Calibrating the Throttle on an F5J Sailplane

Ed Dumas 08-19-2022

This article will describe how to properly set up the throttle, Electronic Speed Control (ESC), and Altimeter/Motor Run Timer (AMRT, or altimeter) on an F5J sailplane so that it runs reliably through all power settings and flight modes. If you've ever had the dreaded - - - .- on your AMRT at the end of a flight when you did not restart your motor, this article is for you.

The following items are required for this procedure and make great additions to your bench and field box if you don't have them already:

Castle Link Software (available from Castle Creations, current version 3.85.00, available here) & laptop or desktop computer with Windows Vista, 7, 8, or 10 operating system.
Castle Link interface device (available from Castle Creations, here)
Servo Monitor (available from ServoCity, here)



The setup described here is for my Ultima 2 which uses a Castle Phoenix Edge Lite 50 Amp ESC, an XPower 2919/10 Light motor with a Vladimir Models (VM) 11 x 7 prop and VM 30/5 Pro Spinner, a Spektrum 8020T receiver, an Aerobtec Altis v4+ AMRT and a Spektrum iX-20 transmitter. Please be aware there may be potential differences from these instructions when using other brands of speed controls, AMRTs, receivers, and transmitters!

Background: To better understand how the receiver, ESC, and AMRT work together to accurately measure the starting altitude of an F5J competition sailplane, please refer to the FAI rules for electric devices in competition, here. Note section 3.4, page 11, that describes the signal criteria the AMRT must use to determine when the motor has been turned on and off.

When the model is powered on, the pulse-width of the throttle signal from the receiver is measured by the AMRT. When this width exceeds 1.2 milliseconds (1200 µsec), the motor is considered ON and the process of measuring the F5J starting altitude begins. When the pulse width then drops below approximately 1100 µsec, the motor is considered OFF, and the 10 second timer begins to determine the final F5J altitude. If the throttle exceeds 1200 µsec anytime after this period before the model is powered off, whether intentional or not, the motor is considered to have restarted and the AMRT will show - - -.

Note the FAI documentation uses millisecond (ms) time scale, while I use the microsecond (µsec) time scale. Note that 1.2 milliseconds is equal to 1200 microseconds, and the timing pulse widths will be shown in µsec in the rest of this article since those units are measured by the Servo Monitor device. Also note the FAI permits a “small amount of hysteresis” to allow for jitter in the throttle signal when making the determination that the motor has shut off. For this article I assume 100 µsec as the hysteresis value relative to the 1200 µsec threshold. So a pulse-width > 1200 µsec is motor ON, and a pulse-width < 1100 µsec is motor OFF. These values are commonly accepted and have worked very well in practice.

A typical cause of the unintentional - - - . - condition is improperly set up throttle endpoints, and possibly an improperly set up switch to activate the motor. Sometimes there can be intermittent connections in servo wires between the receiver, AMRT, and ESC that can cause exacerbating glitches and make diagnosing these types of problems very difficult. Also, it is important to place the AMRT as far away from the motor and ESC as possible due to the emission of strong electric fields from these devices while they are operating!

If you go through these instructions and still have trouble with intermittent occurrences of the dreaded - - - . - when you did not intend to restart your motor, please check all of the electrical connectors throughout your sailplane, particularly if you have shortened the AMRT or ESC leads. We are still surprised at the number of intermittent connections that cause problems in some models!

In my setup, I use switches A and H on my iX-20 to activate the motor. Positioning switch H forward “arms” the motor and positioning switch A forward actually starts the motor turning. The throttle is the left slider. After the motor shuts off, I move both switch A and switch H to the rearward positions. This switch configuration is used to minimize the chance of accidentally restarting the motor during flight.

