

Aero 101 for R/C Pilots Part 3: *Programming your Transmitter to make the Airplane Easier and More Enjoyable to Fly*

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November 15, 2018



Common Questions from RC Pilots

Part 1 (June 2017)

Before takeoff

- Will this plane be stable?

Takeoff

- How does the prop affect the airplane?
- Do I need right thrust?
- Wind
- Is the “downwind turn” a myth?

Cruise

- How to fine-tune the cg
- Do I need down thrust?

General Handling

- Plane snaps out of a tight turn
- Does dihedral help or hinder me?
- Won't respond to aileron when slow
- Unstable or too sensitive?

Part 2 (Feb 2018)

Approach

- How can I slow down safely?
- Should I re-trim for approach?
- Use elevator or thrust?
- What will flaps do?

Judge what a new plane will be like

- Wing Loading and stall speed
- Power loading
- Aspect Ratio
- Servo size

Part 3

- Programming your Transmitter to make the Airplane Easier and More Enjoyable to Fly

Better Handling Qualities and More Fun

- End points, rates and expo
- Unstable or too sensitive?
- Using mixes
- Aileron to rudder mix
- Knife-edge mix
- Flap-elevator functions
- Elevator to flap mix
- Ailerons as Flaperons
- Flaps as Flaperons
- Reflexed ailerons
- Crow (Airbrake)
- Throttle to Elevator mix
- Flight Modes (Conditions)
- Throttle cut on a knob
- Engine ignition or motor kill switches
- Differential thrust for Multi-engine
- Logical switches
- A VTOL concept

This presentation uses
Spektrum DX18 & Futaba T14SG
But general principles apply to any radio



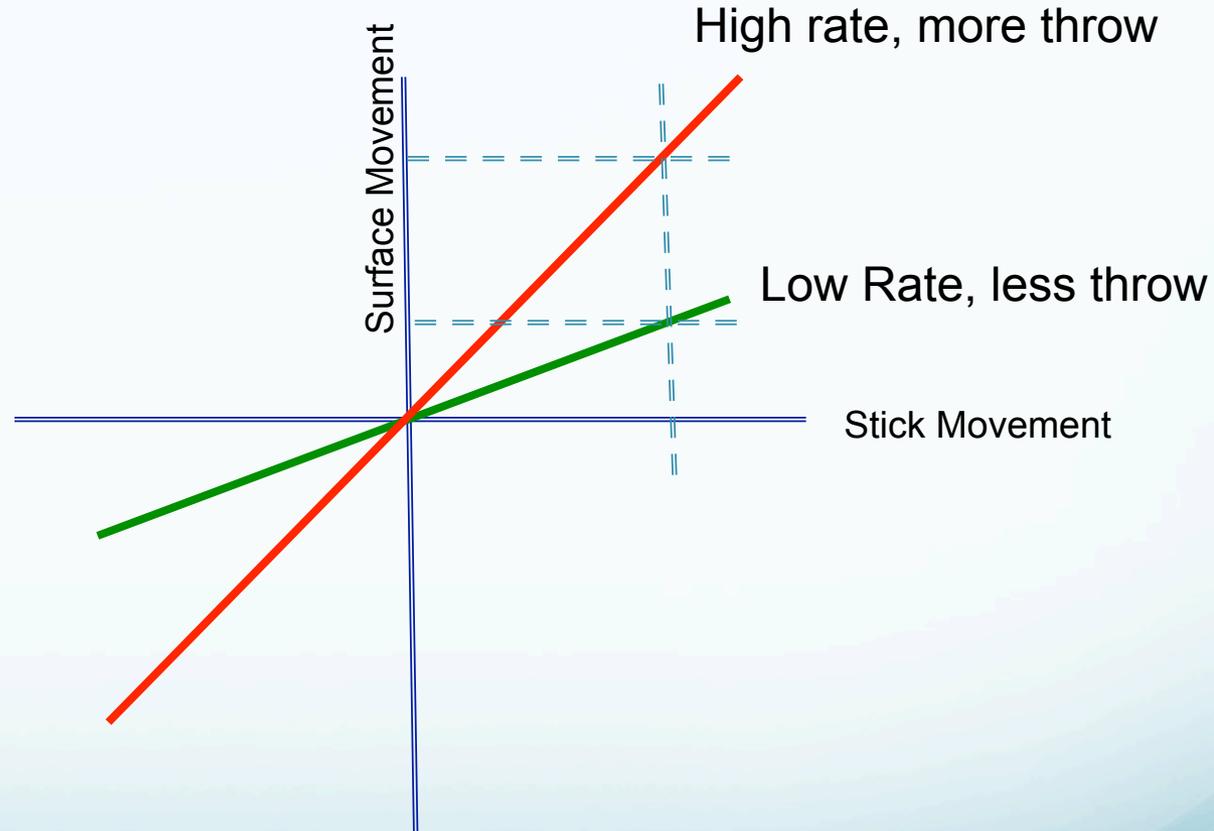
Be Careful!!

When trying any new mix, rate, or Expo, you are a TEST PILOT.

- Do a thorough control check before taking off
- Enable new functions with a switch
- Turn them on for the first time at a safe altitude and moderate speed
- Evaluate flight characteristics (e.g. stalls, steep turns, etc.) at a safe altitude

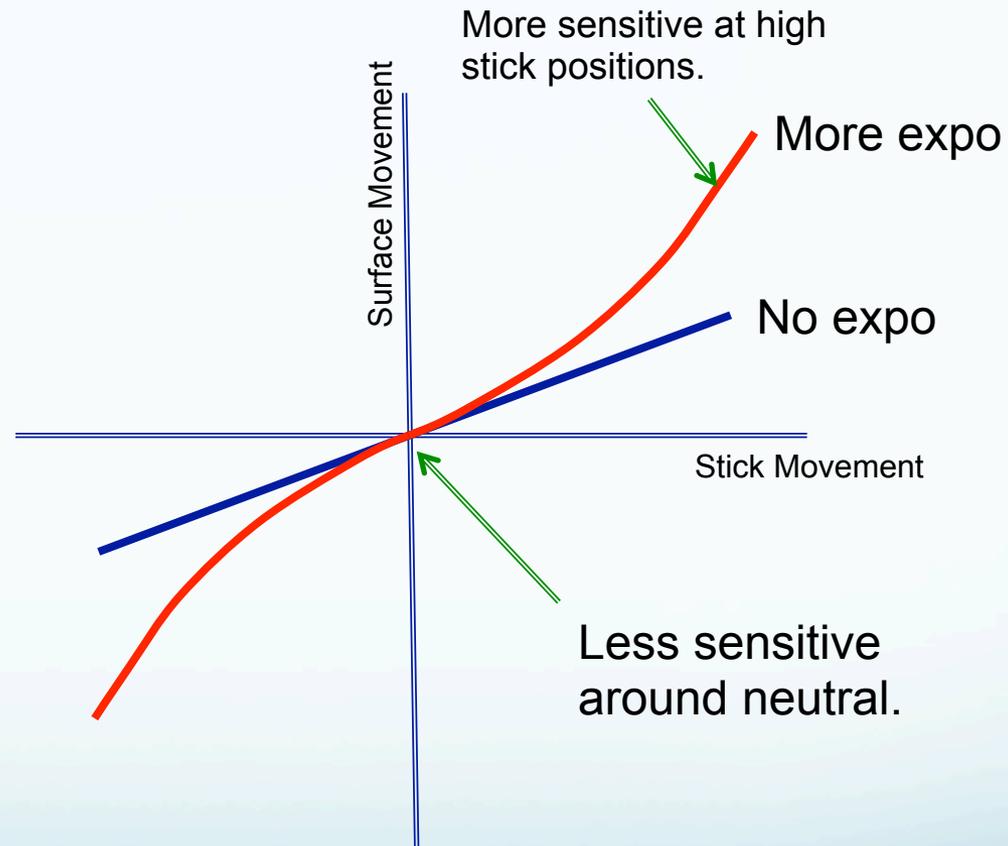
Control Throw & Dual Rates

- Higher **slope** means more **sensitive**, i.e. more surface motion for same stick motion
- Plane may be hard to control if rate (throw) is too high
- Pilot might mistakenly believe the airplane is “**unstable**”



EXPO is a way to get lower slope around neutral while keeping high control surface throw

- Positive % is “good” expo on Spektrum
- Negative % is “good” expo on Futaba
- 0-30% typical for sport planes
- 50% or more often used for 3D planes

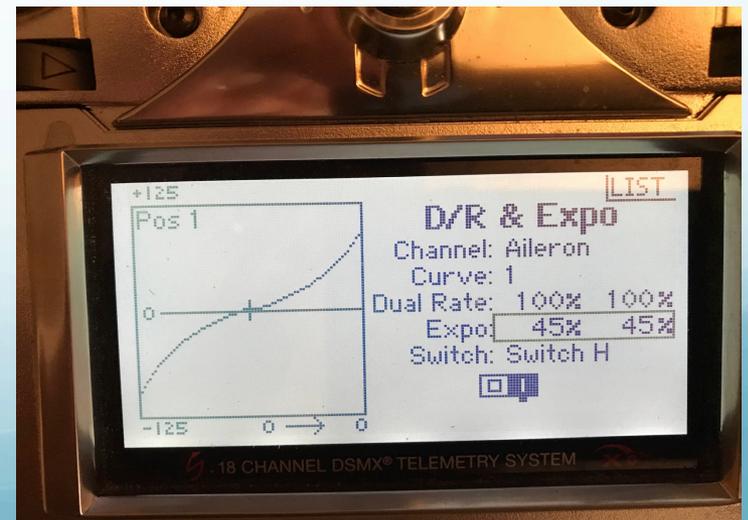
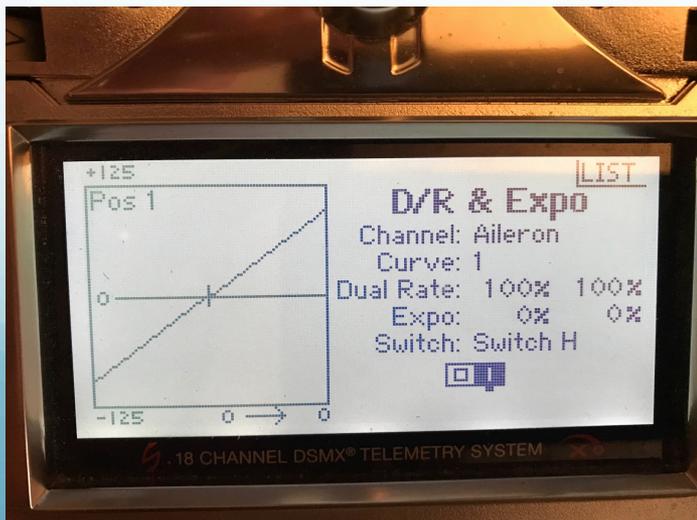
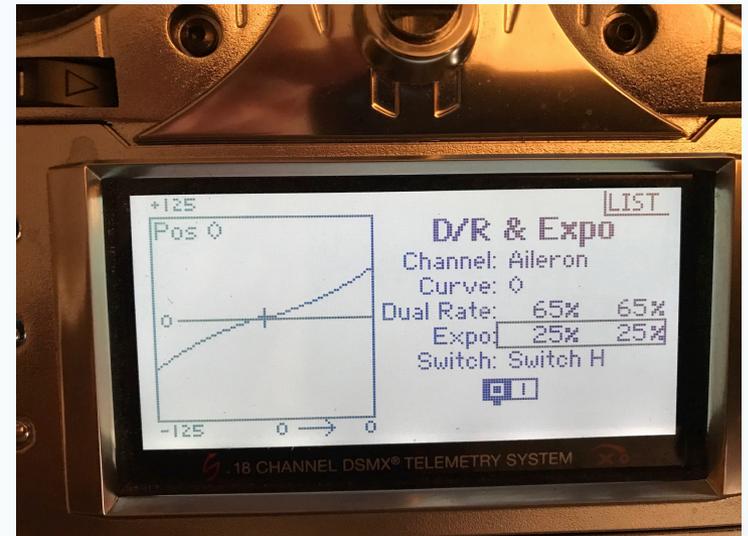
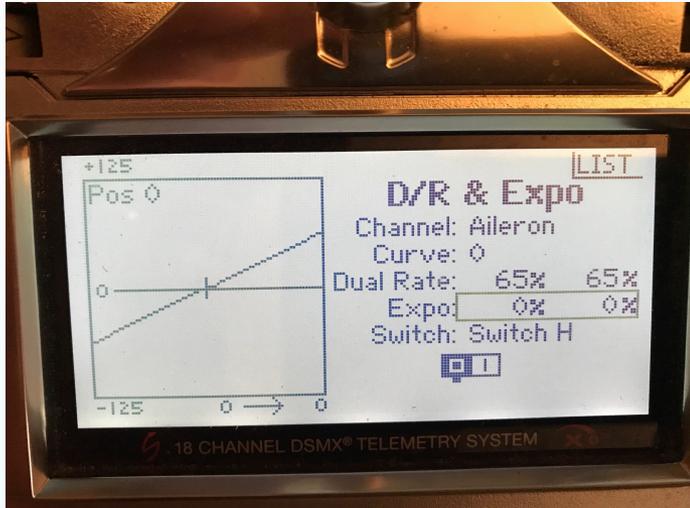


- Too Much expo can cause control to change suddenly above half stick.
- For example, too much expo could make flaring for landing more difficult

Spektrum

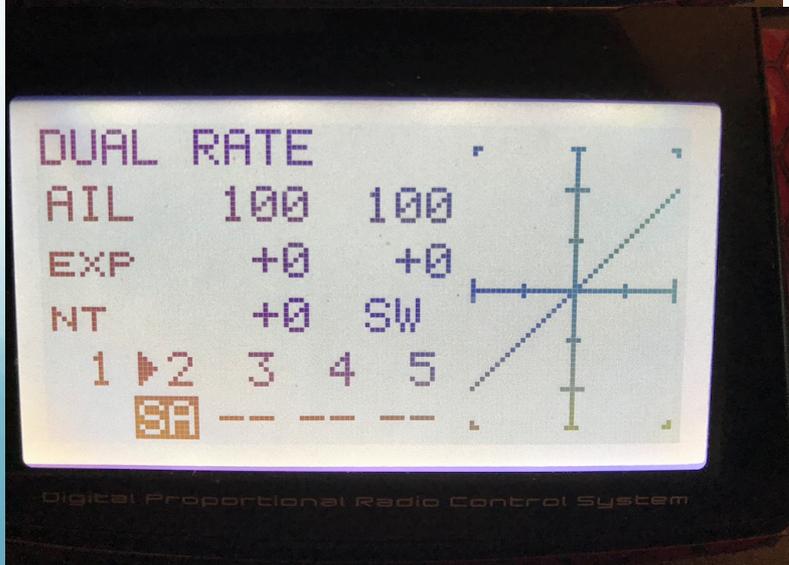
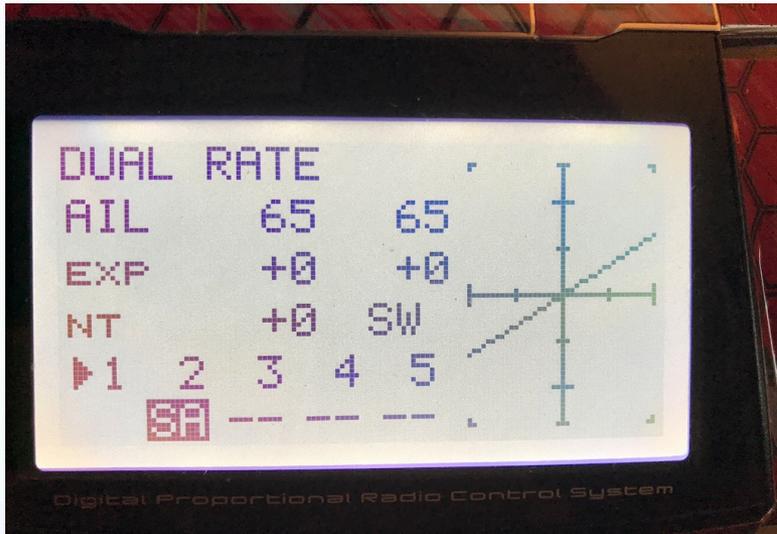
Dual Rates

