1. Sensors and their calibration and parameters we change

We are using px4 firmware on QGround Control (ground station)

Fixed wing sensors used:

-the compass

is built in the GPS

-gyroscope

(calibration only) just follow the steps shown in the ground station

-accelerometer

(just follow the steps shown in the ground station)

-airspeed sensor (very important and essential in fixed wings)

some **good parameters** for the airspeed sensor:

ASPD_STALL (FLOAT)	Airspeed fault detection stall airspeed. (Experimental) **Comment:** This is the minimum indicated airspeed at which the wing can produce 1g of lift. It is used by the airspeed sensor fault detection and failsafe calculation to detect a significant airspeed low measurement error condition and should be set based on flight test for reliable operation.	حسيته كويس يعني لو على حسب ما فهمت هيعرف يعمل ال ستول ودي حاجة كويسة عشان لو السرعة قلت اوي ناخد بالنا والله اعلم	10.0	m/s
FW_AIRSPD_MAX (FLOAT)	Maximum Airspeed **Comment:** If the airspeed is above this value, the TECS controller will try to decrease airspeed more aggressively.	0.0 > 40 (0.5)	20.0	m/s
FW_AIRSPD_MIN (FLOAT)	Minimum Airspeed **Comment:** If the airspeed falls below this value, the TECS controller will try to increase airspeed more aggressively.	0.0 > 40 (0.5)	10.0	m/s
FW_AIRSPD_TRIM **(FLOAT)**	Cruise Airspeed **Comment:** The fixed wing controller tries to fly at this airspeed.	0.0 > 40 (0.5)	15.0	m/s

The airspeed sensor is calibrated by covering the pitot tube for a few seconds but be careful not to block any of the holes. click ok to start calibration, blow into the tube, wait 2 -3 seconds before uncovering it.

Don’t forget to look at the airspeed sensor schematic, the wires may be connected in a wrong way which will prevent it from working.

Advanced configuration

In QGround, we will choose (finding/updating parameters)

- px4 can be tuned using parameters من خلالها بنقدر نعدل اي حاجة او نعملها تيون لو فيها مشكلة.

- Usually we should use full parameters list.

- A parameter may not be present in the firmware because you're using a different version of PX4.

** changing parameter is done by clicking it to update its value, information is also provided for each parameter (**don’t forget to click save, you may also need to reboot the flight controller it is required after changing some parameters**)

2. During flight

“L1 controller”. This *controller* produces much more accurate flight paths both for waypoints and loiter than the previous cross track and PID *controller.*

FW_L1_PERIOD (FLOAT)	L1 period **Comment:** This is the L1 distance and defines the tracking point ahead of the aircraft its following. A value of 18-25 meters works for most aircraft. Shorten slowly during tuning until response is sharp without oscillation.	12.0 > 50.0 (0.5)	20.0	m

It may help to avoid crash.

FW_L1_PERIOD (FLOAT)	L1 period **Comment:** This is the L1 distance and defines the tracking point ahead of the aircraft its following. A value of 18-25 meters works for most aircraft. Shorten slowly during tuning until response is sharp without oscillation.	12.0 > 50.0 (0.5)	20.0	m

3. Geofence

GF_ACTION (INT32)	Geofence violation action **Comment:** Note: Setting this value to 4 enables flight termination, which will kill the vehicle on violation of the fence. Due to the inherent danger of this, this function is	0 > 4	1

	disabled using a software circuit breaker, which needs to be reset to 0 to really shut down the system. **Values:** **0:** None **1:** Warning **2:** Hold mode **3:** Return mode **4:** Terminate		