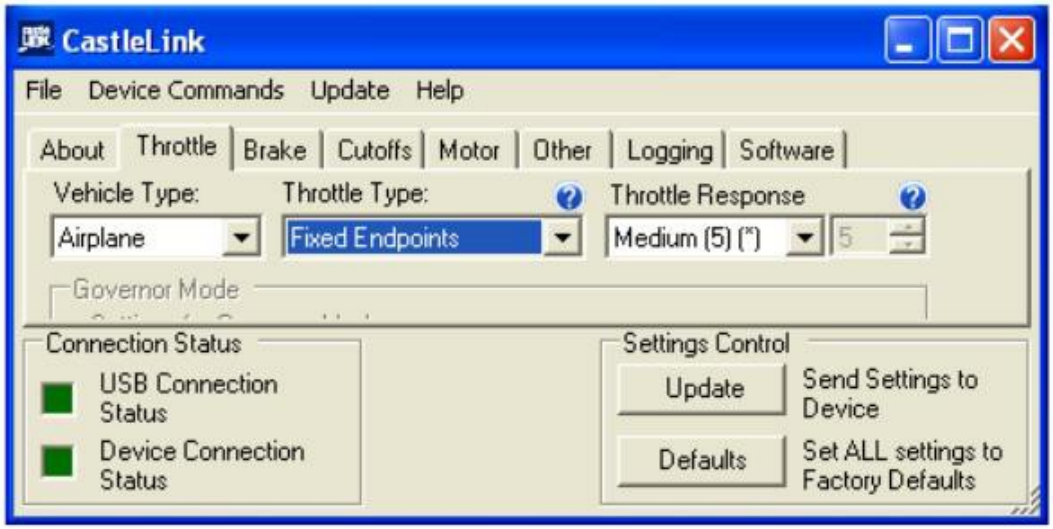
Under the hood, these switches are used to control the flight mode. The motor cut and motor curve functions are then made active or inactive depending on the flight mode that is selected. In my setup, the motor curve is programmed to only be active in launch mode, while the motor cut is programmed to be active in every flight mode except launch. Most transmitters should be able to be programmed in a similar fashion.

In this tutorial, we will begin by setting fixed-endpoints in the Castle ESC, then set the motor cut value significantly lower than 1100 µsec threshold to ensure there is no possibility that the AMRT will falsely detect a motor start. Next, we will adjust points at the low end of the motor curve to achieve the desired low-end propeller RPM in launch mode. We will then adjust the high-end throttle, followed by a double-check that everything works as desired.

Let's begin by setting fixed endpoints for a Castle speed control:

Steps:

1) Connect Castle Link interface module to computer via USB cable.
2) Plug Castle Link interface module into the speed control. Check polarity!
3) Start the Castle Link software. You should see a rapidly flashing red and green light on the interface module.
4) The device should be linked when the software starts. In the lower left corner, look for 2 green boxes that indicate the USB is connected and the device is linked.
5) Click on the Throttle tab. Click on the Throttle Type button and select "Fixed Endpoints", as shown below.



6) Take time to check all other settings while the device is plugged in.
7) When happy, click the "Update" button in the lower right corner.
8) Exit the Castle Link software.
9) You should now see a solid green light on the interface board. Unplug the interface board and replace all connectors in the aircraft.
10) Power your transmitter.
11) Begin by resetting the throttle curve to default values shown below:

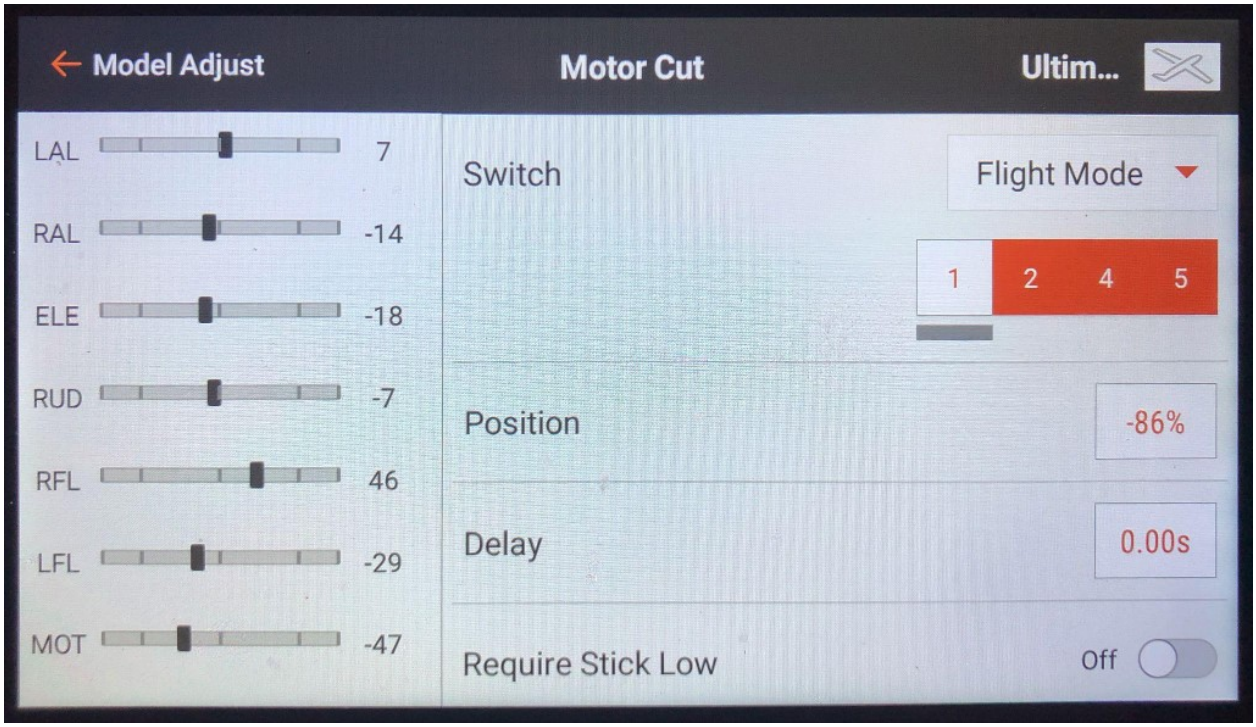
Point	% MOT	X
1:	0%	0%
2:	25%	25%
3:	50%	50%
4:	75%	75%
5:	100%	100%