Dual Rates and Expo

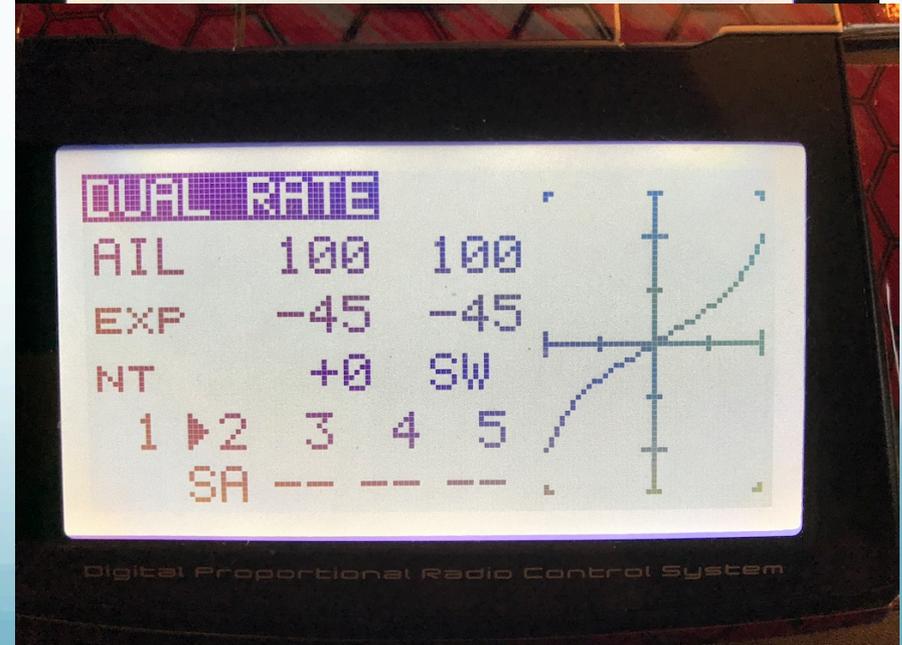
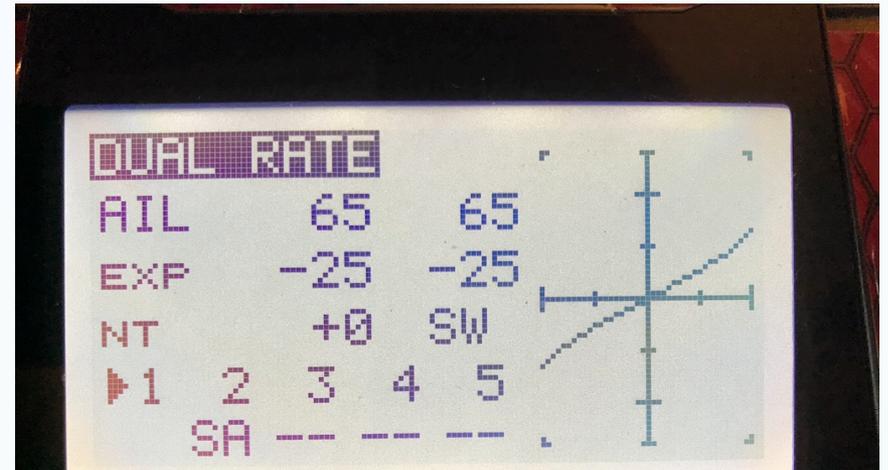


Futaba

Dual Rates



Dual Rates and Expo



“My plane is hard to control in Roll.”

Is it Unstable or Too Sensitive?

- Most likely “*too sensitive*”
 - Reduce throws
 - Try EXPO
 - Or try an airplane with high wing or more dihedral
- Roll:
 - Not likely to be “*unstable*” in roll unless wing has anhedral or forward sweep. (F-104 is an exception. See Aero 101 part 2.)
- Yaw:
 - Not likely to be “*unstable*” in yaw unless fin and rudder way too small, tail too short, or CG much too far aft.

Review: Pitch Stability Dive Test

- Trim for mid to low power
- Fly high and level
- Nose down about 45°
- Hands off controls
- Let airplane accelerate
- Observe pitch

Nose Heavy plane
itches **UP!**

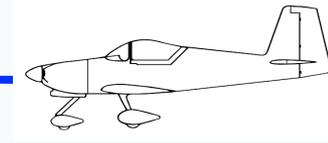
- “***speed stable***”

Neutral
(for aerobatics)

Tail Heavy plane itches **DOWN!**

- Not speed stable
- Difficult to fly on approach

Speed increases



Trim speed

Another way:

<http://www.flyrc.com/aerobatic-trimming/>

“My plane is hard to control in Pitch.”

Is it Unstable or Too Sensitive?

- If not “speed stable”, move CG forward
- If “speed stable”, then elevator throw is too large, horizontal too small, and/or tail too short
- Solutions:
 - First, reduce elevator throw (experiment with dual rates)
 - Second, try EXPO.... Unless it's a 3D plane, then go for expo first
 - Remember, “good” expo is a negative number for Futaba radios
 - Last, try adding horizontal tail area or tail length

Using Mixes

- Mix: Input to one channel also affects another
 - Aileron > Rudder causes Aileron and Rudder to move when the Aileron stick is moved
- A mix can also cause a switch or knob to affect another channel
 - Knob > Throttle can be a throttle kill function using a knob instead of a switch

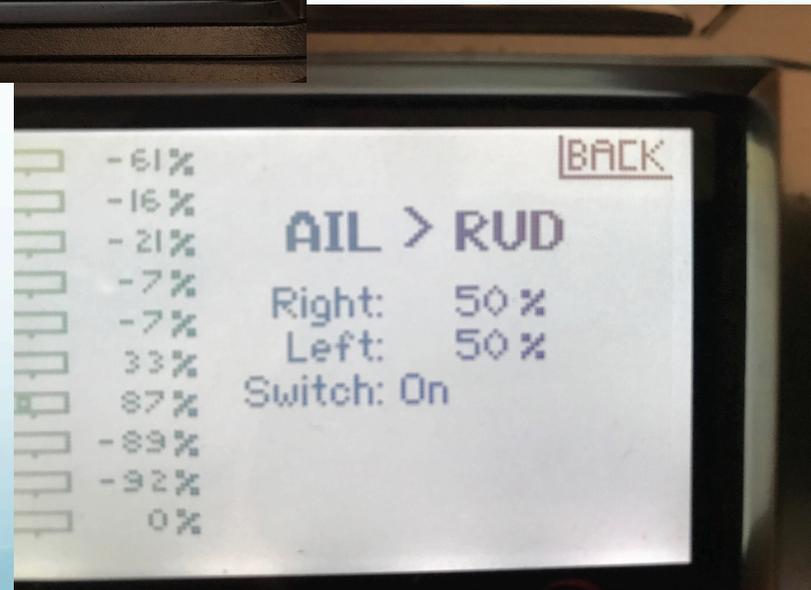
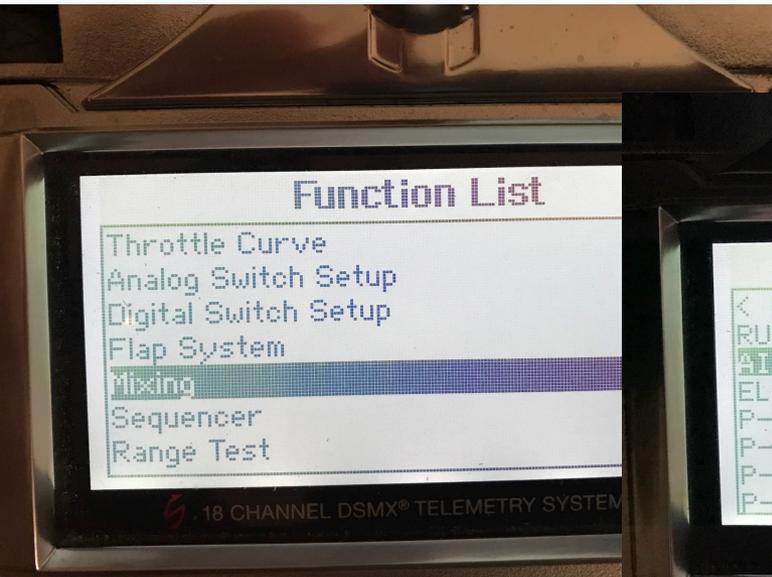
Switches to Control Mixes

- Mixes can be ON all the time or be turned ON or OFF with a switch
- One switch (like a Flap switch) can be used to control many mixes
 - Flaps
 - Drooped or reflexed ailerons
 - Aileron>Rudder
- Multiple mixes can be used to do things like differential throttles on a multi-engine airplane
- Mixes can be a straight percentage, or be programmed to work on a curve

Aileron to Rudder Mix

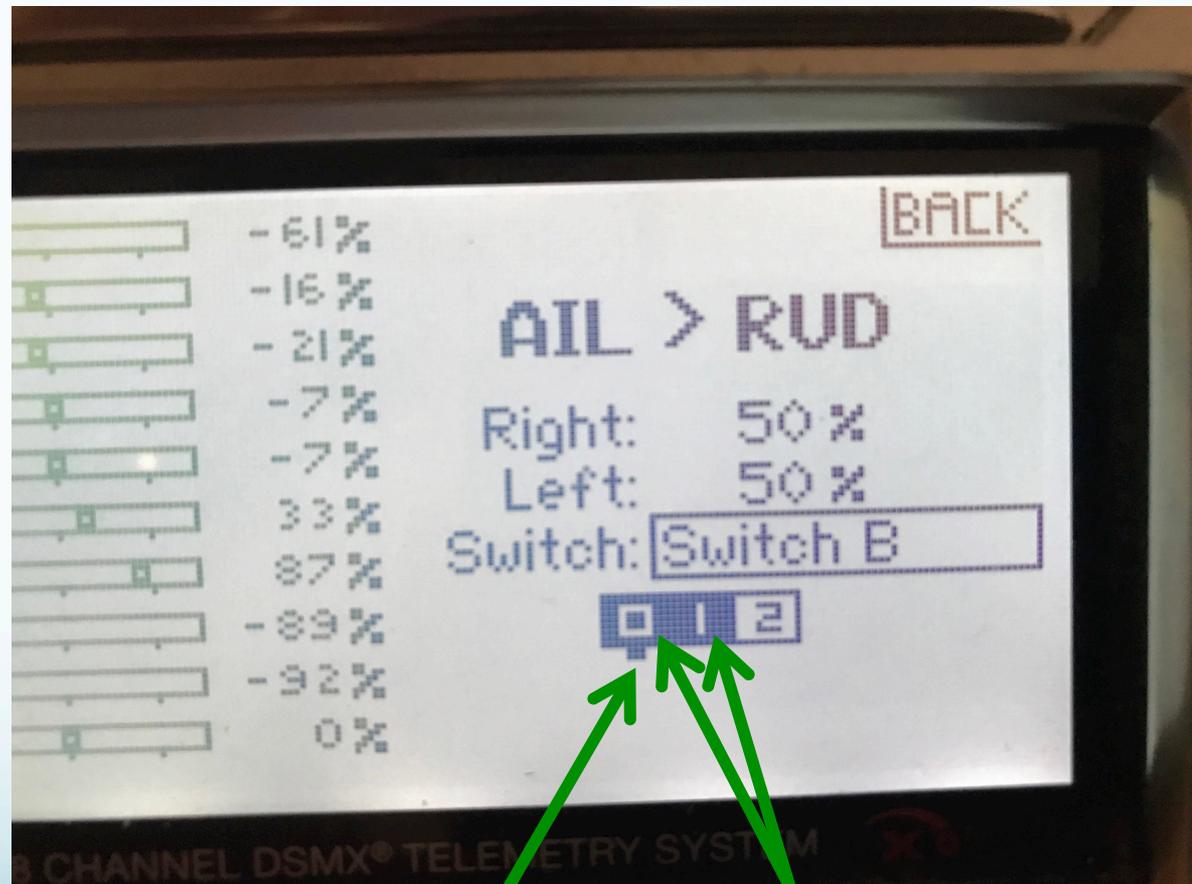
- About 50% works well with trainers.
 - Full aileron gives 50% rudder
- Smoother entry and exit for turns
- Improves poor roll effectiveness at low speeds
- A roll becomes a non-axial barrel roll with mix ON
- For airplanes that do not naturally do an axial roll, a slight “negative” mix, i.e. right aileron causing slight left rudder, can make rolls more axial

Aileron-Rudder Mix - Spektrum



Aileron Rudder Mix, only when flaps are down - Spektrum

B is also the Flap switch, so in this example, the mix only works when flaps are down, positions 0 and 1



