Useful Control Nuances With The FlySky-I6

There are FS-I6 features which may be useful nuances for some and nuisances for others. These features are derivative of FlySky's fixed-wing and helicopter control heritage.

When one refers to the manual to understand and/or set them up this aeronautical heritage doesn't translate readily to sailboats. This paper is neither a recommendation for nor against these features/settings. It is intended to be an aid in understanding their potentially significant if somewhat obscured benefits and instructions.

There are three features which can be helpful to RC sail racers. They can also introduce new complexities which may not be worth the effort/experimentation to set them up, but trying them may be worthwhile.

- DUAL RATE – rudder tuning to reduce over-steer when sailing downwind
- EXPO – rudder tuning to reduce rudder drag and braking effect
- THROTTLE CURVE – sail trim function helpful with knockdown recovery and avoiding "in irons" situations.

SWITCHES

Since DUAL RATE and EXPO are rudder tuners, I assigned them to SWITCH D on my controller which is on the right side near the rudder control. Likewise, since THROTTLE CURVE is a sail trim adjuster, I assigned it to SWITCH A.

Figure 1: FlySky-I6

DUAL RATE

Why? DUAL RATE can reduce the adverse effects of over-steering down-wind by <u>reducing the deflection of the rudder</u> by a percentage <u>you set ahead of time</u> and select/deselect while racing using Switch D.

Total rudder throw is set by Channel 1 End Point Adjustment – whatever those end points are, they are the <u>100%</u> rudder throw referenced in DUAL RATE settings. You cannot set multiple end-points per channel. I have used port 30°-starboard 30° as 100%. A bit of "SUBTRIM" may be required to center the rudder before setting the END POINTS.

There are two settings in DUAL RATE, "NORMAL & SPORT." You cannot change the naming convention. For NORMAL, I used 100%. For SPORT I used 80%, for a reduced rudder throw of P&S 24°.   This is a good place to start experimenting with the percentage that feels best to you. It will be affected by sailing conditions so race day adjustments might be necessary. When you are done setting this up, go to the "SWITCHES ASSIGN" menu entry and make sure you have properly assigned your chosen switch and verify its function by flipping it.

As you sail with DUAL RATE engaged you should be able to see a difference in boat tracking down-wind with less tendency to corkscrew and snap-jibe due to over-control, however too much rate reduction can leave the boat feeling unresponsive.

EXPO

Why? The controller is factory programmed to provide *rotational control signals in response to rotational stick input as slowly or speedily as you can move the stick*. This isn't inherently bad, but it can increase rudder drag, which is slow, and

can variably decrease turning force which is inefficient. This rotational pairing translates to linear paring when the push rod is considered.