12) Set the servo travel on the Motor channel to -5% on the low end and +20% on the high end. Note these values will change after calibration, but need to both be set near zero for the fixed-endpoint calibration to work properly.
13) Turn all motor switches ON and place the transmitter in Launch Mode, if applicable.
14) Move the throttle stick to full.
15) Power the speed control. There will be a series of tones but the final tone will not sound. This will indicate the speed control is in programming mode, not operational mode. This is also indicated by the red light flashing rapidly on the speed control.
16) Go to the menu setting for the high throttle servo travel and slowly advance the travel endpoint up, pausing briefly at each step. Be sure you are advancing the high end! In my case I started at +20% and advanced slowly. After the speed control detects the maximum throttle setting you will hear the final initialization tone and the red light will flash slowly. Go 2 more points beyond this point and enter the value. Mine ended up at 90%. Also, be aware that if the AMRT is hooked up, it will attempt to shut off the motor after 30 seconds which could cause problems setting the high and low ends of the throttle travel. If in doubt, remove the AMRT for this portion of the setup.
17) Unplug the speed control, advance the throttle to full, and power the speed control again. The speed control will go into programming mode as it did before.
18) After the speed control finishes initializing, move the throttle down to the lowest setting. Now begin slowly decreasing the lower endpoint of the throttle until the speed control again plays the final initialization tone. Note the low-end setting! Mine was -56% on the monitor.
19) Unplug the speed control's power again. Now go ahead and set the low throttle endpoint all the way down to -150% and press OK to select the throttle's endpoints.

Now the throttle endpoints have been set. Note on Castle Creations ESC's these endpoints correspond to pulse widths of 1200 µsec and 1800 µsec for low-throttle and full-throttle, respectively. The next step is to set the throttle cut value so that the pulse width is well below that required by the FAI to indicate a motor start. This will ensure that the AMRT will NOT record a motor start as long as the throttle cut switch(es) is/are enabled.

20) Now, hook up the AMRT if it was disconnected earlier. Next, insert the servo monitor between the receiver and AMRT so that the servo monitor's input connects to the receiver and its output connects to the AMRT.