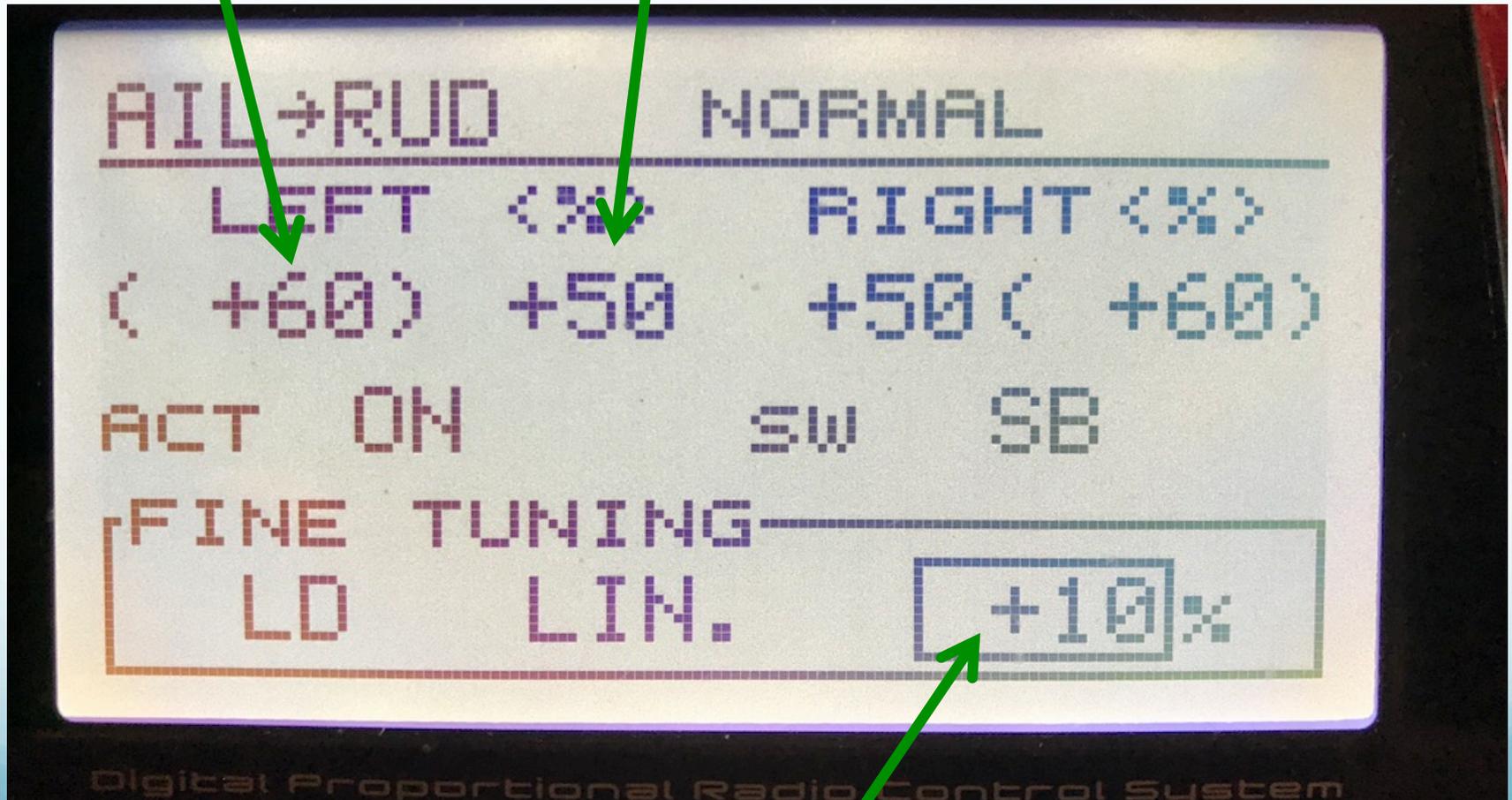
Current switch position

Mix active switch positions, in black

Aileron-Rudder Mix - Futaba

Actual Mix Value from
Fine Tuning

Programmed
Mix Value

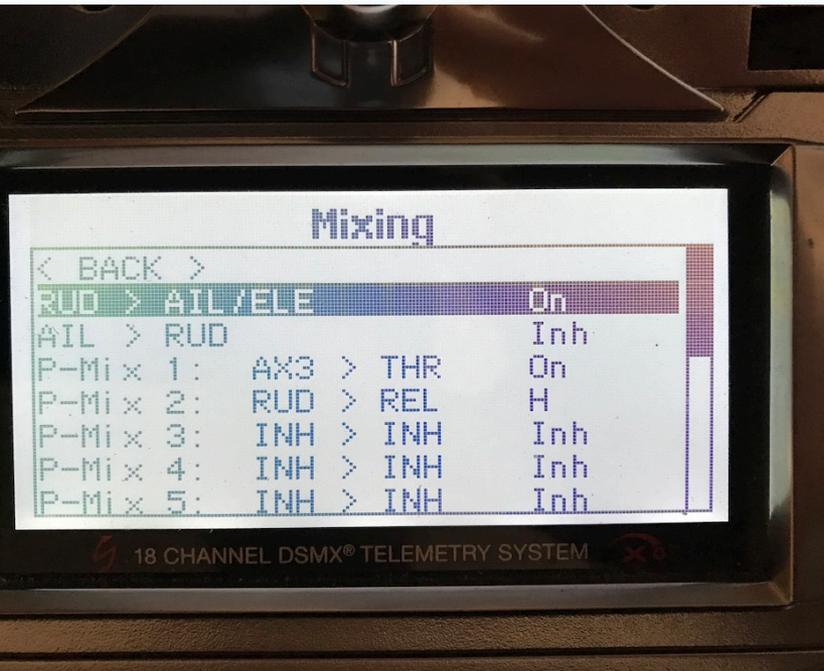


Fine Tuning Knob Authority

Knife-Edge Mixes

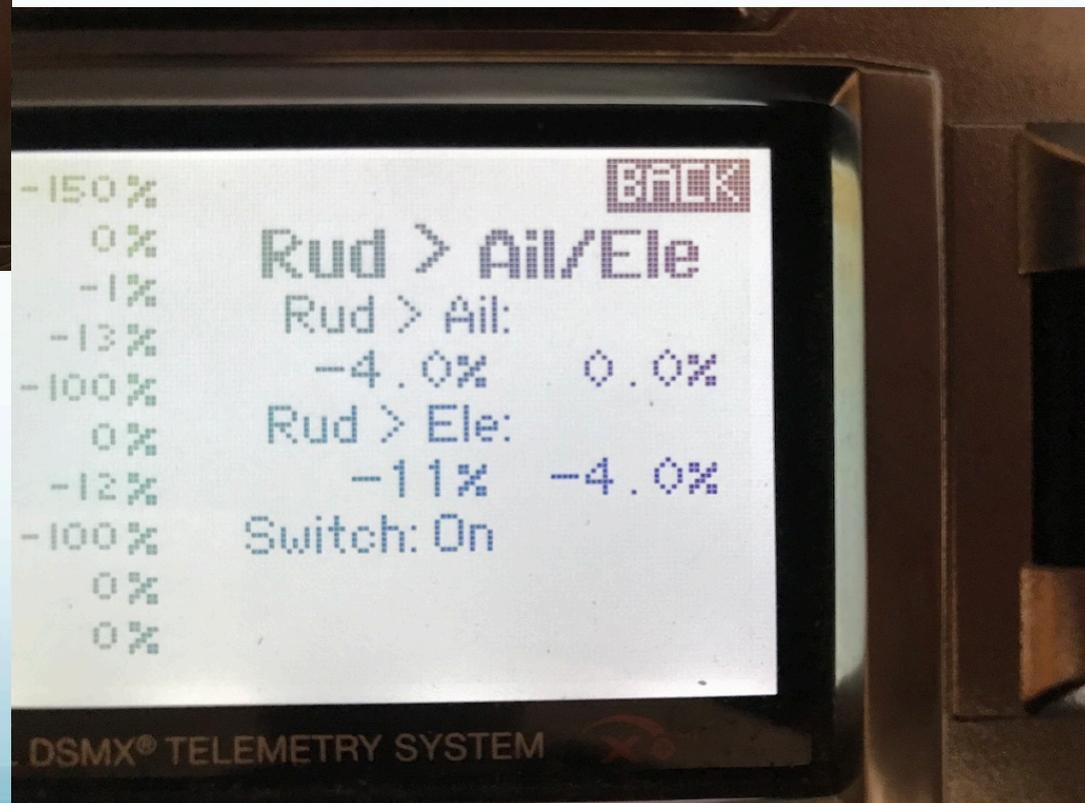
- Used to counter rolling and pitching tendencies with large rudder input
- $RUD > AIL$
- $RUD > ELE$

Knife Edge Mix - Spektrum

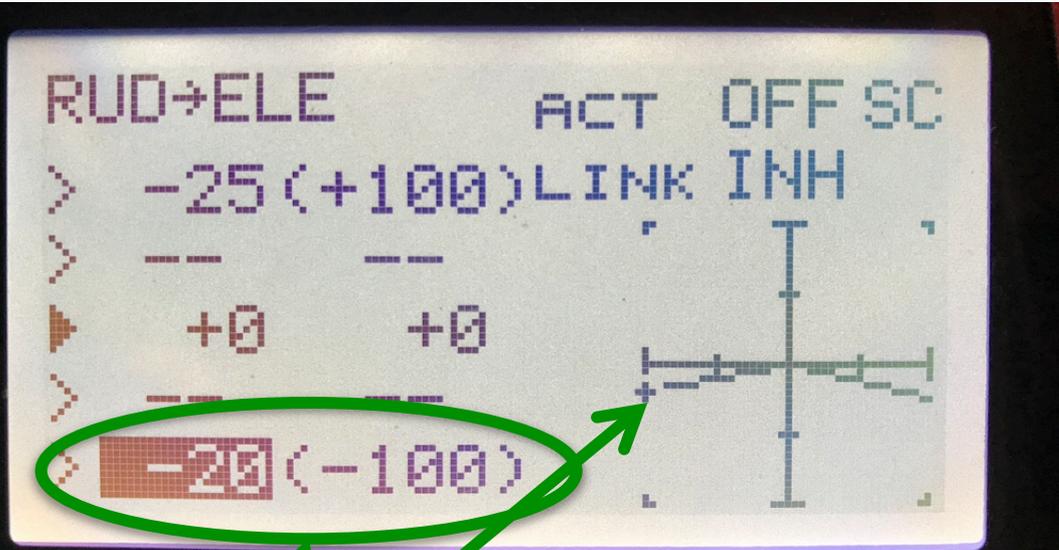


One mix pick does both
RUD > AIL
RUD > ELE

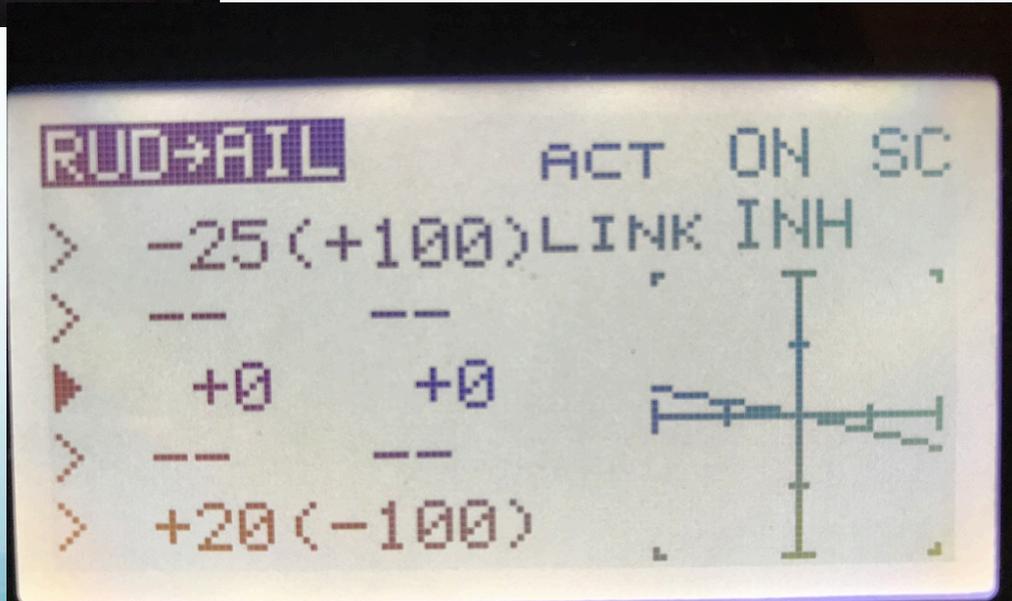
- Typically use small corrections
- Different corrections usually needed for left and right rudder inputs



Knife Edge Mix - Futaba



-20 Elevator throw
at -100 Rudder throw



Flap to Elevator Mix

- Gives elevator to cancel out unwanted pitch when flaps are down
- Flaps down usually results in pitch up
- 5 to 10 percent elevator down usually works
- Can be used with or without flaps to bias the elevator to give a trim state resulting in slower speed for approach and landing

Flap to Elevator - Spektrum

Function List

- Throttle Cut
- Throttle Curve
- Analog Switch Setup
- Digital Switch Setup
- Flap System
- Mixing
- Sequencer

18 CHANNEL DSMX® TELEMETRY SYSTEM

Channel	Value	Flap	Elev
1	-61%		
2	4%		
3	-21%		
4	-7%		
5	-8%	Pos 0	0%
6	12%	Pos 1	-7%
7	-15%	Pos 2	-10%
8	-89%		
9	11%		
10	0%		

Flap System

Flap Elev

Pos 0: 0%

Pos 1: 45%

Pos 2: 90%

Switch: Switch B

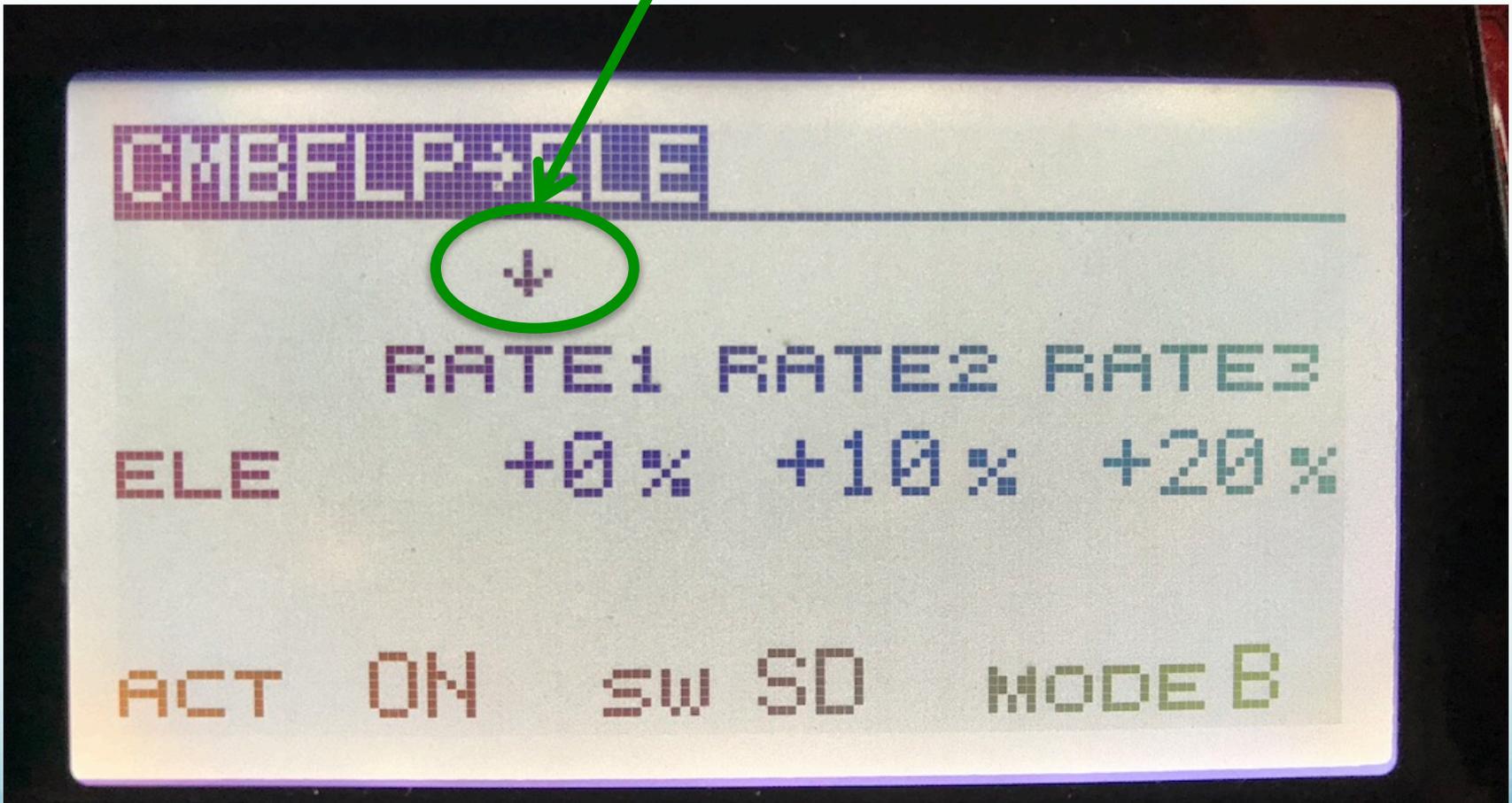
Speed: 2.0s

List

18 CHANNEL DSMX® TELEMETRY SYSTEM

Flap to Elevator - Futaba

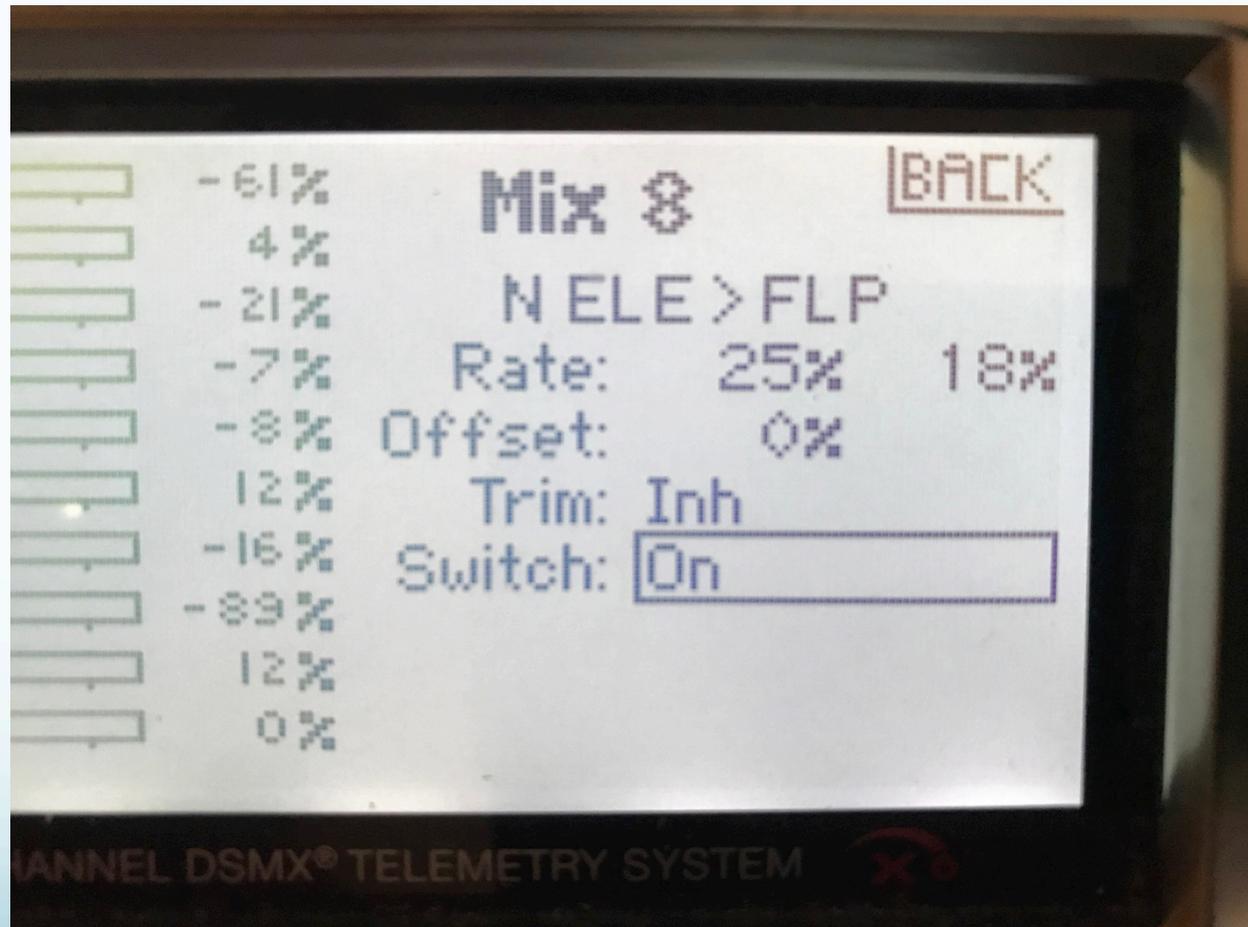
Indicates Flap switch or slider position



