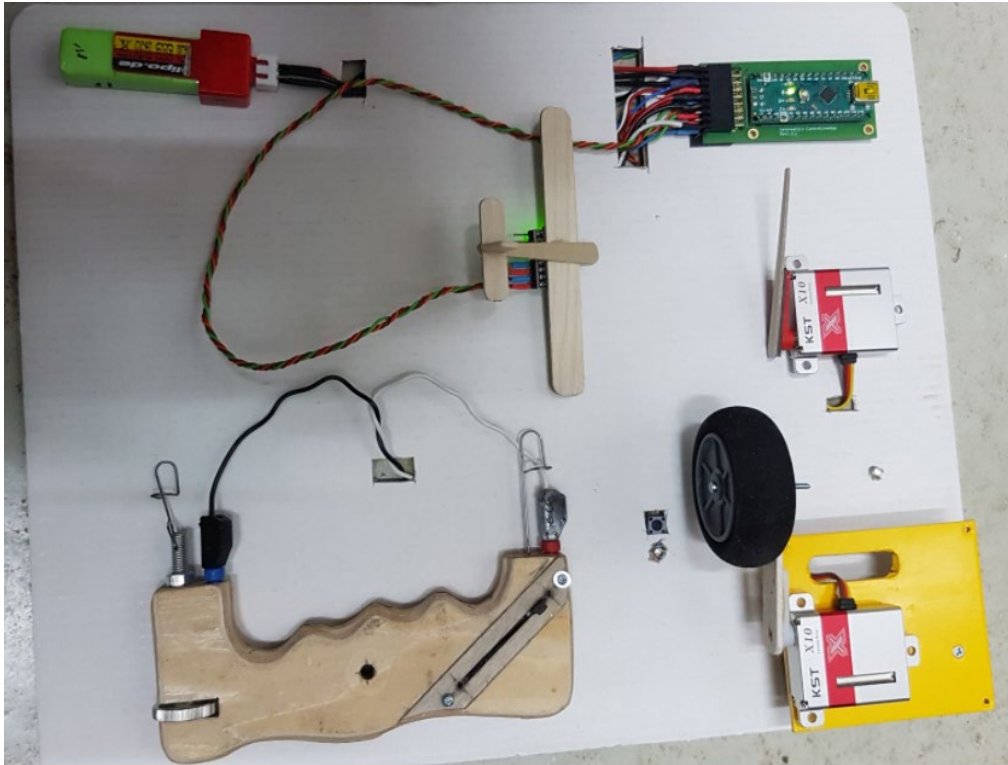


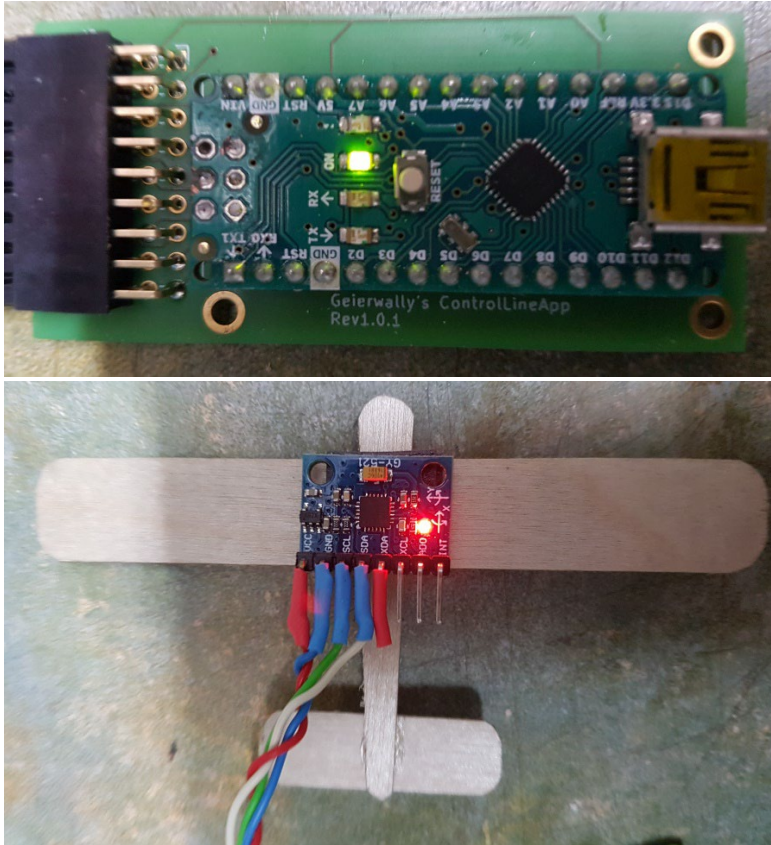
Geierwally's Control – Line – Application