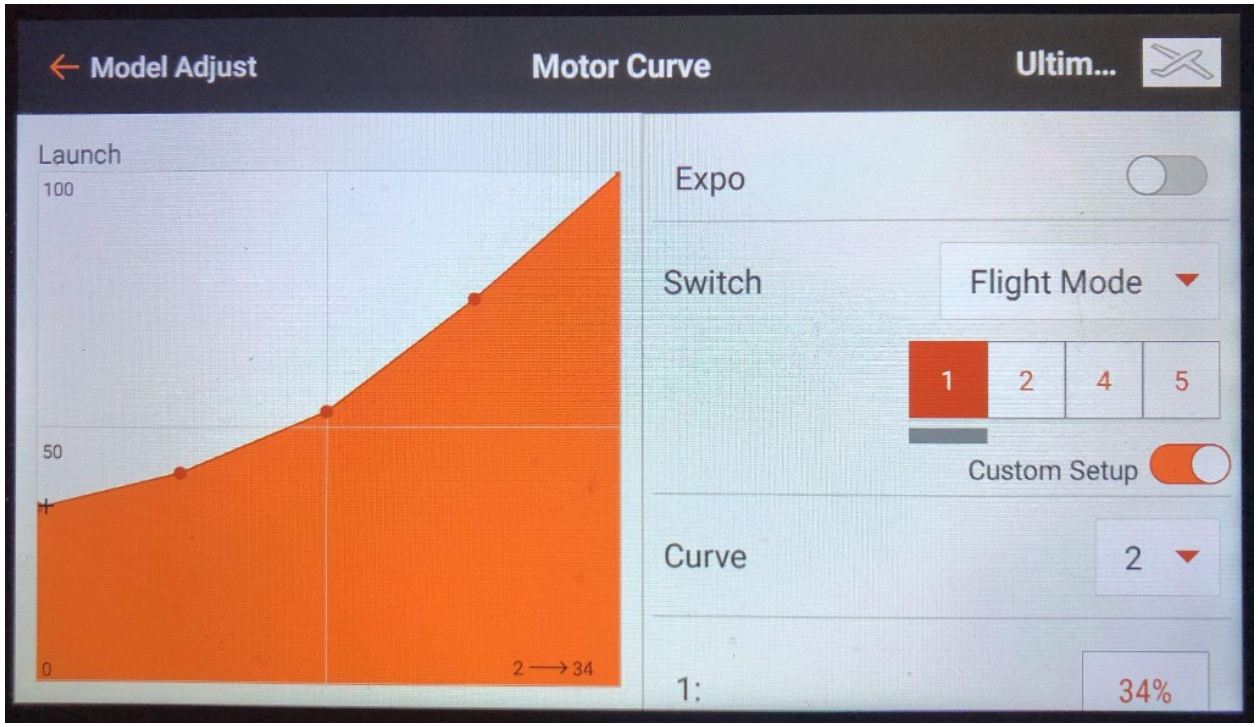
21) Turn the motor switch OFF and set the transmitter for a flight mode other than launch. Go to the Throttle Cut setup screen on the transmitter and go ahead and set it to a low negative number. In my case, I used -86%, as shown in the picture below.



22) Power the speed control and make sure the servo monitor is measuring data in the pulse width mode. If necessary, push the button to cycle through the modes until the pulse width mode is selected.
23) The pulse width should be somewhere around 980 µsec, or close to that. The goal is to make the pulse width between 900 and 1000 µsec. The exact number doesn't matter too much as long as it is somewhere in that range with the motor cut ON. Note that on the Spektrum transmitter the value must be entered after making adjustments in order for the pulse width to be updated on the display. This may be true with other transmitters as well.
24) Unplug the model.

Next, we are going to set the lowest end of the motor curve to just get the propeller turning when the pulse width is above 1200 µsec, then we will adjust the high-end of the throttle curve to get full power and measure the pulse width.

25) Go to the motor curve and select the lowest point, which should be zero, for editing. With the receiver and speed control OFF, select Launch Mode. Check the servo monitor and, with the throttle fully closed, adjust the lowest point on the throttle curve until the monitor shows a number close to the low-end setting that was noted in Step 19. Once this number is close, adjust the next points on the curve (25%) so that the curve rises smoothly toward the 75% point. The picture of my final throttle curve is shown below. Note I had to raise my lowest point to 34%. Your mileage may vary…