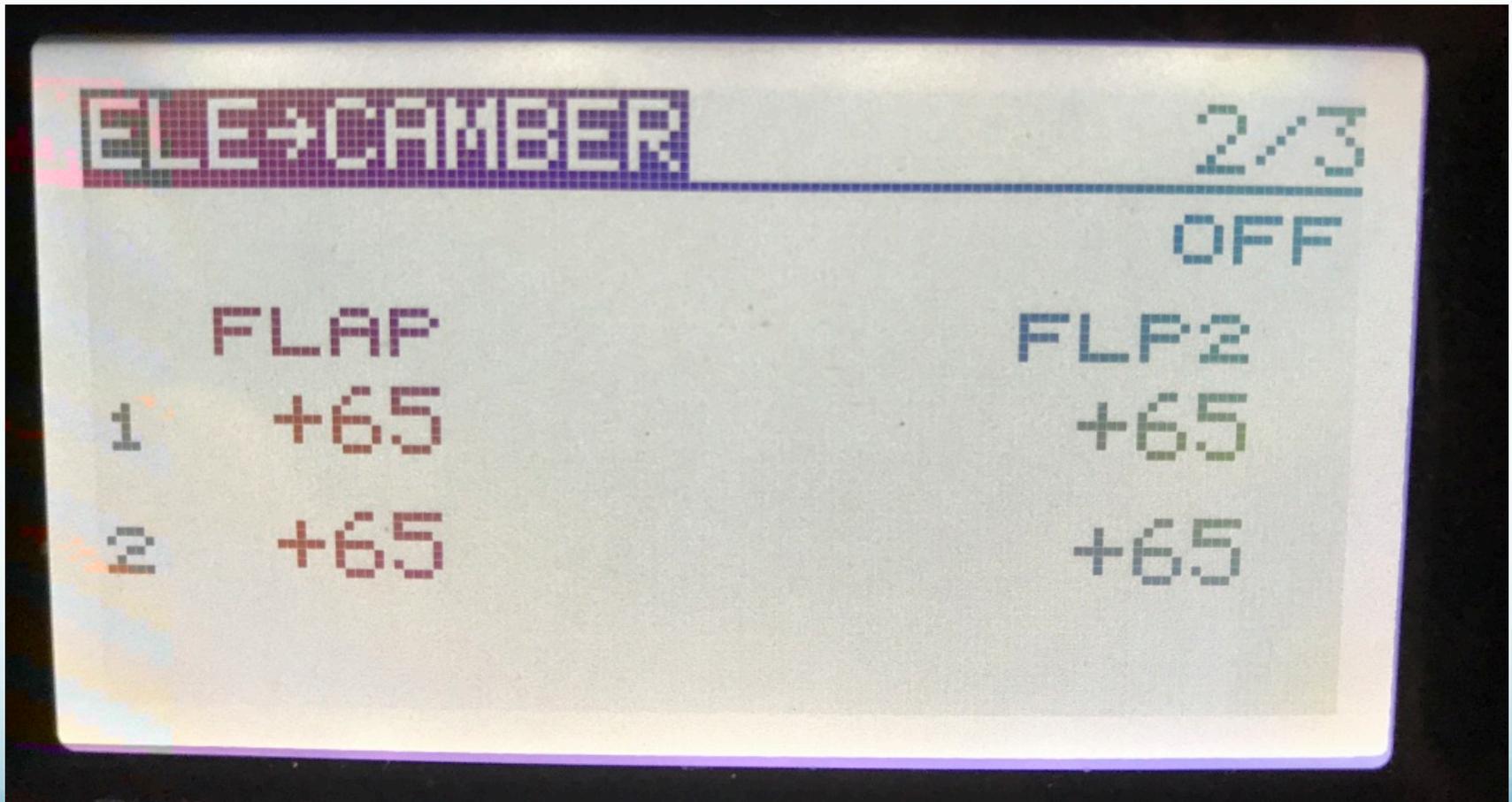
Elevator to Flap Mix

- Flaps DOWN with UP elevator makes for very sharp pitch maneuvers or tight turns
- Increases lift instantly, even before airplane pitches
- Old trick from control-line stunt airplanes
- Feels like a more sensitive elevator

Elevator to Flap Spektrum



Elevator to Flap Futaba

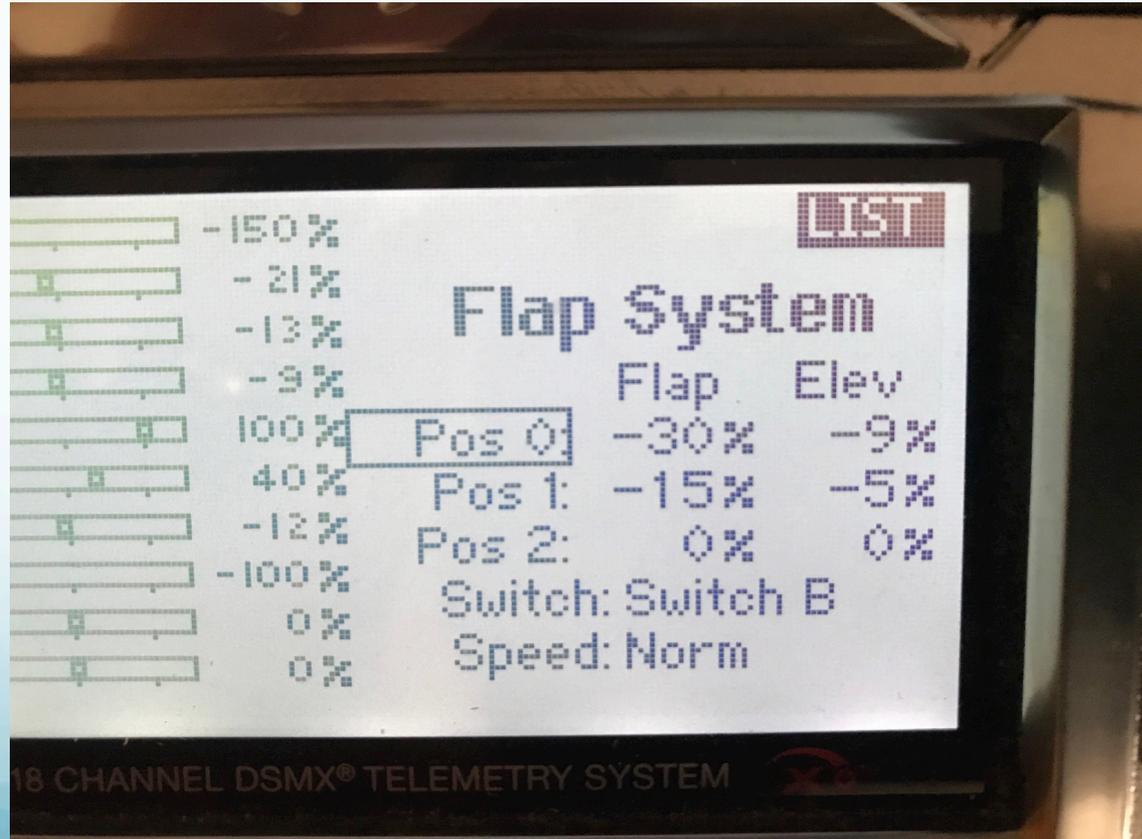
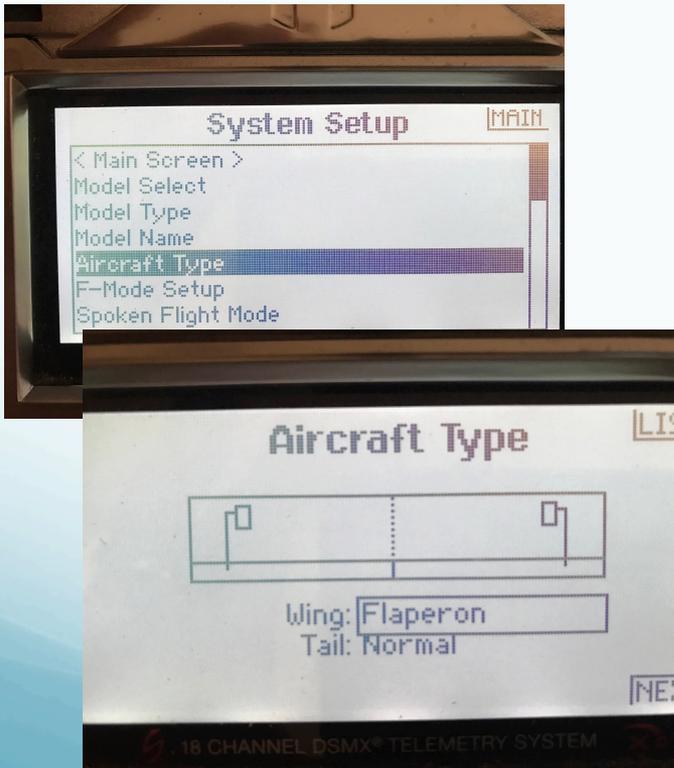


“Strip” Ailerons as Flaperons

- For full span “strip ailerons”
- Two-servo, two-aileron wing (without separate flaps)
- Both ailerons can be commanded to “droop”, making a kind of full-span flap
- Not recommended if ailerons are mostly outboard due to danger of tip stall

Ailerons as Flaperons - Spektrum

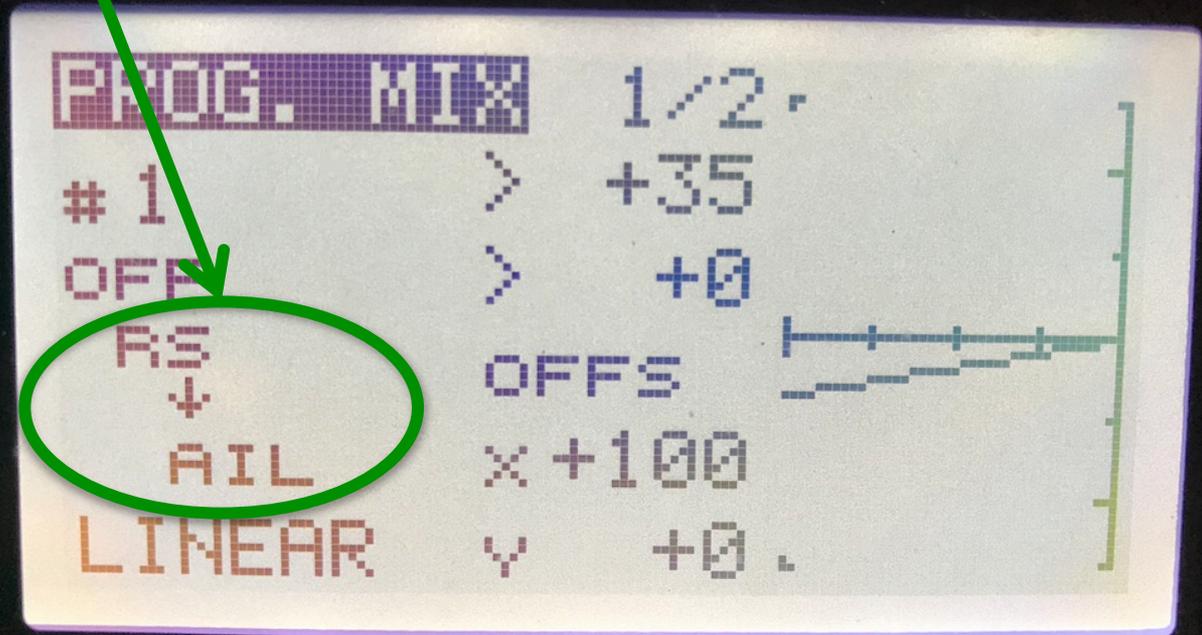
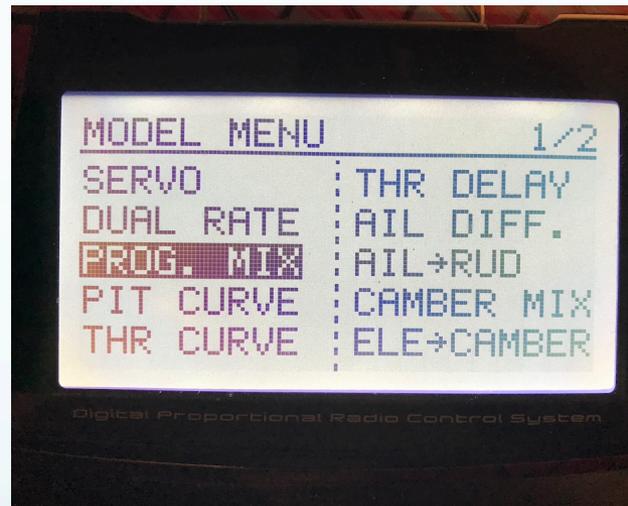
- In SYSTEM SETUP menu, under Aircraft Type, select FLAPERONS as a WING TYPE
- Set up flaperon throw and elevator compensation in Flap System menu



Ailerons as Flaperons - Futaba

Program Mix. Can be proportional on a slider

Right Slider > Aileron

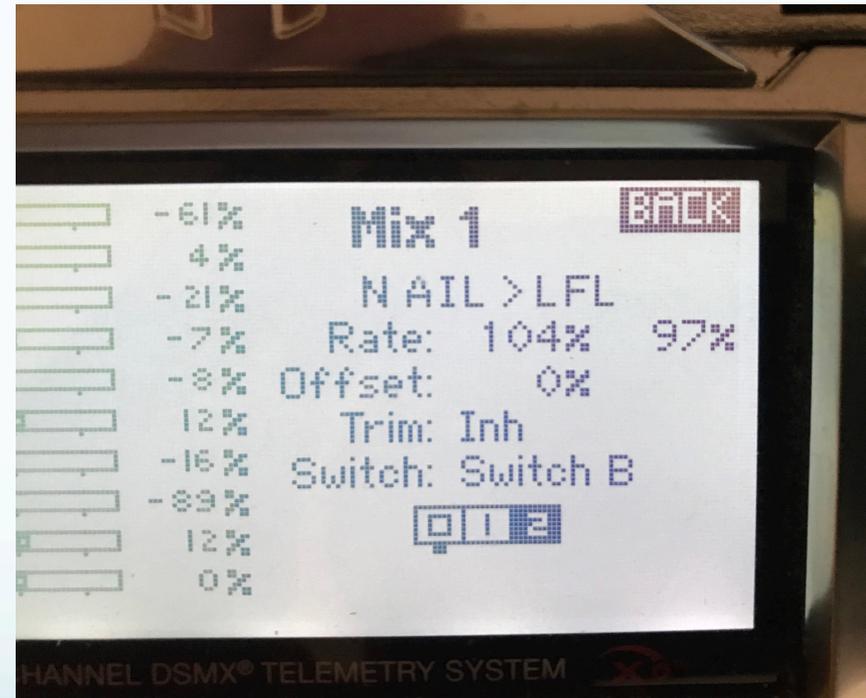


Flaps as Flaperons

- For a 2-aileron, 2-flap wing
- Flaps move with ailerons to increase roll rate
- Caution: Can actually *reduce* roll rate if used with large flap angles
 - Increased flap deflection may result in more flow separation, thus reducing lift and increasing drag on one side

