the way forward from the time the nozzle solenoid is told to shut off. Pushing a BB through the bucking lips will slow the nozzle return speed down some especially if its fit is fairly tight or if you are using heavier ammo. If the dr is lower than 12 the poppet valve will fire off before the BB is seated properly and the nozzle has made a good seal with the bucking. This will result in an air leak and a loss of power, consistency and accuracy or jamming especially in full auto. If you notice you have a rather wide shot grouping then having the dr set too low could be the culprit. To experiment you can start increasing your dr by 5 at a time until you see that the shot group gets tighter. Once the group doesn't appear to be getting any tighter, you can lower the dr by 1 at a time until you find where it starts to affect the shot grouping. If you are not trying to achieve a high rate of fire the dr should be set conservatively high to allow the maximum amount of time for the BB to settle and the air nozzle to seal.

This concludes the main dwells which affect performance. For some, making changes to the FCU can be a little disconcerting if you don't really understand what the adjustments do are how they really affect the systems performance. This long winded explanation should shed some light on the mysteries of the FCU but just remember that nothing you do in the FCU will actually damage the engine. If any changes made seem to make the F2 no longer function properly, the changes can always be undone or reset to default. The FCU can easily be reset to factory default by simply holding in on the joystick while plugging in the battery. The FCU will display DEFT when the battery is connected and all of the settings will go back to factory default.

We can now touch on the non-essential settings of the FCU to better explain how they are adjusted and their function.

Selector Modes (S1 & S2) - To program a fire mode to each selector position you would adjust the S1 and S2 settings in your FCU programing menu. On most common rifles such as an M4, the S1 is your semi auto selector position and S2 is your full auto selector position. By default the S1 should be set to S101 for Semi Auto, and the S2 should be set to S200 for full auto. Changing the number will change the fire mode set to that selector position.

00 = Full Auto, 01 = Semi Auto, 02 = 2 Round Burst, 03 = 3 Round Burst, etc. on up to 09 = 9 Round Burst.

Max Semi Auto ROF (Sr) - The semi auto delay mode is available on FCU's that have firmware revision rE1.0 and higher. To program it, enter programing mode and scroll to the "Sr" menu. The default is Sr0F (off). If you press up on the joystick you will change it to Sr01 which is a 0.1 second delay in-between shots. You can continue to increase that number in 0.1 second increments up to Sr99 which is a 9.9 second delay in-between shots.

Anti-Stiction (iS) & (iP) - Stiction (static friction) is the affect of two parts being pressed together for a prolonged period of time. Liken it to a sofa sitting on a hardwood floor. It takes more effort to start pushing the sofa across the floor after it has been sitting there for a while then after it had just been moved a few minutes ago. The same thing applies to an HPA system. After it has been sitting a while it can take a longer dwell to fire off after it has been sitting idle for a while then after it was just recently fired.

Normally if you have your dP set correctly the anti stiction mode is not needed. However, under certainly conditions such as operating in cold temperatures, it may be needed to ensure the system will fire off on the first shot. The anti stiction mode provides you with the ability to increase the dP for only the first shot after a pre-defined amount of time has passed without requiring you to readjust your main dP setting.

The "iS" is the anti-stiction timer. Each number has a value of 10 seconds (i.e. 01 = 10sec, 02 = 20 sec, ect.). The timer will begin after each trigger input and once it ends it will add the value you have set in "iP" to your "dP" for the first shot.

Therefore if you have "iS03", "iP10" and "dP50", after the system has been idle for 30 seconds it will automatically increase your dP to 60 for the first shot and then lower it back to 50 for the following shots until the system has once again sat idle for 30 seconds.

Note that if you have nothing set for your iP (i.e. iP00) then it will not add an extra plus to the dP regardless of what you have iS set to. The iS is simply a timer.

Shot Counter - To view the shot counter you simply enter programing mode so that you can see the revision number (e.g. rE3.0) and then hold the joystick in the down direction. It will display a 4 digit alphanumeric number. Type that into a hexadecimal converter and it will give you the number of shots that FCU has cycled. If you have a "high mileage" engine and you have reached the maximum number for those 4 segments, the count will continue to another 4 segments which can be viewed by pressing up on the joystick. Those are simply placed in front of those displayed on the "lower" display. For example, the down direction on the joystick displays 3bcE and the up direction displays 0006. You put the 6 in front of the 3bcE so you have 63bcE which equals 408,526.