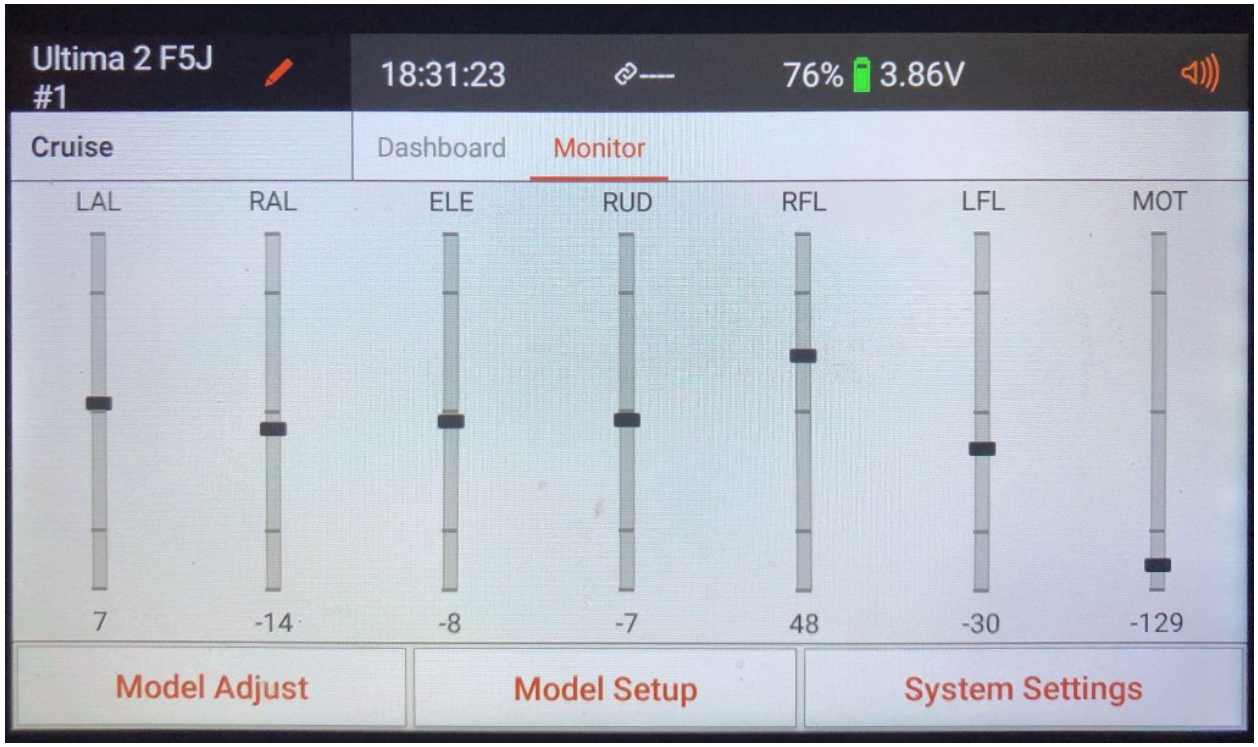


26) Now, secure the model, any wiring, and the servo monitor. Orient the servo monitor so you can read it with the motor running and double-check the prop is clear. The next steps will power the motor and spin the prop!
27) Make sure the transmitter is NOT in Launch Mode, and power the model normally. Double-check the pulse width matches what it was set to earlier in step 24. Double check the throttle is in its lowest position!
28) Switch into Launch Mode and note whether the prop turns or not, and note the pulse width. Adjust the lowest point on the throttle curve so that the pulse width is at least 1200 µsec and the RPM is the lowest you would like for the model coming out of your hand on launch. In my case, my pulse width at minimum throttle ended up at 1310 µsec.
29) Next, slowly throttle up to full power and note the pulse width. At full power, mine is 1845 µsec. Adjust the throttle curve as necessary to achieve these or similar values.
30) Finally, as a last double-check, power everything off and start from scratch, just as you would do on a normal flight. Power the transmitter, power the backup system if you have it, then power the receiver. You should be able to start the motor, run any combination of throttle settings while the motor runs for the entire 30 second period, and finally end up with a valid altitude at the end. Remember if you're in your shop, don't expect more than 1-2 meters for the final altitude.