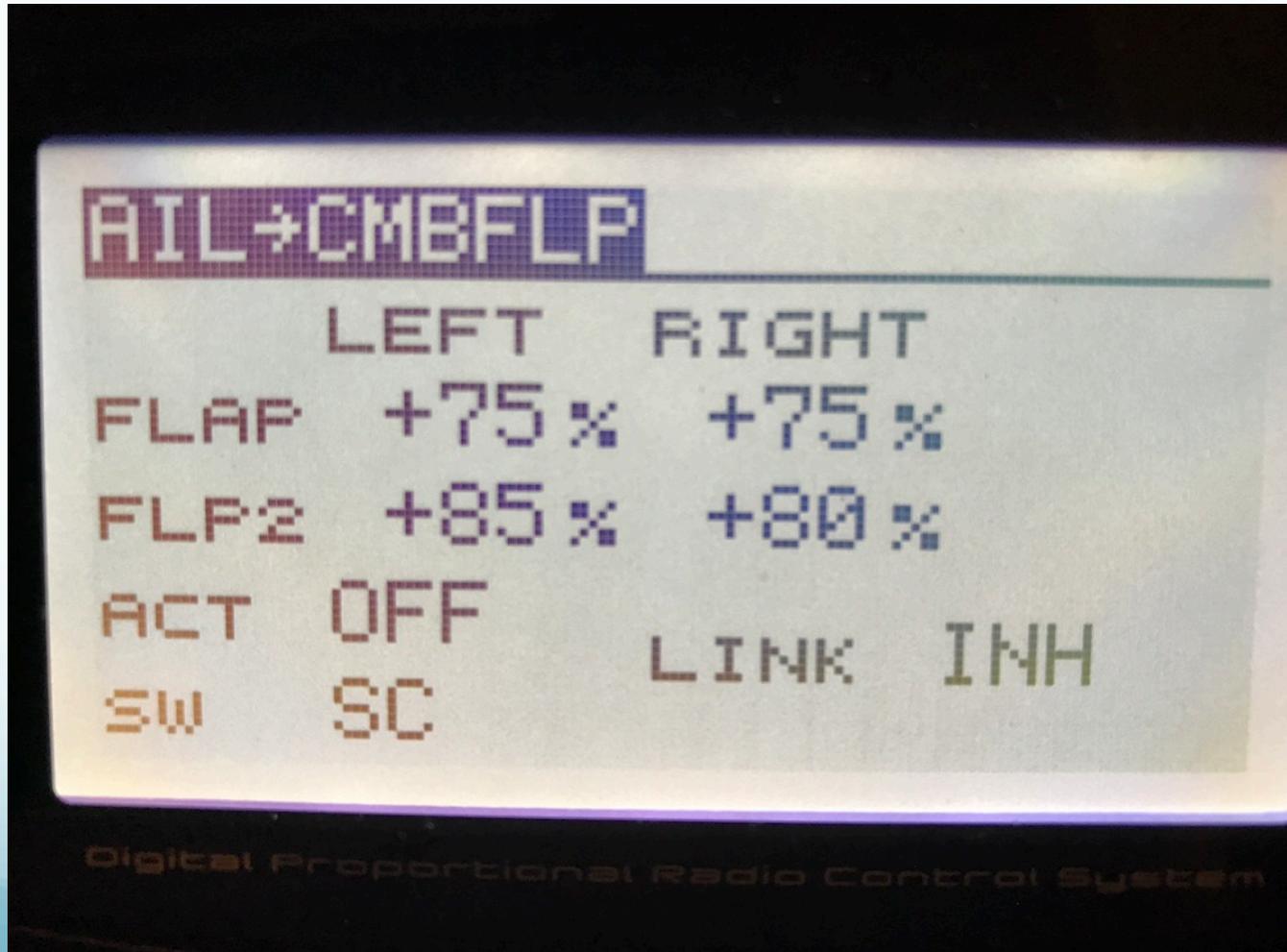
Flaps as Flaperons - Spektrum

- Enabled when WING TYPE is 2 ailerons and 2 flaps
- Flaps will move either together or opposite depending on whether LFL or RFL is chosen
- This example turns Flaperon function ON only when flaps are up (Switch B = 2)



Flaps as Flaperons - Futaba

- Use canned mix: AIL > CMBFLP

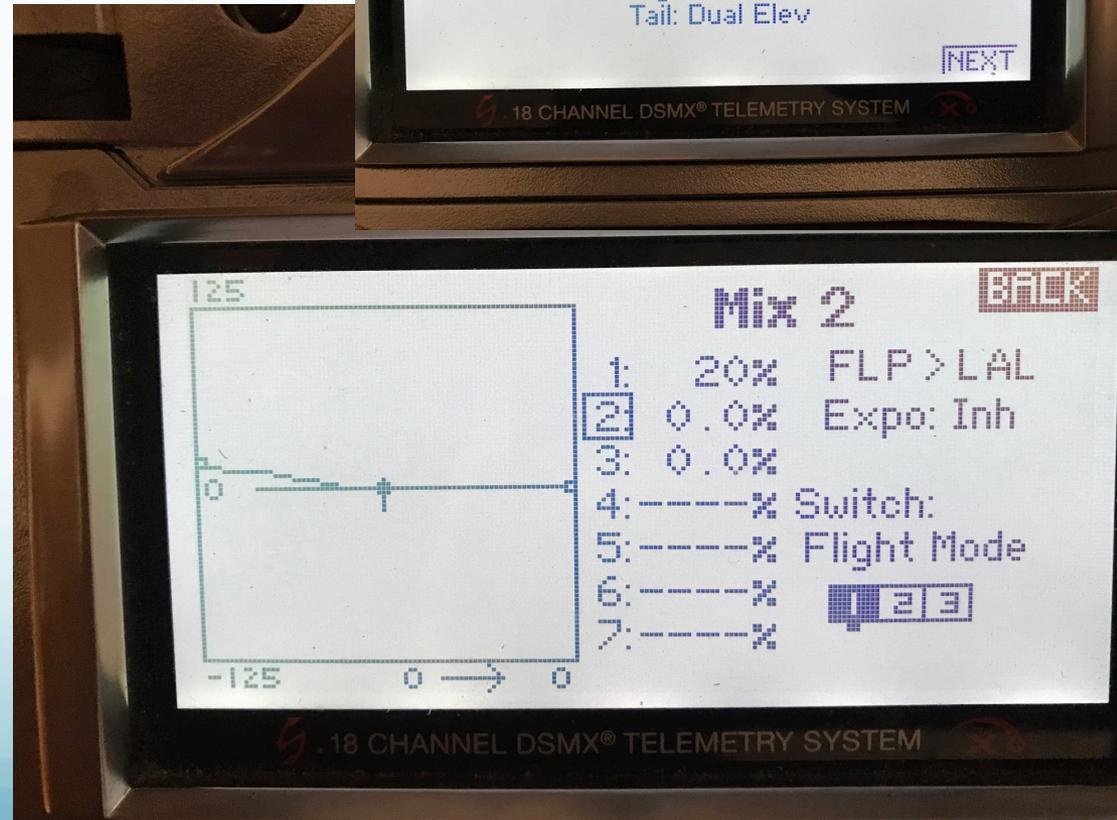
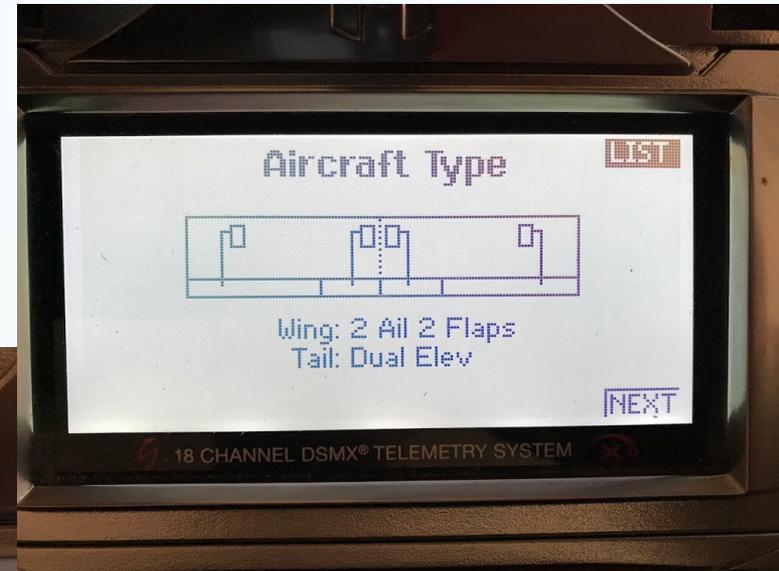


Reflexed or Drooped Ailerons

- Both Ailerons reflexed upward can reduce tip stall
- Drooped Ailerons can reduce stall speed when used in conjunction with flaps, but with increased risk of tip stall.
- Typically uses during approach or takeoff
- Can activate with flap switch positions

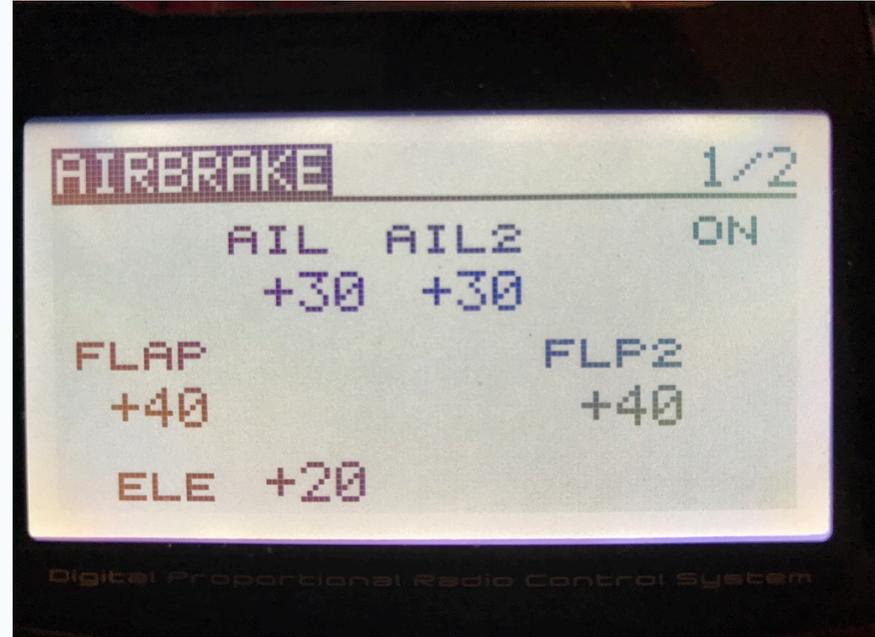
Reflexed or Drooped Ailerons - Spektrum

- Mix FLAP > LAL or RAL
- Ailerons will move either together or opposite depending on whether LAL or RAL is chosen
- May assign switch to flap positions. In this example, only at full flaps, Flight Mode switch = 1
- Curve mix shown gives movement in one direction only, but can also be done with anormal mix

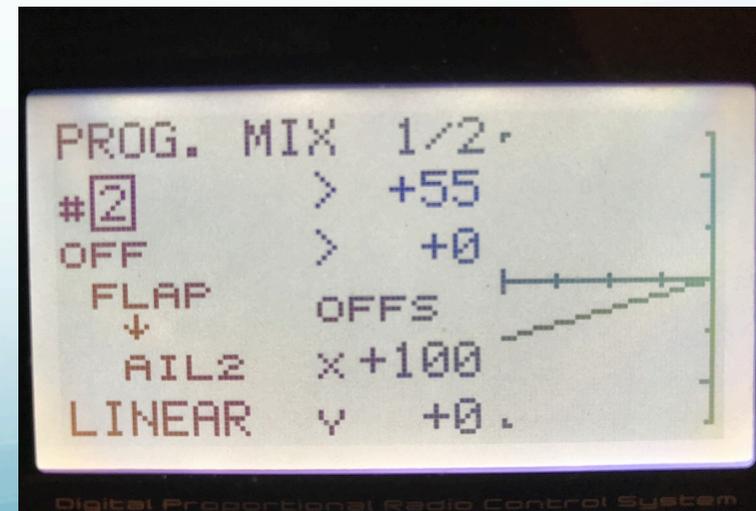
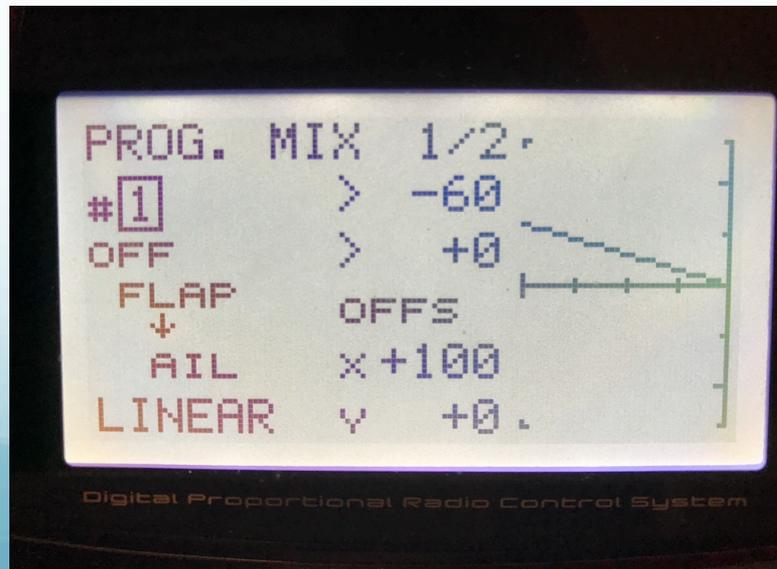


Reflexed or Drooped Ailerons - Futaba

- Can use AIRBRAKE, but not proportional



Or use
FLP > AIL



Crow, or Butterfly

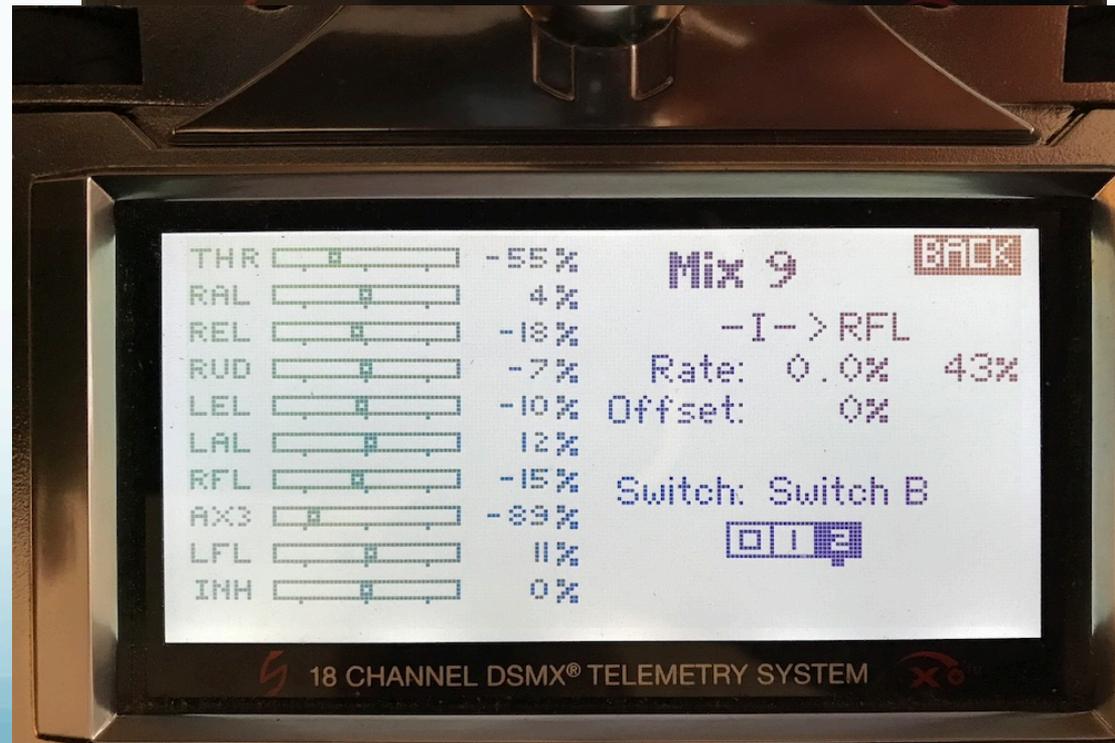
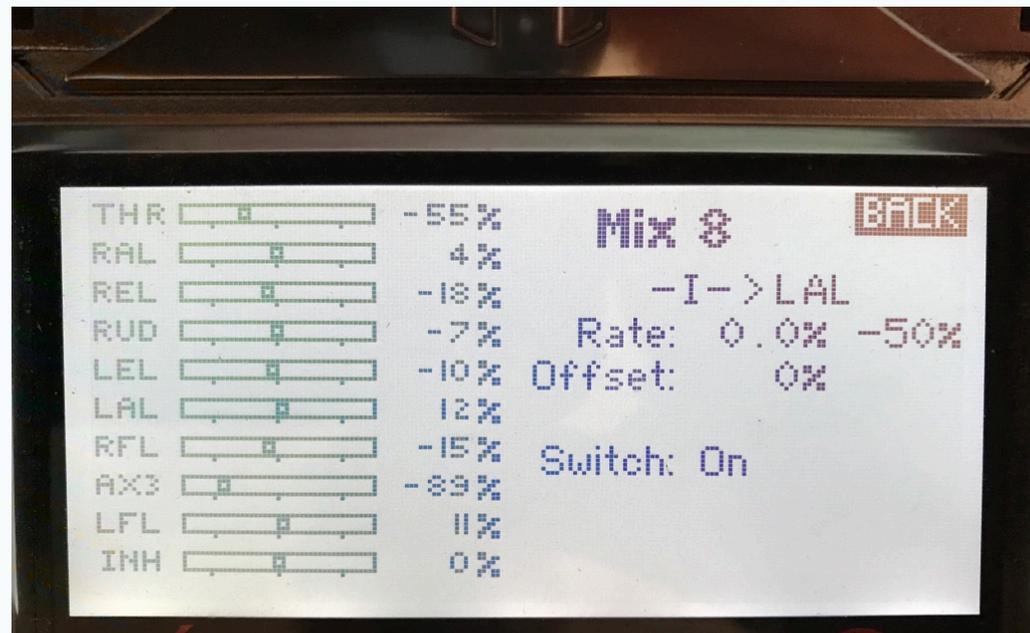
- Use a switch, knob, or slider to move ailerons up and flaps down simultaneously to increase drag
- Often used on competition RC sailplanes with large throws to greatly increase drag and enable steep approaches to spot landings
- Found in sailplane menus
- ... or separate program mixes
 - Aileron part: Same as reflexed ailerons, but much more travel