There are two main forms of rudder drag. "Form Drag" derives from the shape of the rudder. It is designed in, and you can't change it. Theoretically, it affects everyone in a one design fleet in the same way and to the same degree *on average*.
"Flow Separation Drag" on the other hand is a result of how abruptly and how much one adjusts the rudder when turning – fast rudder movements and/or large adjustments can cause flow separation (known as the *Coanda Effect*) which has the same impact of towing a drogue. Less rudder applied more slowly means a faster boat.
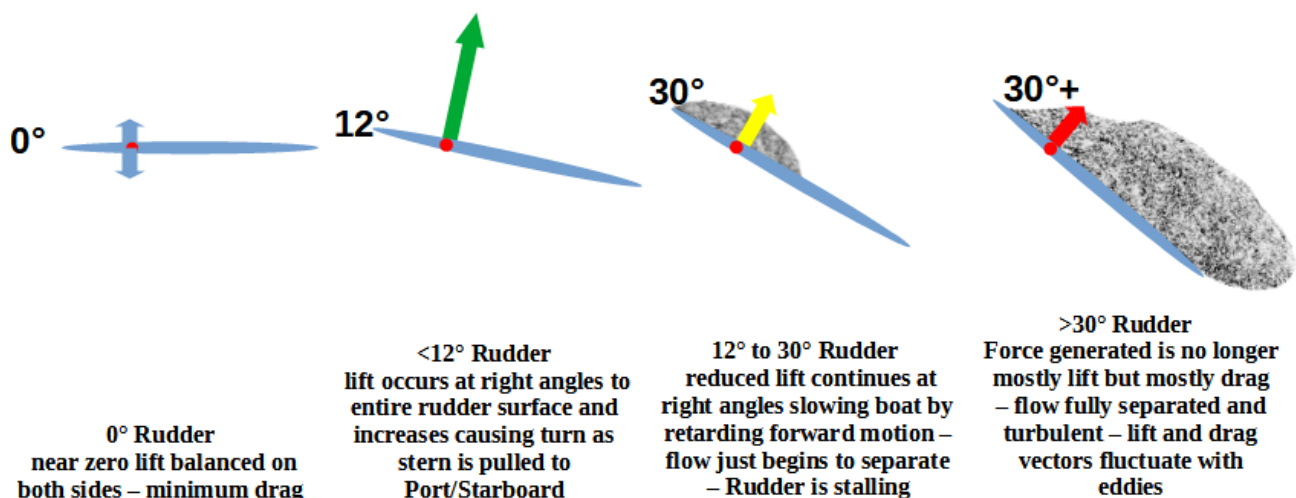
| 0° Rudder near zero lift balanced on both sides – minimum drag | <12° Rudder lift occurs at right angles to entire rudder surface and increases causing turn as stern is pulled to Port/Starboard | 12° to 30° Rudder reduced lift continues at right angles slowing boat by retarding forward motion – flow just begins to separate – Rudder is stalling | >30° Rudder Force generated is no longer mostly lift but mostly drag – flow fully separated and turbulent – lift and drag vectors fluctuate with eddies |

Figure 2: Lift, Drag and Turbulence as a Function of Angle of Attack

EXPO changes the amount of rudder motion relative to stick motion. In DUAL RATE NORMAL mode with EXPO = 0% (blue line in graphic), each 5° of stick motion left or right of center causes 5° of rudder deflection with an END POINT set for 30° right rudder throw.

In DUAL RATE NORMAL mode with EXPO = -100% the first 5° of stick motion from center causes only 1.5° rudder deflection. The last 5° of stick motion delivers 15° of rudder deflection. The rudder deflection curve (orange line to right) is adjustable by changing the percentage of EXPO (-100% to + 100%). However, the graphic shown on your controller screen is notional, not specific – it shows "more" and "less" and a general curve for how it is applied to rudder control. The graphics in this paper were prepared from data from a test stand that could increment stick inputs by 1° to 30° and deliver similar 1° rudder outputs +/- 1°.
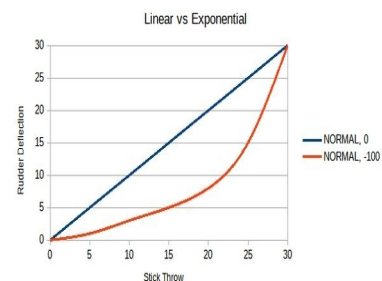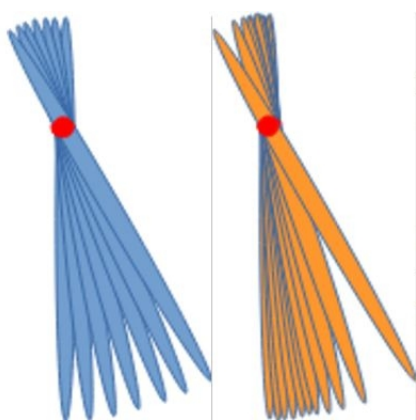
Figure 3: Linear vs Exponential

This gradually increased application of rudder deflection reduces separation drag especially in tacking at low hull-speeds. As the boat stern moves in the desired direction, the flow across the rudder is kept attached and remains efficient.