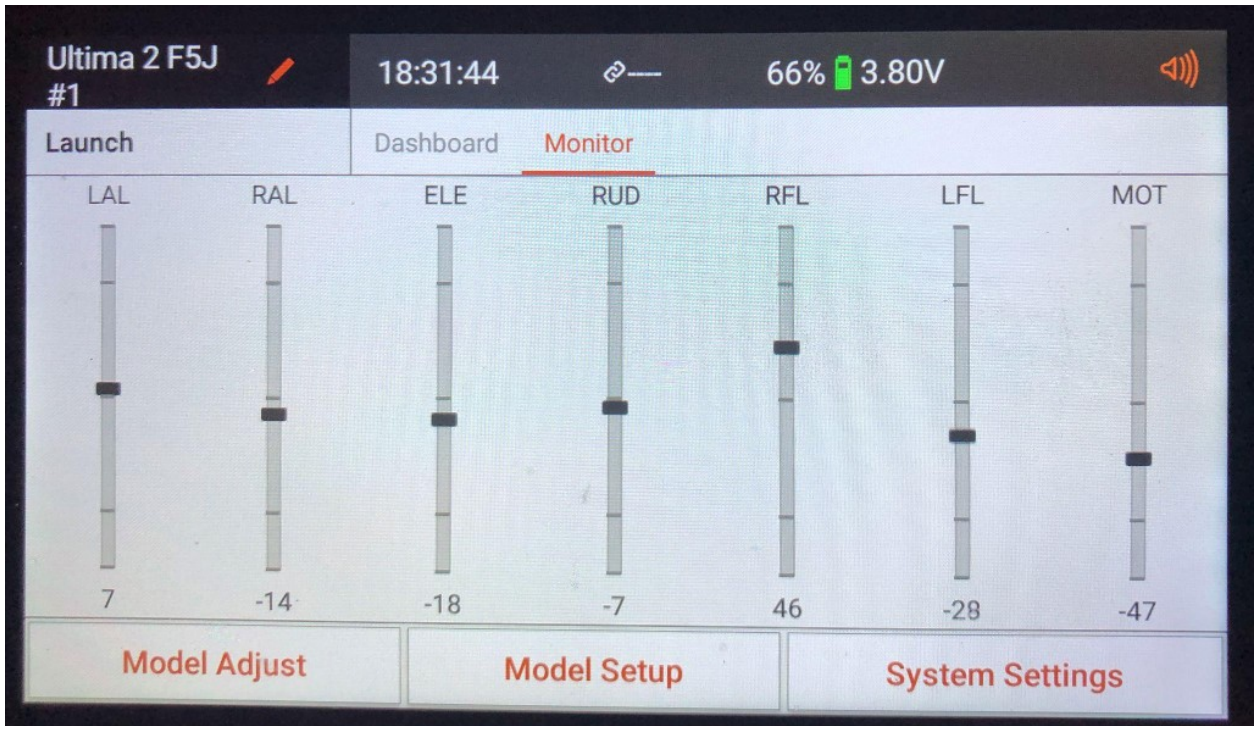
But, if you happen to get the dreaded - - -.-, go back and measure the pulse width for the throttle cut and the low and high power settings again and make sure they are within the proper parameters. Also, be sure to check any modified servo connectors for intermittent connections, as well as the position of the AMRT relative to your ESC and motor.

The key points are: Make sure that when in launch mode at minimum throttle the pulse width is at least 1200 µsec, and make sure that in any flight mode other than Launch, the motor cut sets the pulse width below 1000 µsec. I use 980 µsec and it has worked fine. Finally, check that the pulse width at full throttle is at least 1800 µsec. Best of luck!

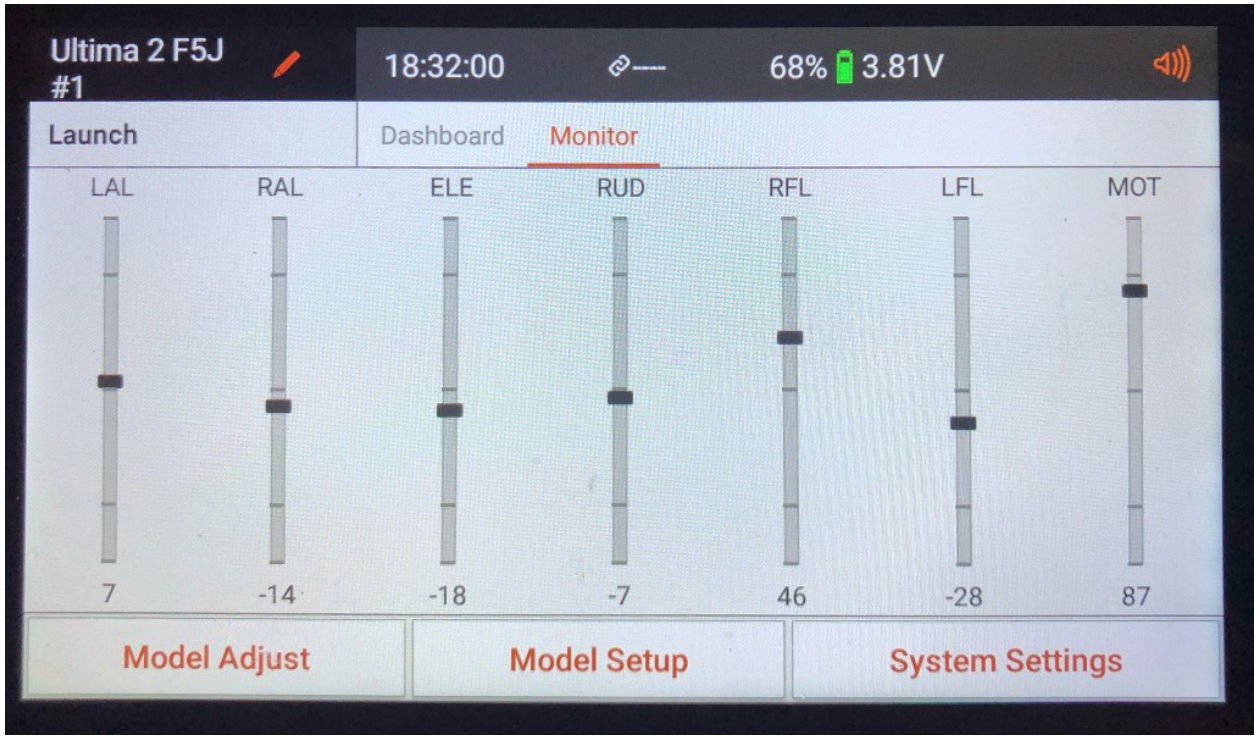
The following screenshots are included for reference:



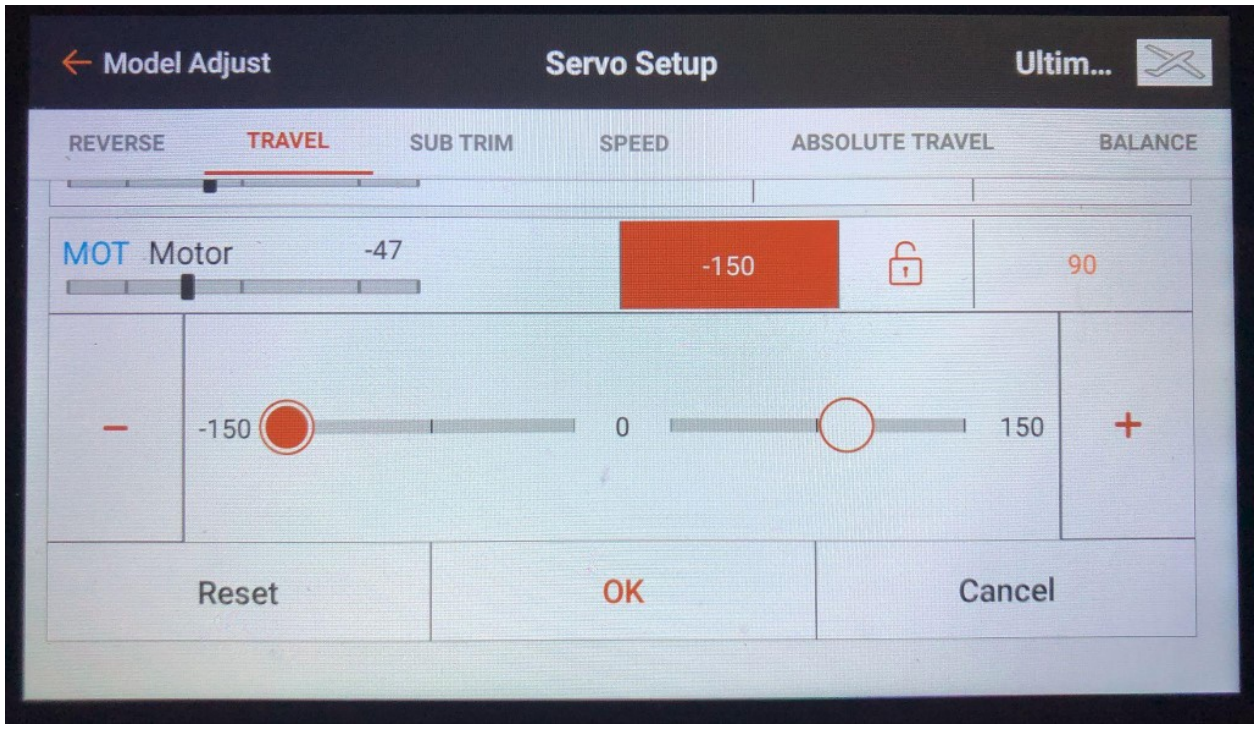
The screenshot above shows the monitor for the throttle (on the far right) in motor cut mode. The percentage shown is -129%, which corresponds to 980 µsec.