Crow using programmable mix - Spektrum

- Can use Camber Presets in Spektrum if the Model Type is selected as “Sailplane”
- Or use programmable mixes for airplanes
- Ailerons must have large throw without binding to allow for the large reflex plus normal aileron travel

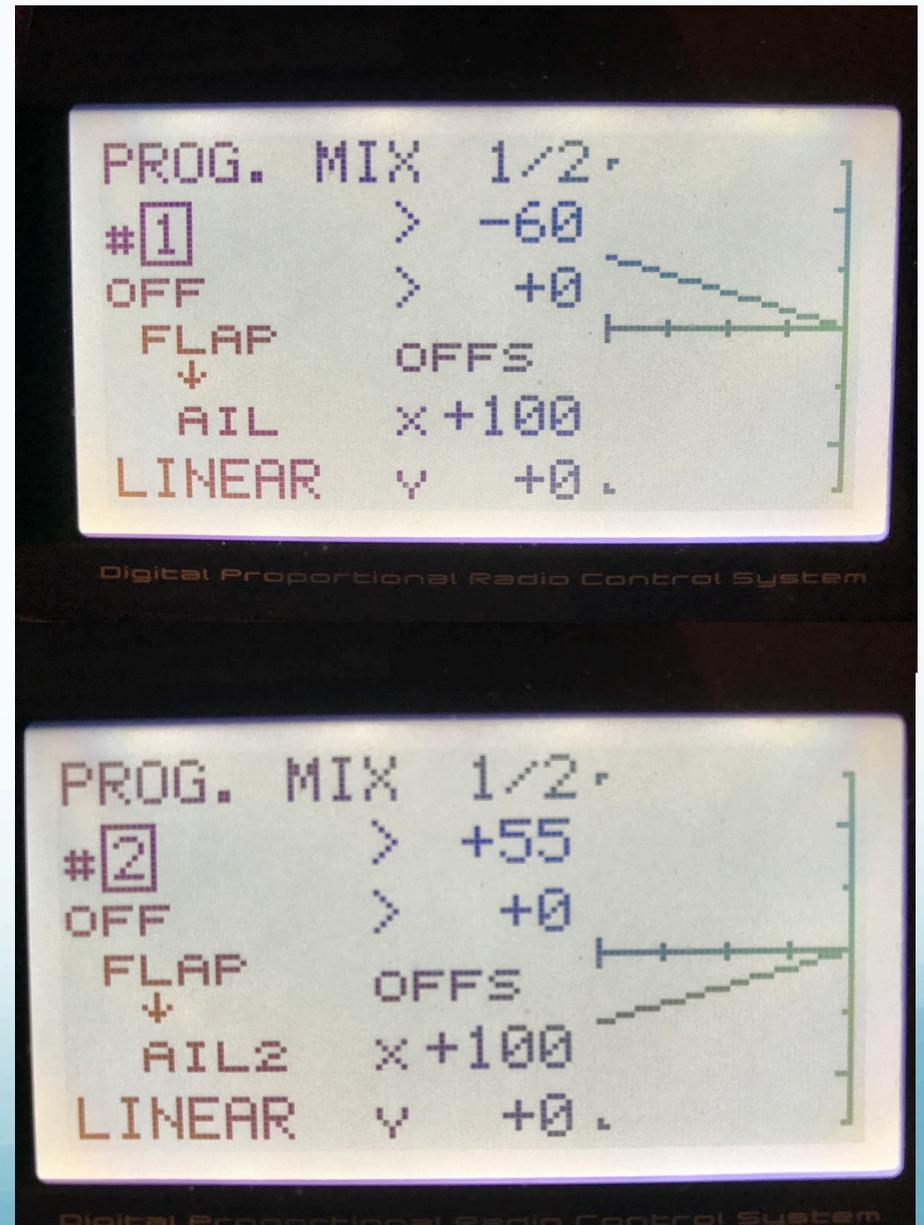
Crow - Spektrum

- Mix 8 reflexes ailerons up whenever button -I- is pressed
- Mix 9 lowers flaps whenever button -I- is pressed
- Mix 9 only works if flaps are up (switch B=2) so that no additional flaps are commanded if flaps are already down



Crow - Futaba

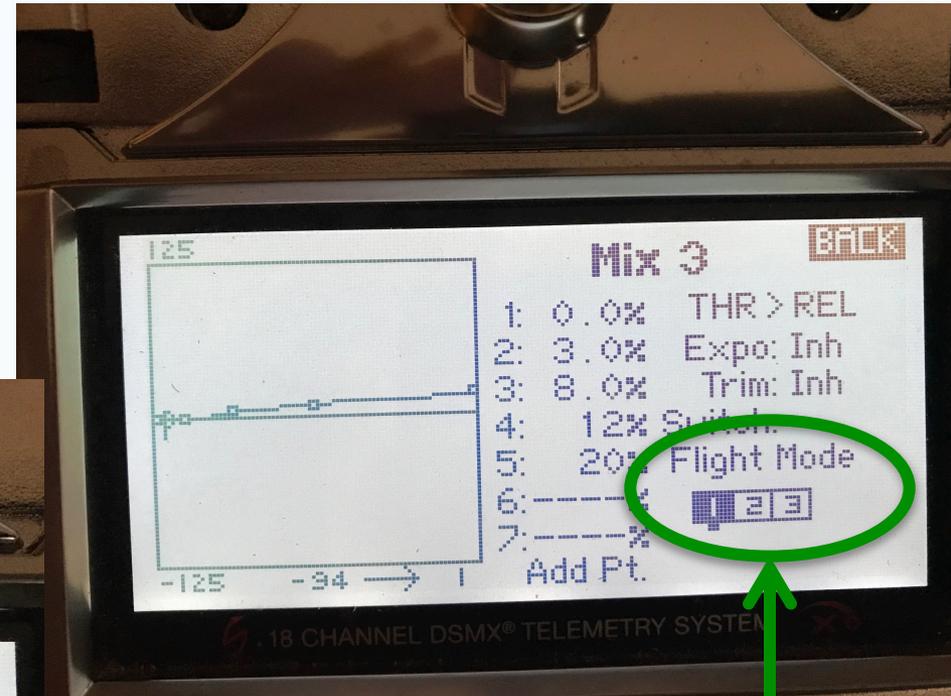
- Could use AIRBRAKE, but not proportional and cannot adjust each aileron individually
- Or use 2 Program Mixes, one for each aileron
 - FLAP > AIL
 - FLAP > AIL2



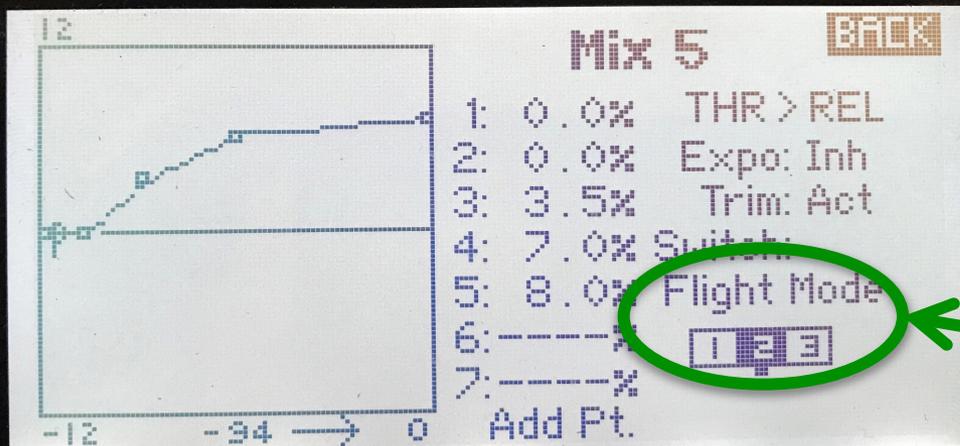
Throttle to Elevator Mix

- At high flap angles, airplane will pitch up strongly with increased power
- Can be countered by mixing Throttle to Elevator
- Can use separate mixes for different flap settings
- Turn mixes on with switch used for flap setting
- Using a curve mix can be helpful

Throttle to Elevator - Spektrum

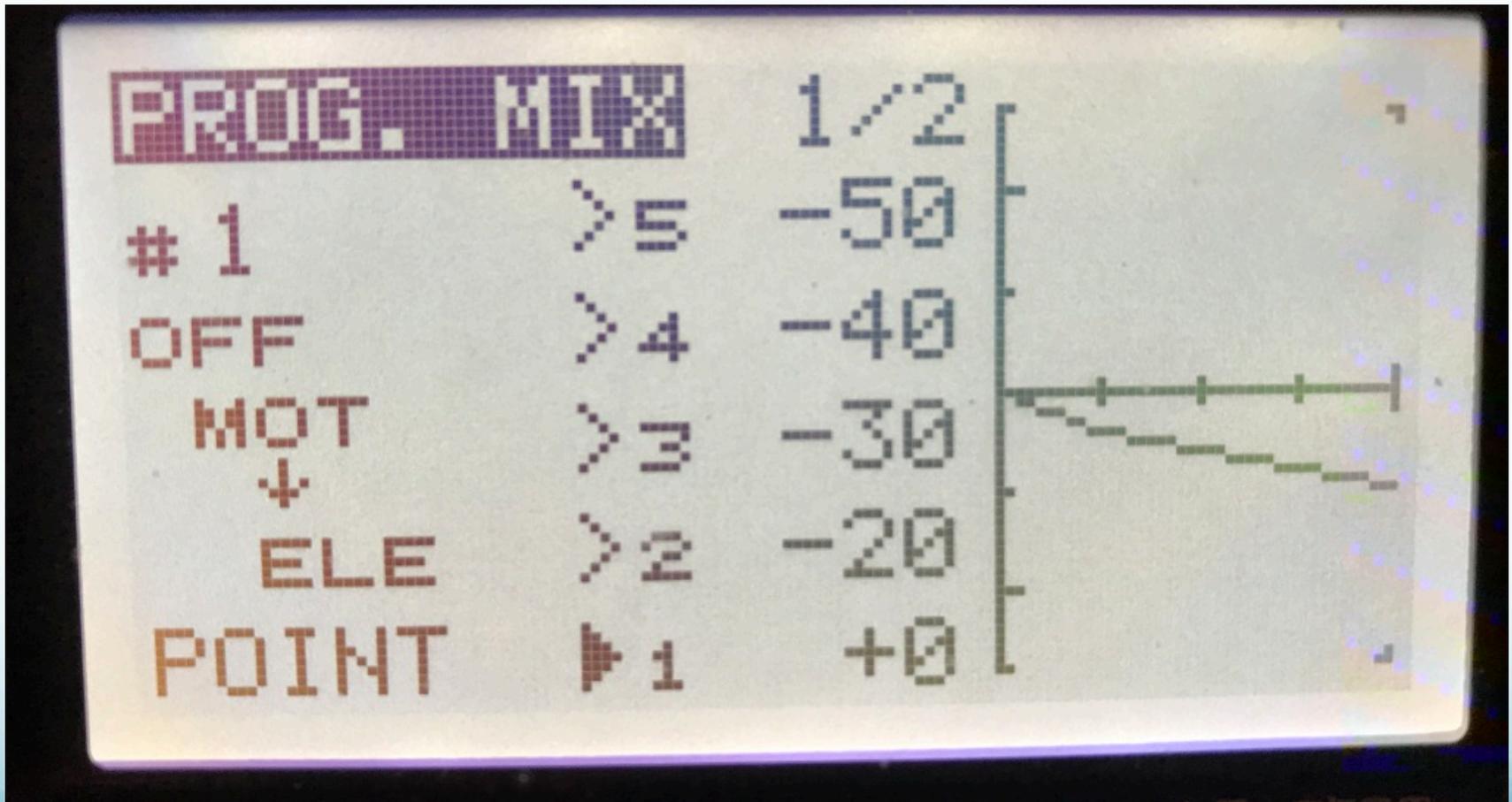


Landing Flaps



Mid Flaps

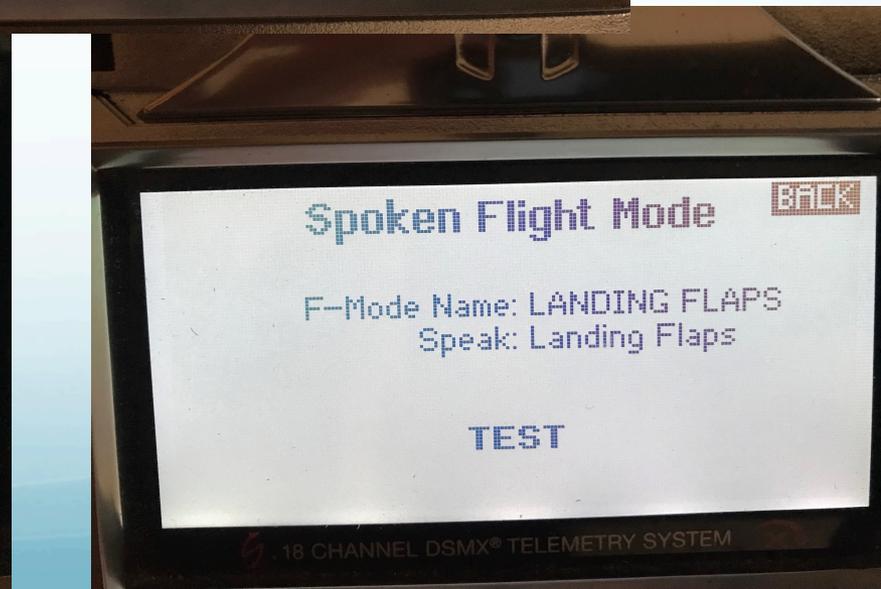
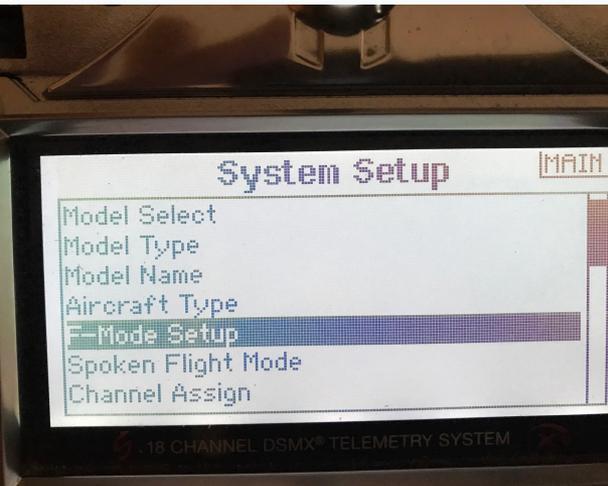
Throttle to Elevator Futaba



Flight Modes (Spektrum) Conditions (Futaba)

