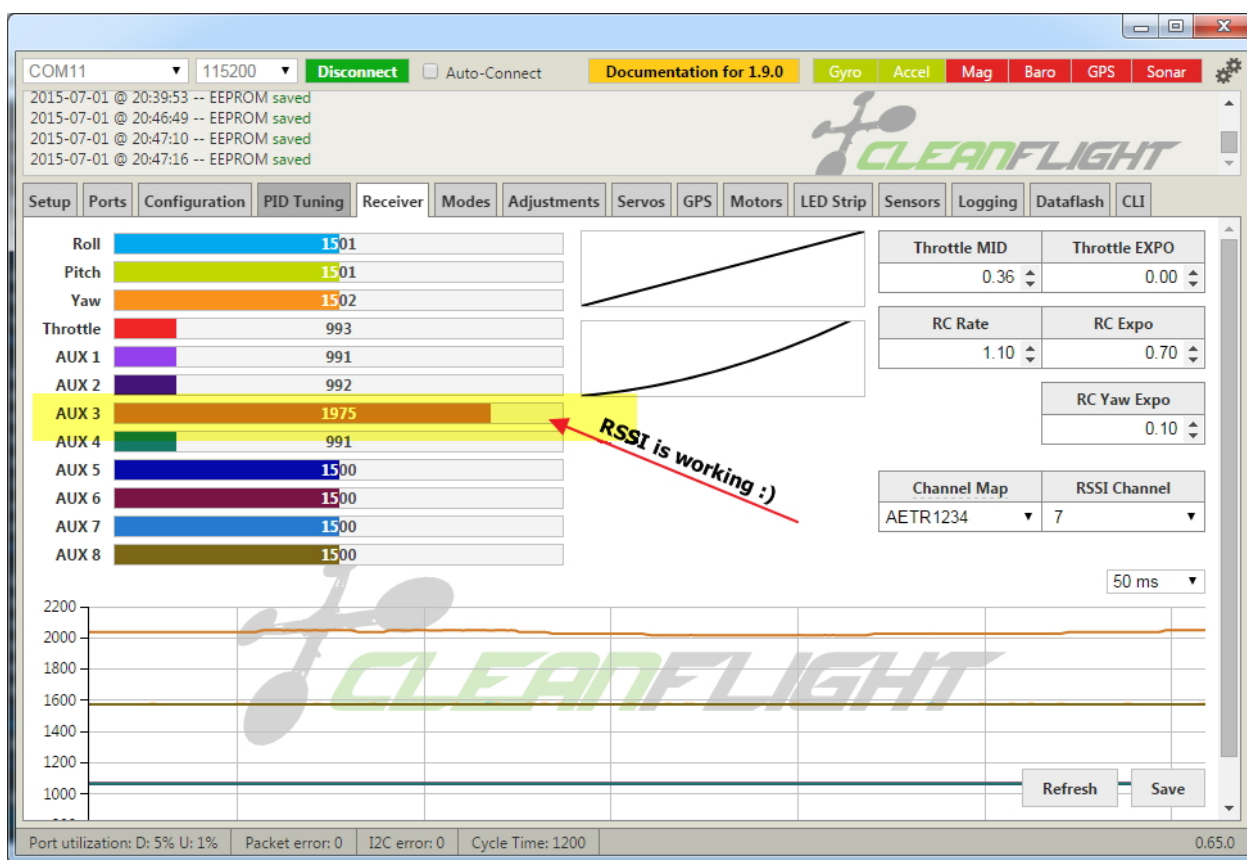


“RC RATE” VS “ROLL/PITCH/YAW RATE” FOR MINI QUAD



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This post explains the differences between RC rate, expo and Super Rate, how these settings can affect your quadcopter performance, and how to set them up.

You might be also interested in [PID tuning](#).

What is RC Rate and Expo?

In a nutshell, RC rate set the speed of rotation for stick travel. Expo adjusts the centre-stick softness against full-stick speed.

RC Rate

RC Rate is the multiplier on your Radio Transmitter inputs for all 3-axis: pitch, roll and yaw (one value for all 3 axis). If you increase RC rate, your quad will respond more aggressively to your stick inputs. Think of RC rate as the stick sensitivity setting.

RC Expo

Generally, Expo is a value between 0% and 100%. By increasing it, it reduces the sensitivity of your stick input around the centre.

Imagine that Expo applies a “U” curve to your stick output, where it’s flatter in the middle. With 0% of expo, it means there is no sensitivity reduction, and you will get a “V” curve.