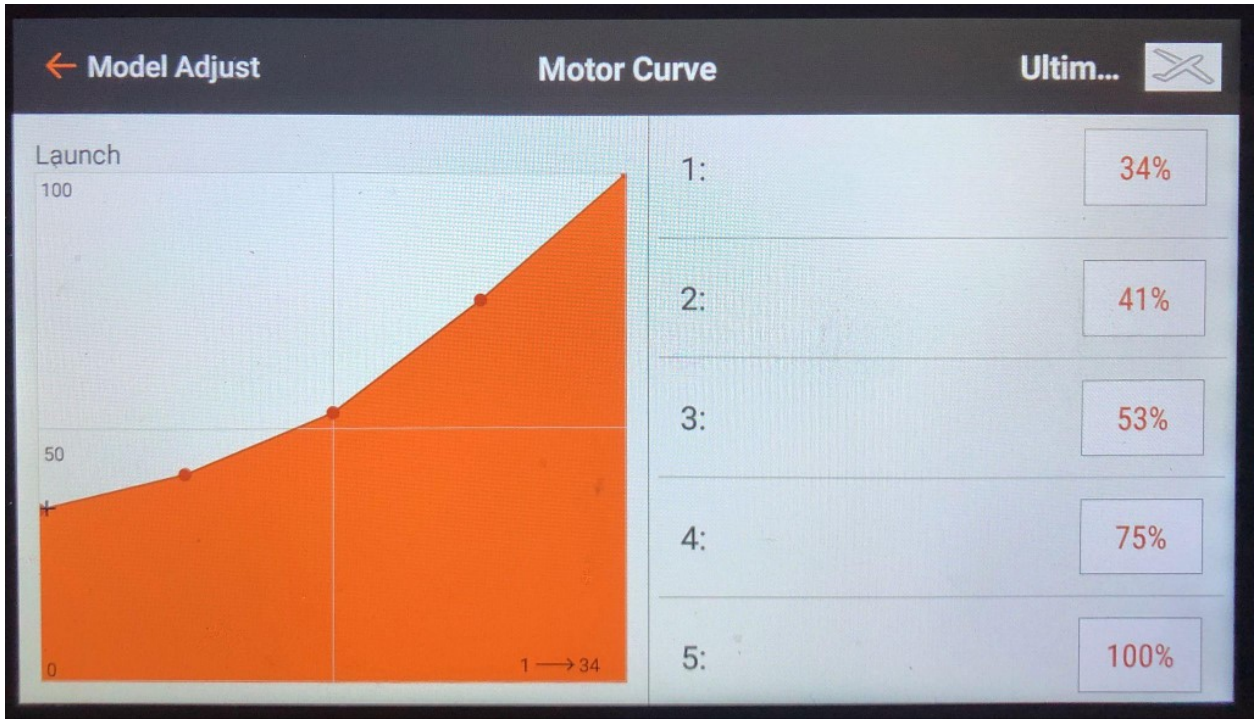
The screenshot above shows the monitor for the throttle (on the far right) in Launch mode at the lowest throttle setting. The percentage shown is -47%, which corresponds to 1310 µsec.



The screenshot above shows the monitor for the throttle (on the far right) in Launch mode at the highest throttle setting. The percentage shown is +87%, which corresponds to 1845 µsec.



This is my final throttle travel screen, which goes from -150% at the low end to +90% at the high end.



Finally, here is my final motor curve for this model. Note the x-values for points 1-5 are 0%, 25%, 50%, 75%, and 100%.

Acknowledgements:

I want to thank Jim McCarthy, Gary Ogilvie, Charles Thomas, and Ron Kukral for their assistance preparing this article and for the many “best-practices” discussions we’ve had about motor setup and AMRT troubleshooting. Hopefully this document will contribute to a “rising tide” that helps everyone get the most out of their F5J sailplanes.

References:

The basic document from Castle that references the technique to set fixed-endpoints is here. Note it is for helicopters and doesn’t deal with AMRTs at all.

Here is a Castle Quick Tip video on how to calibrate end-points.
Here is another video showing how to calibrate a high-power Castle Phoenix Edge ESC.
Here is a video comparing auto calibration versus fixed-endpoint calibration.
Here is the user’s guide for the Castle Phoenix Edge series of ESC’s.

Please feel free to report any errors. Thanks!

Ed Dumas
937 W Outer Drive
Oak Ridge, TN 37830
ed@eddumas.com