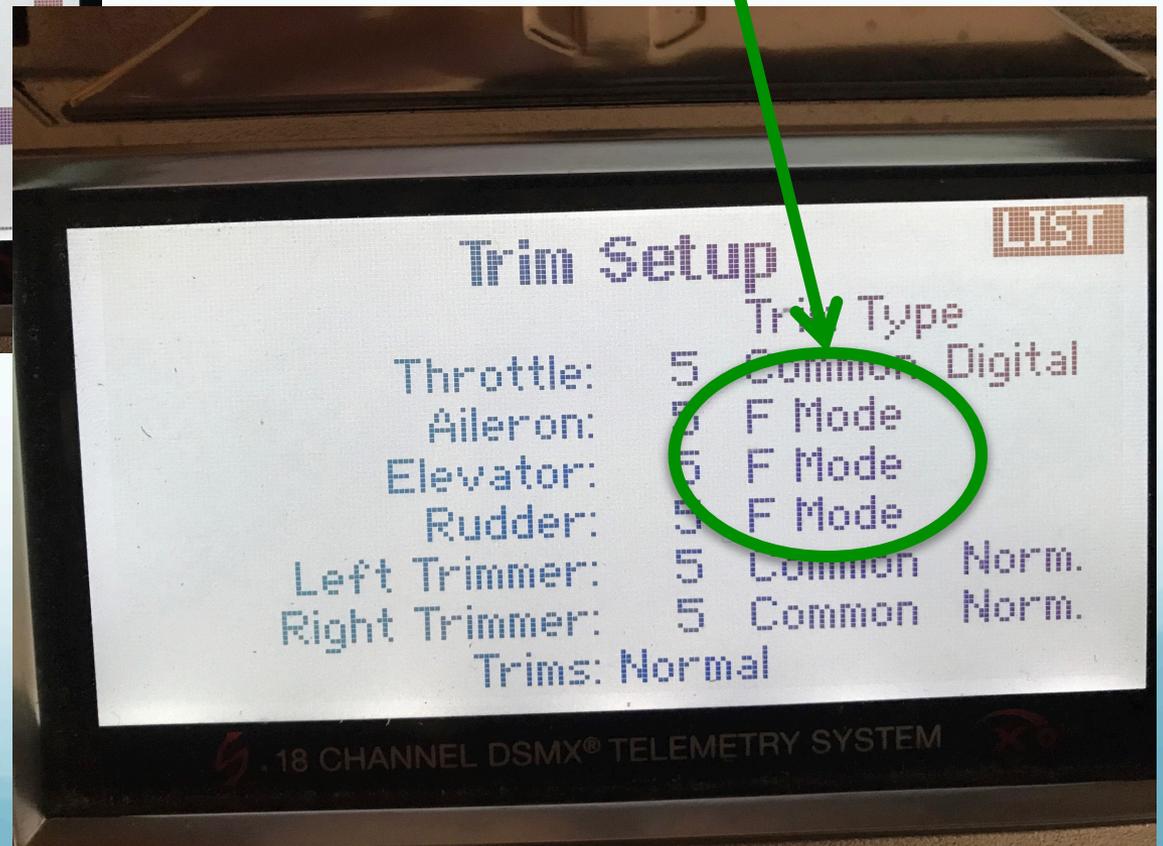
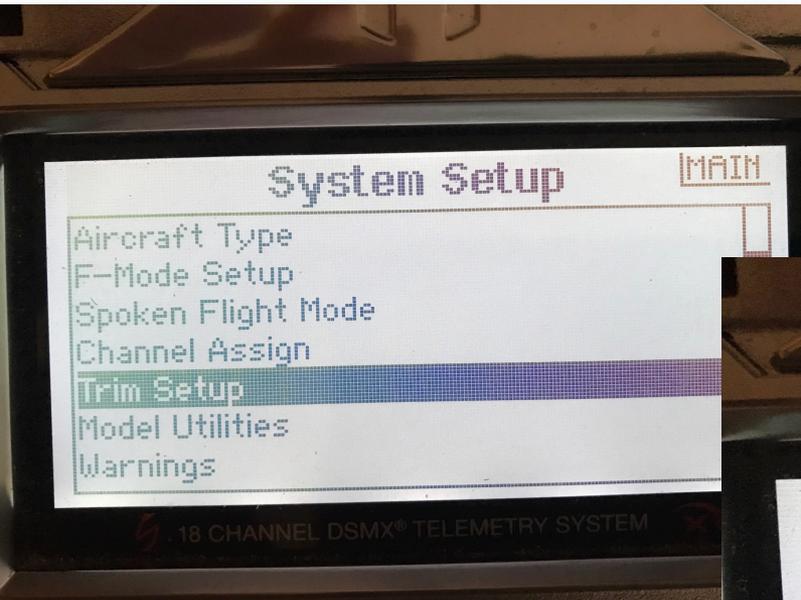
- Flight Modes (Conditions) can remember individual TRIM states for various flight configurations controlled by one or two switches
- Makes initial trimming flights much easier – just trim for each configuration
- R/C sailplanes control camber across the whole wing
 - Launch, cruise, penetration, thermal, spoilers, crow, flaps, etc.
- RC airplanes
 - Takeoff config, landing config, flap settings, gear position, speed brakes, crow, etc.

Flight Modes - Spektrum



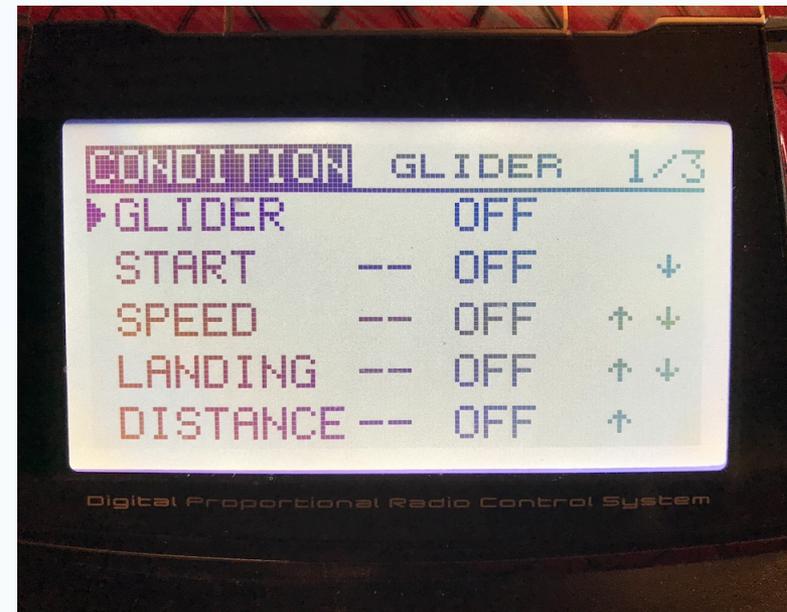
Flight Mode Trim setup - Spektrum

Must change to F Mode for trim settings to be remembered in each Flight mode



Flight Modes - Futaba

- Available in Glider model type
- Can be used for airplanes too
- Highly flexible and capable Conditions can control any surface, landing gear, spoilers, trim, rates, expo, etc on one switch, or combination of switches.
- Beyond the scope of tonight's presentation!
- Read the manual and check youtube videos of sailplane programming

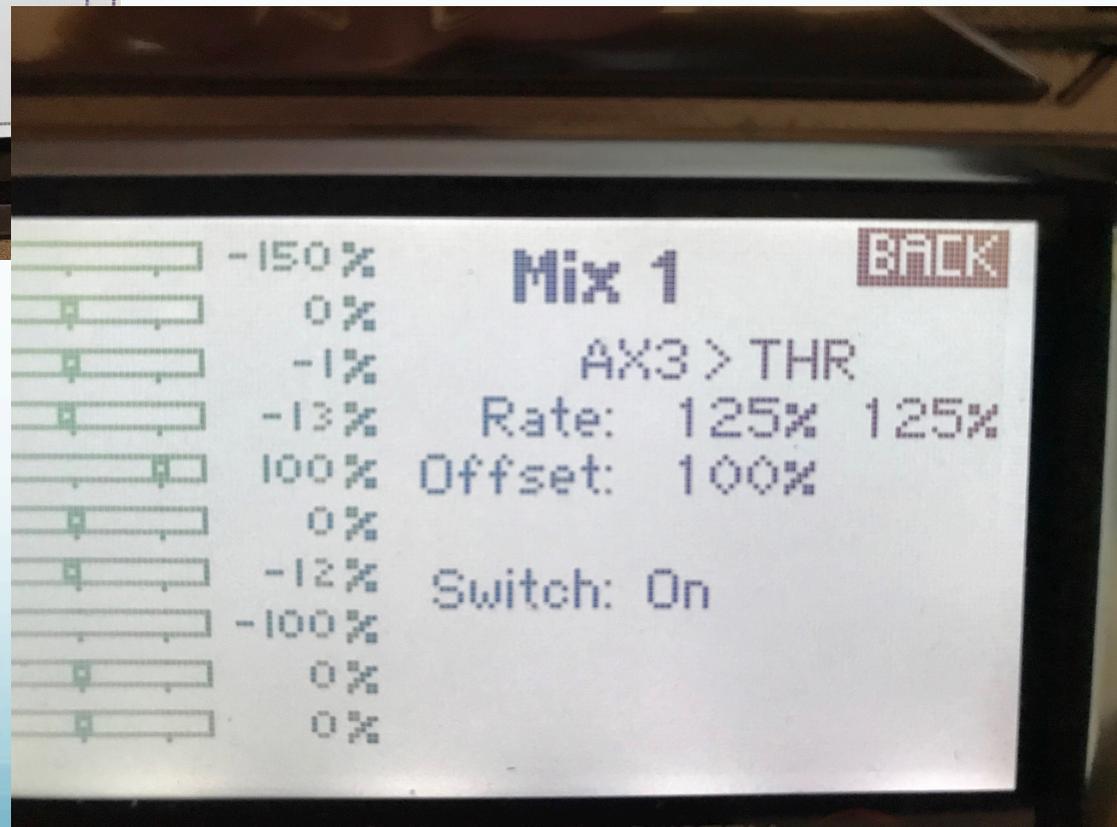
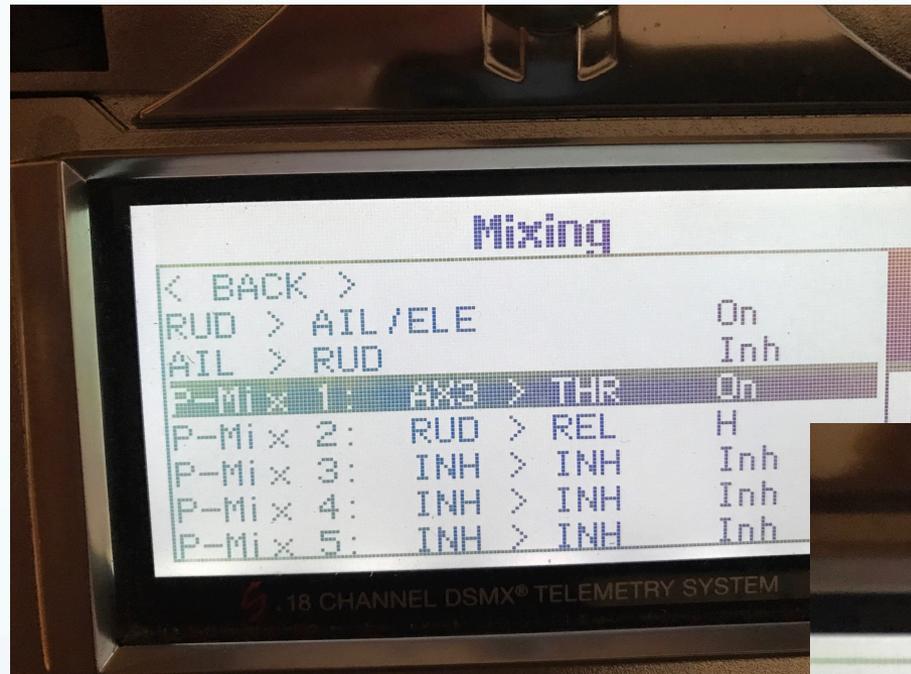


Throttle Cut on a Knob

- On Spektrum, built-in Throttle Cut function forces you to use a switch to cut throttle for safety
- BUT the switch can easily be bumped in flight or confused with another switch, shutting down the motor.
- Knob > Throttle mix solves this

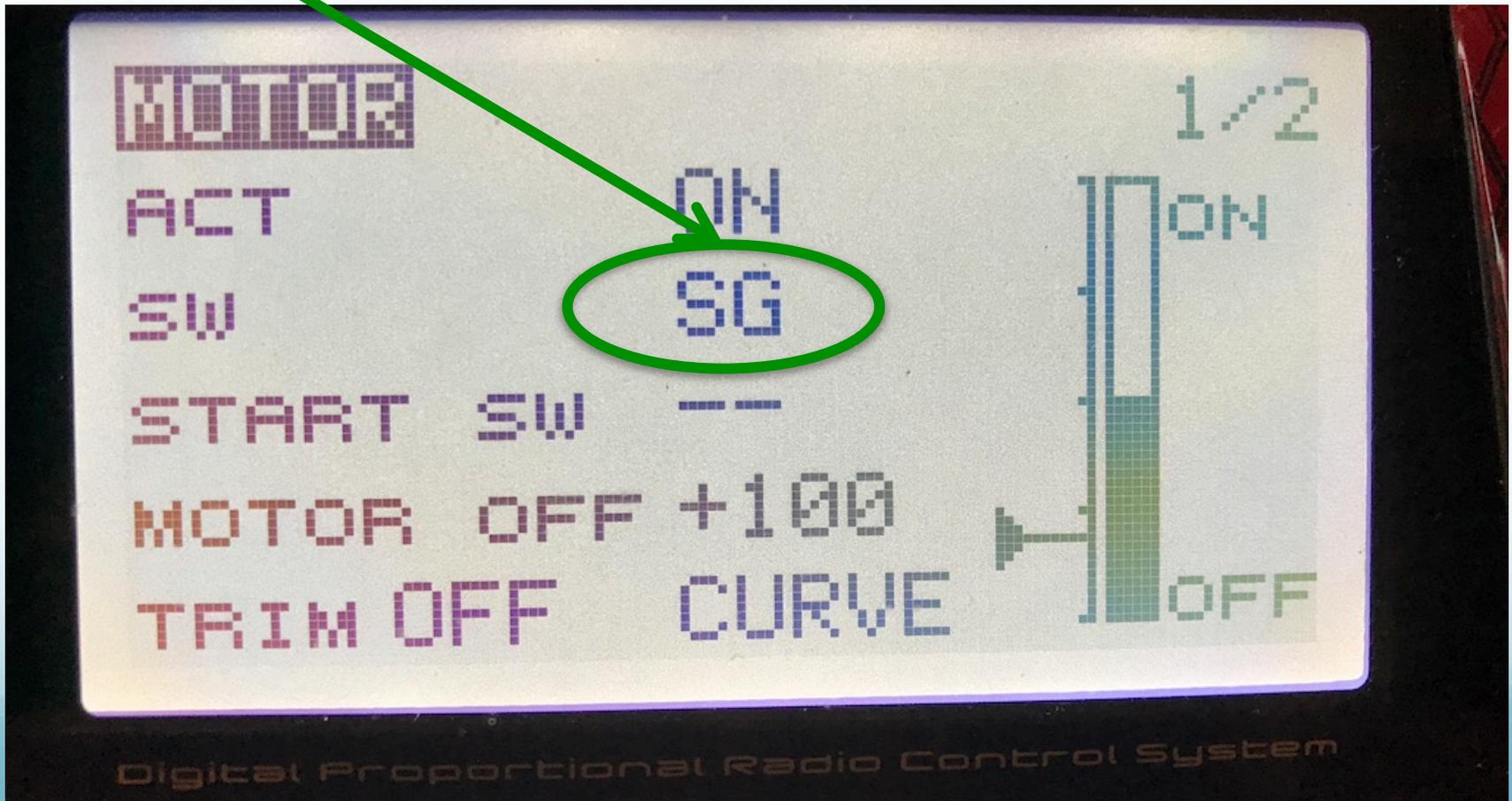
Throttle Cut on a Knob - Spektrum

Knob is assigned to channel AX3 in
System Setup
/ Channel Assign
/ Channel Input Config



Throttle Cut on a Knob Futaba

Switch G is a knob

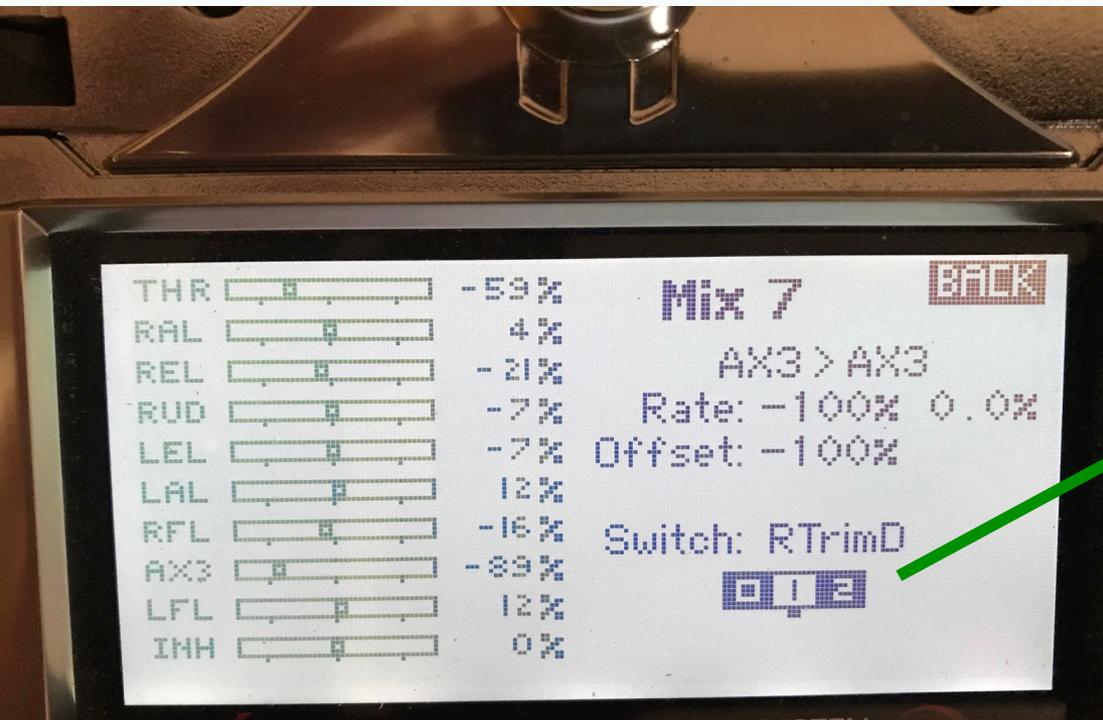


Ignition Kill Switch

- AMA recommends for gasoline ignition engines in addition to throttle trim or throttle cut
- Ignition kill device plug into a separate channel
- Assigned to a knob or switch