It is good also to avoid crash

4. MISSION

MIS_DIST_WPS (FLOAT)	Maximal horizontal distance between waypoint Comment: Failsafe check to prevent running missions which are way too big. Set a value of zero or less to disable. The mission will not be started if any distance between two subsequent waypoints is greater than MIS_DIST_WPS.	0 > 10000 (100)	900	m
MIS_LTRMIN_ALT (FLOAT)	Minimum Loiter altitude Comment: This is the minimum altitude the system will always obey. The intent is to stay out of ground effect. set to -1, if there shouldn't be a minimum loiter altitude	-1 > 80 (0.5)	-1.0	m

RUNWAY TAKE-OFF parameters

RWTO_AIRSPD_SCL (FLOAT): the minimum airspeed to takeoff

RWTO_HDG (INT32): heading of the takeoff

RWTO_MAX_PITCH: max pitch during takeoff

RWTO_MAX_ROLL: the same as pitch

RWTO_MAX_THR: // // // //

Fixed-Wing PID tuning guide

* Incorrect PID tuning may crash your vehicle ☺
* Incorrectly set gains during tuning can make altitude control unstable. There must be a manual override control for such a case.

4. Roll Tuning:

Bank hard right with full roll stick until 60 degrees roll, then bank hard left with full roll stick until 60 degrees roll in the opposite position. Take notes while adjusting the following gains.

Tuning the feedforward gain

This gain is essential for tighter manoeuvres and tougher response.
First set the other gains to zero: (**FW_RR_I**, **FW_RR_P**, **FW_RSP_OFF**)
Then tune the feedforward gain **FW_RR_FF** by starting from a value of **0.4**, increasing the value by double each time until the plane rolls satisfactorily and reaches the setpoint.
Back down the gain **20%** at the end of the process.

Tuning the rate gain

This is all about speeding up the airplane banking without any wobbling.
Start **FW_RR_P** with a value of **0.06**. Increase the value by double until the airplane starts to wobble. Then reduce gain by **50%**.

FW_R_RMAX limits the roll angular rate (in **deg/s** from **0** to **90**).

Tuning the trim offsets with the integrator gain

Start **FW_RR_I** with a value of **0.01**. Increase by double until there is no offset between commanded and actual roll value (requires looking through a log file, plot the demand vs. actual and determine the gain value at which the actual roll matches the demand

The portion of the integrator part in the control surface is limited by the value of **FW_RR_IMAX**, can be picked from **0** to **1**, the default value is **0.2**.

Adjusting the time constant of the outer loop

Set **FW_R_TC** to a default of **0.5 secs**, increase to make the response softer, decrease to make it harder.

The roll airframe offset **FW_RSP_OFF**, is an airframe specific offset of the roll setpoint in degrees from **-90** to **90**.

5. Pitch Tuning:

Pitch up hard 45 degrees, then pitch down as hard. Take notes while adjusting the following gains. The objective of the following parameters is similar to those of the roll tuning but into a different control mission of course.

Tuning the feedforward gain

First set the other gains to zero: (**FW_PR_I**, **FW_PR_P**, **FW_PSP_OFF**)
Then tune the feedforward gain **FW_PR_FF** by starting from a value of **0.4**, increasing the value by double until the plane pitches satisfactorily and reaches the setpoint.
Back down the gain **20%** at the end of the process.

Tuning the rate gain

Start **FW_PR_P** with a value of **0.04.** Increase the value by double until the airplane start to twitch. Then reduce gain by **50%**.

FW_P_RMAX_NEG limits the negative / down pitch angular rate (in **deg/s** from **0** to **90**).
FW_P_RMAX_POS limits the positive / up pitch angular rate (in **deg/s** from **0** to **90**).

Tuning the trim offsets with the integrator gain

Start **FW_PR_I** with a value of **0.01**. Increase by double until there is no offset between commanded and actual pitch value (requires looking through a log file, plot the demand vs. actual and determine the gain value at which the actual pitch matches the demand).

The portion of the integrator part in the control surface is limited by the value of **FW_PR_IMAX**, can be picked from **0** to **1**, the default value is **0.4**.