One can apply EXPO separately and differently to both the DUAL RATE NORMAL and SPORT settings. The general recommendation is to start with -30% EXPO and find your higher or lower preference through experimenting. Just keep in mind with too much negative EXPO it will feel like your rudder control has gone dead in the center of its range. For the purposes described above *Positive EXPO, in sailboat applications, will aggravate separation drag.*

Figure 4: Difference in Linear vs Exponential Rudder Position

Keep in mind, excessive angle of attack – more than12° and aggressive rudder movement at any angle of attack can lead to flow separation and associated drag.

- With rudder throw set at 30° Port and Starboard
- With RATE NORMAL = 100% & 0% EXPO, 12° angle of attack is achieved with 40% stick.
- With RATE NORMAL = 100% & -50% EXPO, 12° is achieved with 70% stick.
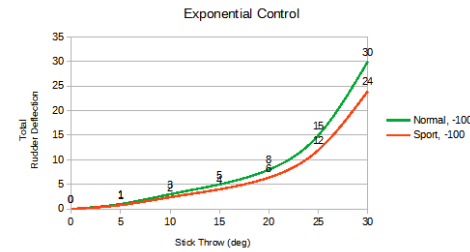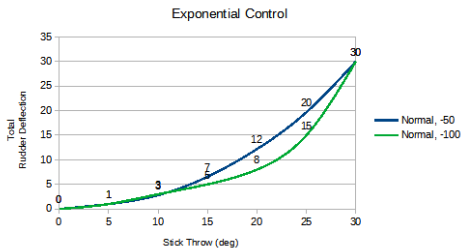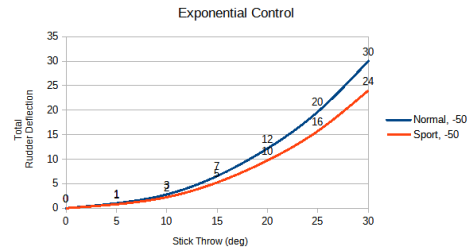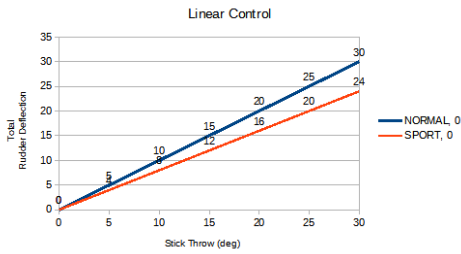
THROTTLE CURVE

Throttle?!? To the extent sails are our motors, sheets are our throttles. "NORMAL" on this setting will give the full range of sheeting controlled by end points. The factory programming is linear as shown in the controller's on-screen graphic (L = 0%, 1 = 25%, 2 =50%, 3 = 75%, H = 100%).
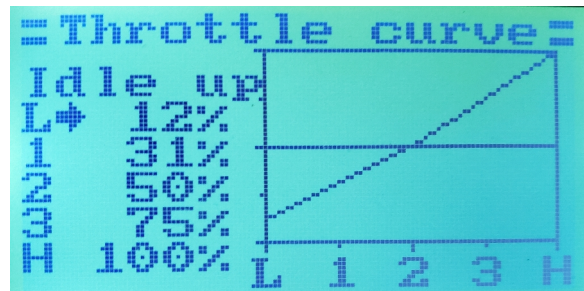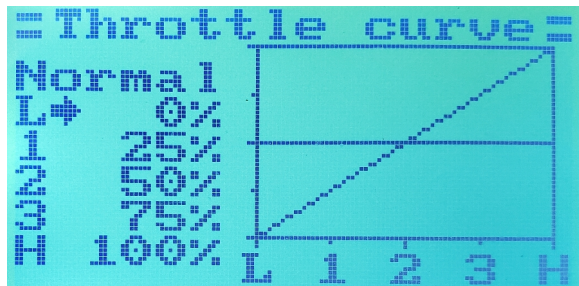
Changing the shape of this throttle curve changes the sheet response. Drastic reshaping of these curves is not the goal here. What we are trying to do is enable a very quick release of the sheets to change the pressure on the sails or the wind drag ahead of the mast and a smooth transition back to linear control.