Ignition Kill - Spektrum

- AX3 is the channel used for the ignition cut system in this model
- AX3 is assigned to the knob
- Knob used to turn ignition on prior to start
- Can also use a mix to kill ignition quickly regardless of knob position. Mix 7 forces AX3 to zero by activating the spring-loaded Rtrim switch either direction



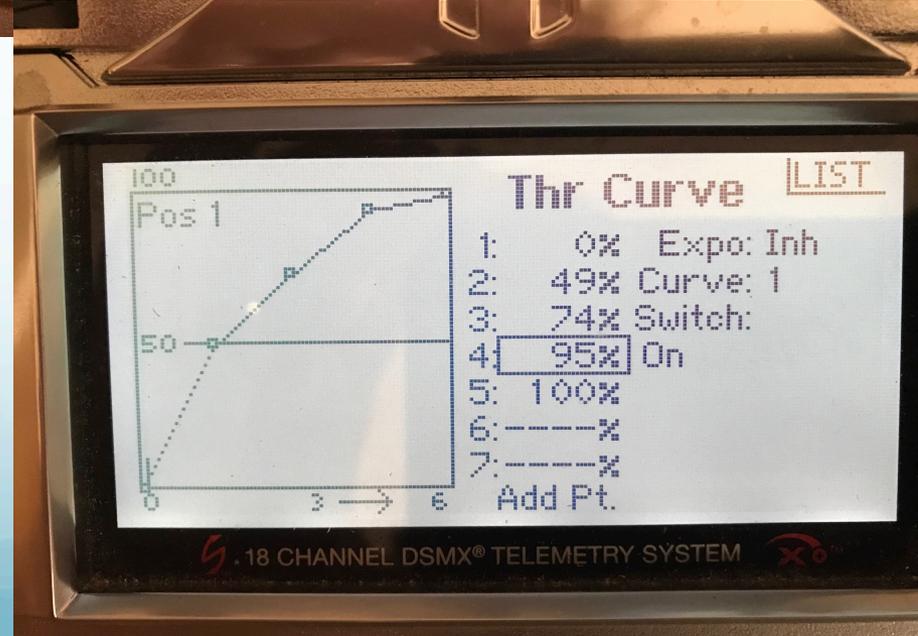
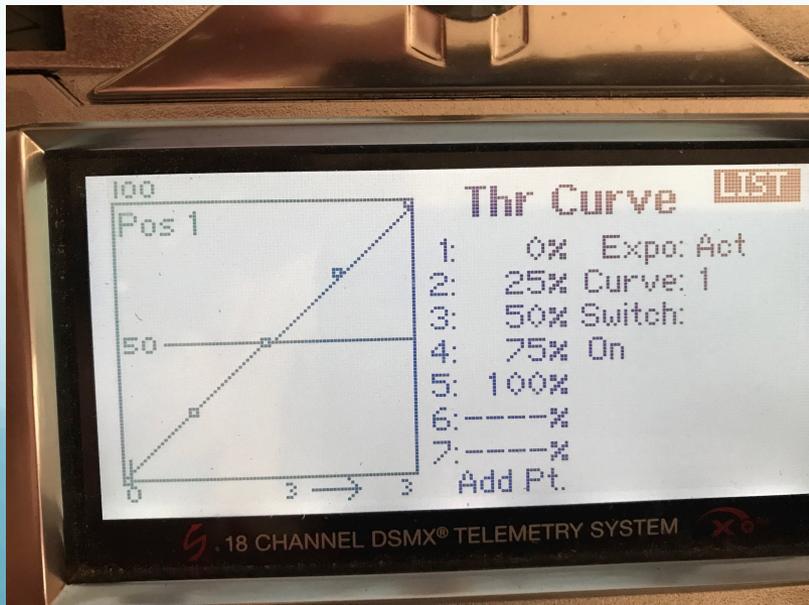
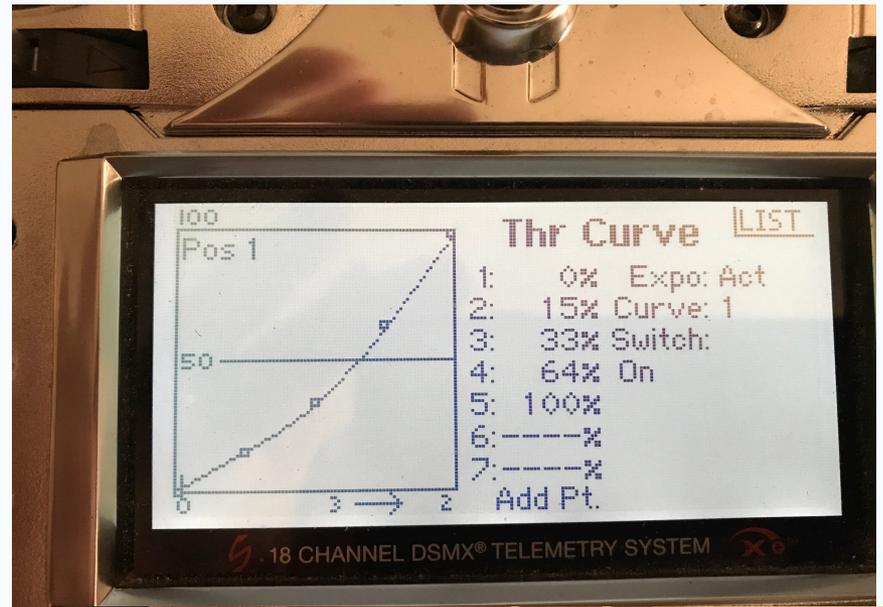
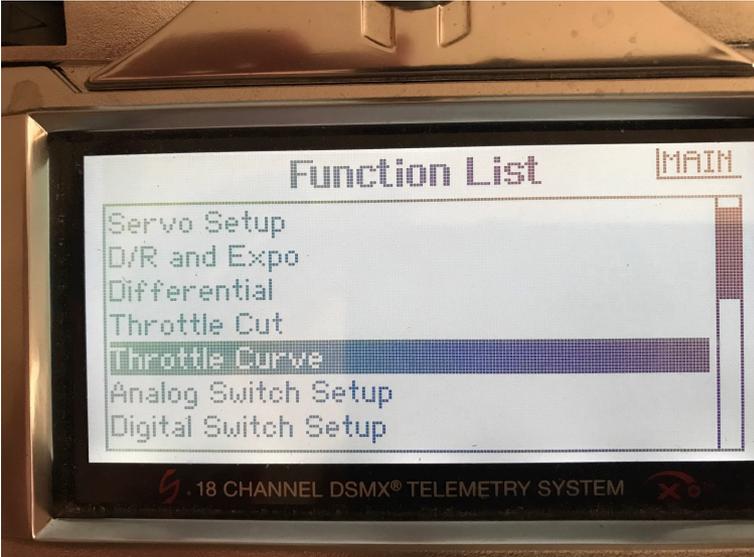
Ignition Kill - Futaba

- Use programmable mixes, mix knob, slider, or any switch to the ignition kill channel

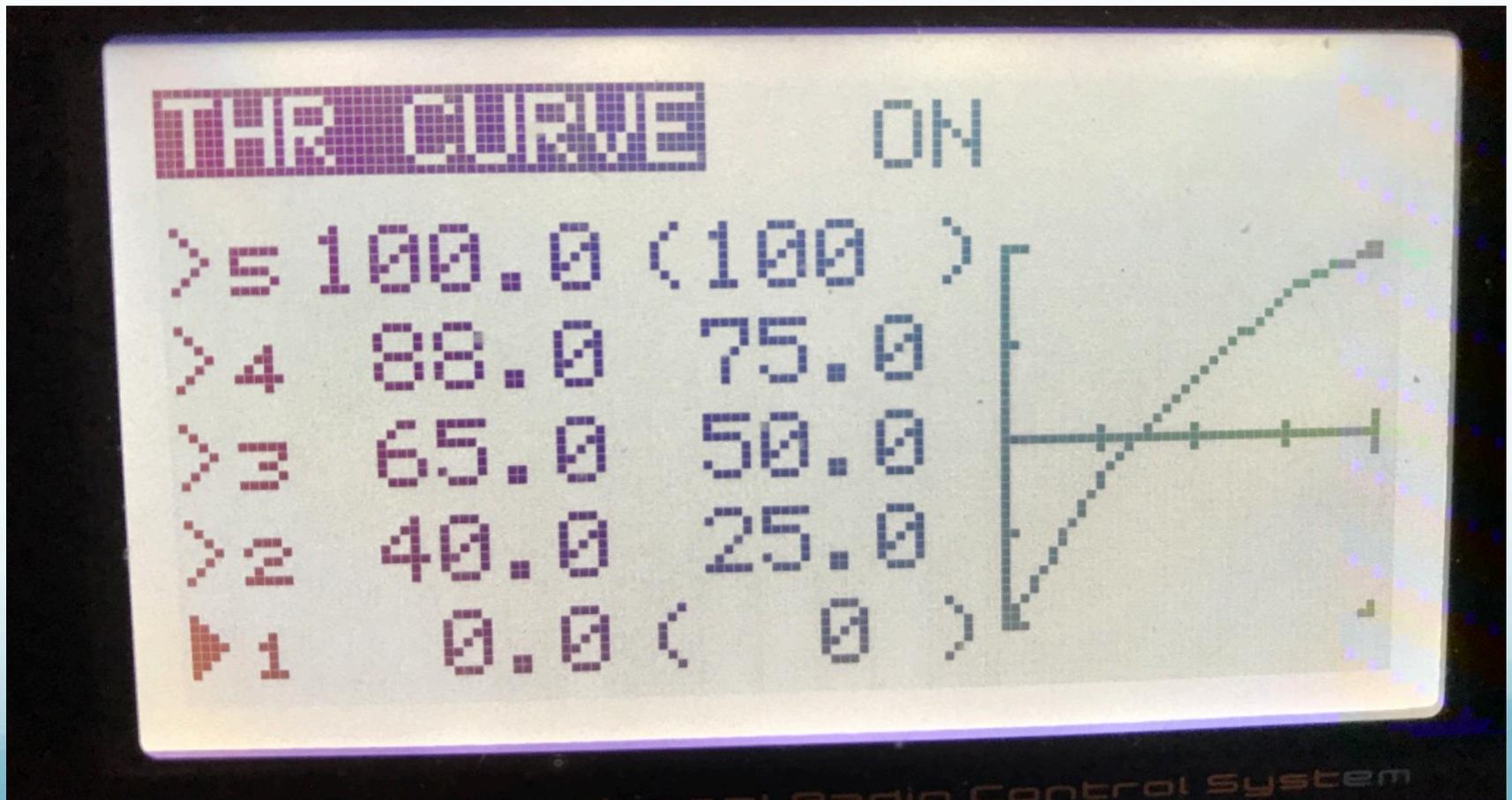
Throttle Curve

- Used to make power feel more “linear”
- That is, same amount of power for stick movement at both low and high throttle
- Engine throttle responses are often not linear

Throttle Curve - Spektrum



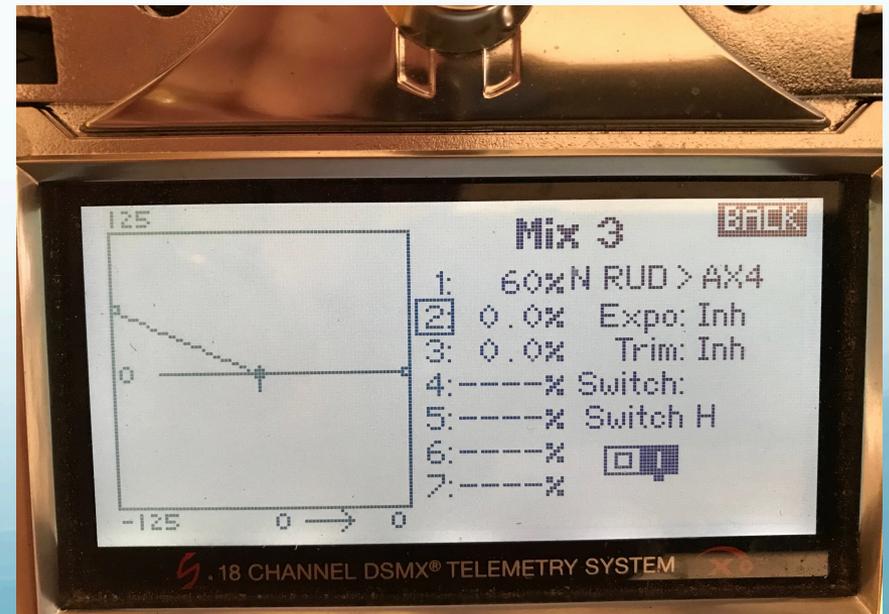
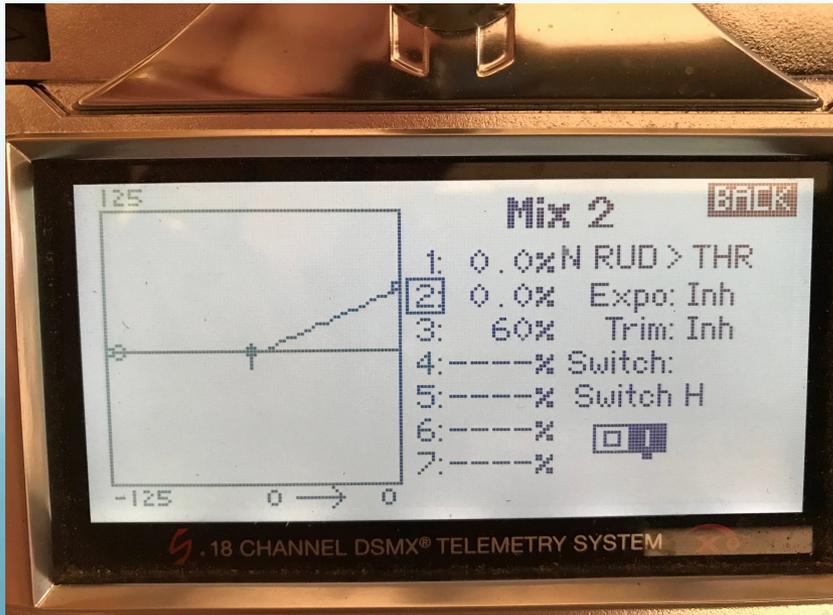
Throttle Curve - Futaba



Differential Thrust for Multi-Engine Planes

- Enables better control of multi-engine seaplanes when on the water, especially if there is wind
 - Assign throttle channel to Left engine
 - Throttle > aux channel for Right engine throttle
 - Rudder > Throttle (left Engine)
 - Rudder > aux channel (right Engine)
- If glow or gas, make sure rudder input while throttle is at idle won't kill the engine
- Use curve mix so that rudder only increases the thrust on one engine and does not reduce throttle on the other engine

Differential Thrust - Spektrum



Differential Thrust - Futaba

- Same concept as for Spektrum, using programmable mixes

VTOL Concept Using Free Mixes

- Quad copter configuration in hover
- Use Flight Modes and Flap function to tilt motors forward from hover, to transition, to cruise.
- Flaps, wings, or other parts might tilt with the motors
- Use mixes to create “copy” inputs of pitch, roll, and yaw to the quad controller, e.g. ELE > AX4, AIL > AX5, ...
- Flight Mode switch turns mixes off in forward flight to prevent quad controller from interfering with aerodynamic controls – quad controller then only controls thrust.

Logical Switches (Futaba) Combo Mixing (Spektrum)

- Mixes or other functions enabled by two switches
- Function ON with switch 1 **AND** switch 2
 - both must in desired position
- Function ON with switch 1 **OR** switch 2
 - either switch will activate
- Can be switches, sticks, knobs, or sliders

Why would you need a Logical Switch?

- Example: Nose Gear steering rate
- 3 mixes of RUD > nose gear channel
 - One for gear up (no steering, zero rate)
 - One for takeoff (low rate, say 40%)
 - One for taxiing (high rate, 100%)
- Zero rate when Gear switch is up to center the nosewheel
- Takeoff rate when gear is down **AND** throttle above some value
- Taxi rate when gear down **AND** throttle below some value