Adjusting the time constant of the outer loop

Set **FW_P_TC** to a default of **0.5 secs**, and it's a typical good value. However, increase this value to make the response softer, decrease to make it harder.

The pitch airframe offset **FW_RSP_OFF**, is an airframe specific offset of the pitch setpoint in degrees from **-90** to **90**.

6. Yaw Tuning:

Yaw right as hard as possible, then yaw left as much hard. Take notes while adjusting the following gains. Similar parameters as in roll and pitch tuning within a different mission.

Tuning the feedforward gain

First set the other gains to zero: (**FW_YR_I**, **FW_YR_P, FW_RLL_TO_YAW_FF**)
Then tune the feedforward gain **FW_YR_FF** by starting from a value of **0.3**, increasing the value by double until the plane yaws satisfactorily and reaches the setpoint.
Back down the gain **20%** at the end of the process.

Tuning the rate gain

Start **FW_YR_P** with a value of **0.05.** Increase the value by double until the airplane start to twitch. Then reduce gain by **50%**.

Tuning the trim offsets with the integrator gain

Start **FW_YR_I** with a value of **0.01**. Increase by double until there is no offset between commanded and actual pitch value (requires looking through a log file, plot the demand vs. actual and determine the gain value at which the actual pitch matches the demand).

The portion of the integrator part in the control surface is limited by the value of **FW_YR_IMAX**, can be picked from **0** to **1**, the default value is **0.2**.

Roll control to yaw control feedforward gain

The gain **FW_RLL_TO_YAW_FF** can be used to counteract the "adverse yaw" effect for fixed wings. When the plane enters a roll, it will tend to yaw the nose out of the turn. This gain enables the use of a yaw actuator (rudder, airbrakes, ...) to counteract this effect. Can be adjusted from **0** to **0.01**.

7. TECs Tuning (Altitude and Airspeed) - Advanced

Tuning TECs (Total Energy Control System) is mainly about setting the airframe limitation correctly. Those limitations can be specified in terms of parameters that can be determined from a sequence of flight manoeuvres, which are described below.

* *You should fly in **Stabilized mode** for this tuning session.*

1st: Trim Conditions

Use throttle to adjust airspeed and pitch to keep level flight in trim airspeed.

Set **FW_AIRSPD_TRIM** to the desired trim airspeed, **FW_THR_CRUISE** to the throttle required at trim speed, and **FW_PSP_OFF** to the pitch angle required to maintain level flight at trim speed.

2nd: Airspeed & Throttle

Increase throttle while maintaining level flight using pitch control - until the vehicle reaches the maximum allowed airspeed.

Set **FW_THR_MAX** to the throttle you applied to reach the maximum airspeed during level flight, **FW_THR_MIN** to the minimum throttle the plane should fly at, and **FW_AIRSPD_MAX** to the maximum airspeed you've reached at **FW_THR_MAX**.

3rd: Pitch & Climb Rate Limits

Apply maximum throttle **FW_THR_MAX** and slowly increase the pitch angle of the vehicle **until** the airspeed reaches **FW_AIRSPD_TRIM**.

Set **FW_P_LIM_MAX** to the pitch angle required to climb at trim airspeed when applying **FW_THR_MAX, FW_T_CLMB_MAX** to the climb rate achieved during the climb at **FW_AIRSPD_TRIM.**

Reduce the throttle to **FW_THR_MIN** and slowly decrease the pitch angle until the vehicle reaches **FW_AIRSPD_MAX**.

Set **FW_P_LIM_MIN** to the pitch angle required to reach **FW_AIRSPD_MAX** at **FW_THR_MIN** Set **FW_T_SINK_MAX** to the sink rate achieved during the descent.

In a newer flight, reduce throttle **to FW_THR_MIN** and adjust the pitch angle such that the plane maintains **FW_AIRSPD_TRIM**.

Set **FW_T_SINK_MIN** to the sink rate achieved while maintaining **FW_AIRSPD_TRIM**.