First, THROTTLE CURVE has two settings, "NORMAL" and "IDLE UP." You cannot change the naming convention. Leaving the setting at NORMAL without response curve adjustment will provide linear sheeting in and out as set by Channel 3 END POINTS.

Selecting and setting "IDLE UP" to 6%-12% at the "L" position (where the factory setting is 0%) will cause the sheet to be *instantly* eased ~8-15mm when SWITCH A is flipped from NORMAL. If your boat has been knocked down and is not righting quickly, flipping SWITCH A will allow it to come back up more quickly and the (neutral) rudder will start to take hold sooner. As soon as the boat rights, flipping back to NORMAL will recover the eased sheets and return to linear sail control. This is because easing the sheet even a small amount helps breaks the surface tension between the water and sails

Incidentally, this same IDLE UP usage will allow one to move quickly between Pointing and Footing when going to windward in a shifty breeze.

Likewise, with this same arrangement, if IDLE UP is selected with SWITCH A <u>going into an off-speed</u> tack, the eased jib will increase the wind drag in the fore-triangle and will swing the bow away from the wind more reliably. As soon as the bow is past the eye of the wind, SWITCH A can be flipped back to NORMAL and the boat will quickly sheet for close hauled. This may require more than 6%-12% at L and it may be desirable to smooth the transition with settings such as L = 12%, 1 = 31%, 2 =50% – or whatever combination smooths the curve between the value selected at L and 2 = 50%. (With 1 = average of L value & 2 = 50%.) Keep in mind that actions selected with SWITCH A occur at full servo speed.

THE SETUP MENU FOR EACH OF THE ABOVE:

DUAL RATE

- With MODEL SELECTED in SYSTEM >> Press and hold CANCEL for acceptance tone
- On MENU screen go to UP to SETUP
- Use OK to go to FUNCTIONS
- Use DOWN(x5) to go to DUAL RATE/EXP use OK to accept
- In Dual Rate/exp NORMAL screen, Flip SWITCH D toward you to show the SPORT screen
- Use OK to move down to RATE
- Then use UP or DOWN to adjust the RATE value
- Flip SWITCH D back to NORMAL Screen
- Then use UP or DOWN to adjust the RATE value
- Press and hold CANCEL for acceptance tone

EXPO

- With MODEL SELECTED in SYSTEM >> Press and hold CANCEL for acceptance tone
- On MENU screen go to UP to SETUP
- Use OK to go to FUNCTIONS
- Use DOWN(x5) to go to DUAL RATE/EXP use OK to accept
- In Dual Rate/exp NORMAL screen, Flip SWITCH D toward you to show the SPORT screen
- Use OK(x2) to move down to EXP
- Then use UP or DOWN to adjust the EXP value
- Flip SWITCH D back to NORMAL Screen
- Then use UP or DOWN to adjust the EXP value
- Press and hold CANCEL for acceptance tone

THROTTLE CURVE

- With MODEL SELECTED in SYSTEM >> Press and hold CANCEL for acceptance tone
- On MENU screen go to UP to SETUP
- Use OK to go to FUNCTIONS
- Use DOWN(x6) to go to THROTTLE CURVE use OK to accept
- Select using OK – leave NORMAL Screen as is (L = 0%, 1 = 25%, 2 =50%, 3 = 75%, H = 100%)
- Flip SWITCH A to IDLE UP screen

- Use OK to get to "L" use UP or DOWN to set "L" at between 6% to 12%
- [Or, L = 12%, 1 = 31%, 2 =50%, 3 = 75%, H = 100%]
- Flip SWITCH A back to NORMAL
- Press and hold CANCEL for acceptance tone