Expo is often coupled with high rates, so the pilot can perform aggressive moves when maintaining precise control around stick centre.

There is no right or wrong expo/rate value, as long as it suits you. For example, I personally have shaky fingers, so my expo might be a bit higher than others. :p

History of Pitch/Roll/Yaw Rate, and Super Rate

In the past, we used to have separate Rate settings for Pitch, Roll and Yaw, on top of RC rate.

Pitch/Roll/Yaw Rates change the speed at which the quad moves in a given angle or rotation. For example, if you increase ROLL RATE, the quad will spin around roll axis faster and more than at a lower rate.

You might wonder, we already have RC rate, why did we have another rate for each axis? Long story :)

Why additional rates were introduced, and what is “Super Expo”?

As we know the very origin of Baseflight, Cleanflight and Betaflight, were Multiwii. Back then, it was all very simple, we only had RC rate and Expo, and that was it.

As “Mini Quad’s” were getting more and more popular, more pilots demanded higher rate to perform faster spins and crazier moves. So additional rates were added in MW2.3 PID controller, to relaxed the PIDs as stick deflection increases, and increase the maximum rotation rate at extreme stick deflection.

This feature was known as “**Super Expo**” at the time – basically it means you can have relatively moderate stick sensitivity around mid sticks for “normal flying maneuvers”, and yet super fast roll/flip at stick end points.

With MW2.3 PID controller, Pitch/Roll/Yaw Rates have some influence on PID Controller. For example by increasing pitch/roll rate, you get faster spins, but your multicopter might feel less in control at stick end points. Also, **it affects all-round stick range and not just the end points!**

“Super Expo” Effect Removed in Cleanflight

In 2015, Cleanflight introduced more PID controllers in the firmware, such as Re-Write and Luxfloat. In these PID controllers, P/R Rates no longer have an effect on PID values (however it still does have effects for controller 0, 4, 5 and 6).

That means the Pitch/Roll rate setting that was still there will no longer give you the “super expo” effect. They are now just multipliers that simply increase the overall rate on top of existing RC rate linearly.

Update 07 Oct 2016 – “Super-Expo” is Back in Betaflight

Flyduino’s KISS FC is another branch of Multiwii. They inherited the “Super-Expo” feature in their PID Controller, and it was particularly popular within their users.

So in Betaflight the developers decided to bring it back, and it’s named “Super Rate” or “S.Rate” in Betaflight. And P/R rate was soon removed too.

What is Super Rate in Betaflight

Super Rate (or S.Rate) changes your full-stick-deflection rate, also your centre stick precision.

It’s bit like the combination of both Rate and Expo. Although it gives you more flexibility on tuning and control, but you have play around with RC Rate, Expo and S.Rate back and forth to achieve the desired curve while still maintaining the desired full-deflection rate that you like.

How to set RC Rate/Expo and Super Rate?

I mostly fly FPV in acro mode and I always tune RC rate first by cruising around (no flips/rolls), to make sure the quad respond quickly to your stick inputs. For me I usually start from somewhere between 0,9 to 1.2.

Then I crank up Super Rate for flip, rolls and acrobatics, until I am happy with the speed of rotation. Note that it also affects your centre stick sensitivity, so you might want to adjust rate again, but again Rate will affect your end point deflection.... you might need to do this forth and back a few times to get it right :)

Finally you can add a little bit of RC Expo to have a bit more precise control in the mid stick if you want. 0.05 to 0.1 is a good range to start.

One thing I notice from all the different flight controller software is, they all have different ranges of PID, rates and expo number scaling. So I never bother trying to relate those values from one to the other, just whether the value should be lower or higher.

Also, avoid applying Expo on the radio (TX), because it reduces your stick resolution. ONLY set Expo in the flight controller!

Throttle Mid and Expo

Lastly, Next to RC rate and expo, you also have Throttle Mid and Throttle Expo.

THROTTLE MID is default at mid throttle, but in my opinion this should be set to a value where your quad hovers. If you have to raise your throttle stick past the centre to hover, increase it. If your quad has higher power-to-weight ratio than 2, (hover at less than 50% throttle), you might want to drop it, so it's easier to control your altitude. You need to use this with some throttle expo, otherwise it won't do anything. If you set Expo = 0, you can ignore throttle mid.

One funny situation I see very often, is that some people fly an over-powered mini quad, and their throttle mid is set way higher than the hover point, and they cannot land it without crash into the ground. :D

THROTTLE EXPO is how flat you want your throttle mid to be on a curve, so the flatter curve, the softer response it will give you. I personally just a tiny bit of throttle expo (<10) to get a better resolution with