Geierwally's Control – Line – Application (GCLA) realizes a throttle control in combination with position control and additional functions for control line models with stroke engines. This allows the model to be started without helpers, a flight that can be interrupted at any time and an optional automatic control of the throttle carburettor depending on the flight position. The linear potentiometer for the throttle control is located in the control handle. The encoder signal is transmitted through the two control lines, evaluated by a microcontroller (Arduino Nano) and mechanically transmitted via a servo to the throttle carburettor of the stroke engine. An LED in the edge arc of the model indicates the operating status of the controller, as well as the remaining flight time during the flight. Optionally, the position-dependent throttle control can be activated or deactivated during the flight. The position control automatically makes the engine leaner during ascending - and fatter during descending flight. The control areas can be taught. Optionally, expo from 10 – 100% can be mapped to the control. The minimum throttle position as well as the position for engine shut-off can be also taught. Flight times can be set from 1 – 10 minutes. After each minute, the remaining flight time is flashed by the status LED. If the flight time has elapsed, this is signalled by continuous flashing of the LED and by briefly throttling the engine for one second. In addition, the microcontroller monitors both cell voltages of the supply battery (2S LiPo 330 mAh). If this drops below 3.5 V for one or both cells, this is also signalled by continuous flashing of the status LED. Short throttle pulses can be used to switch the flight attitude control on or off and to control additional functions such as retractable landing gear or landing lights.

1. Description of Hardware Components

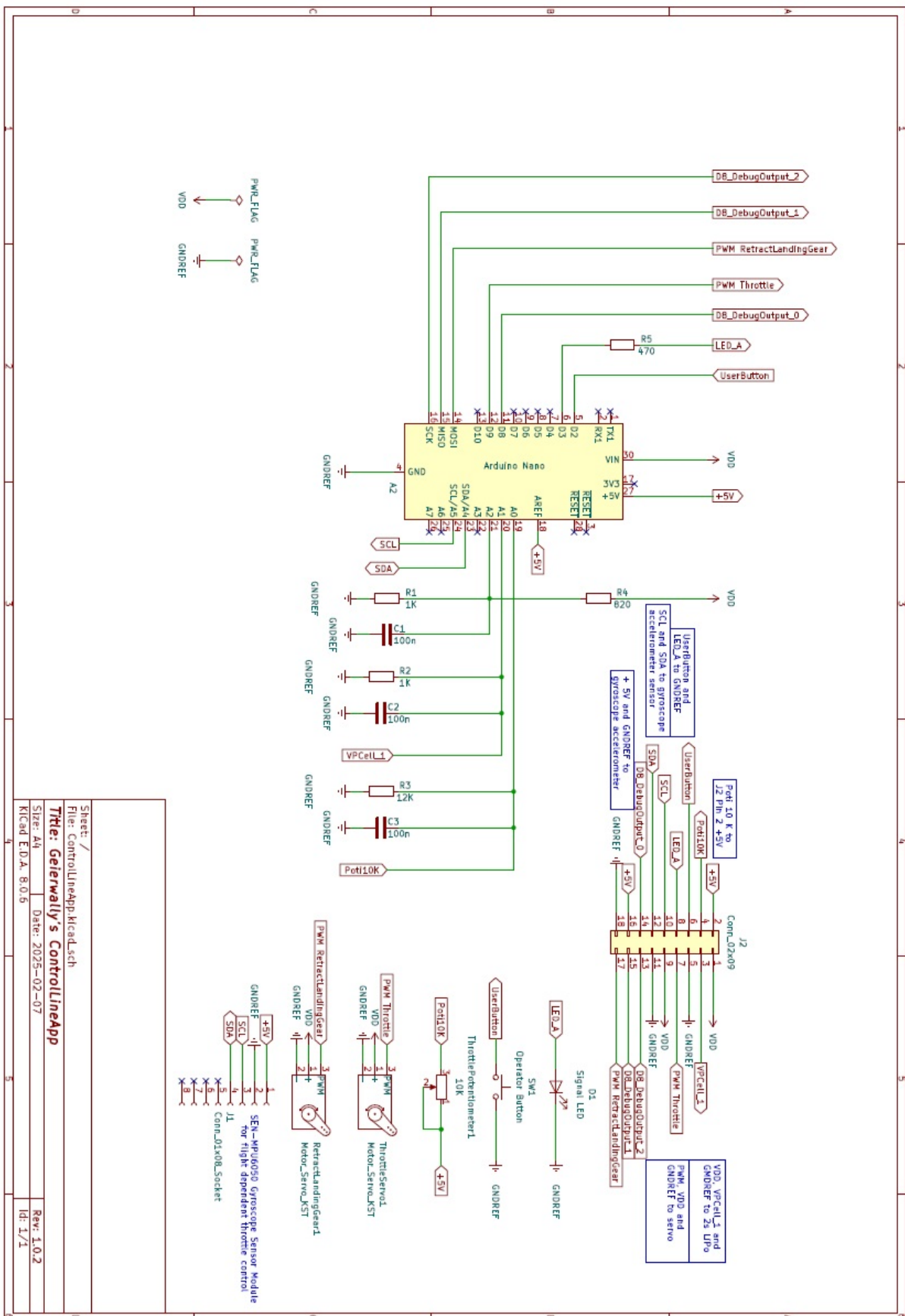
The core of the control system is an Arduino Nano microcontroller. The position control sensor is an MPU 6050 gyroscope accelerometer unit. The sensor signals are read in via I²C interface. Further connection assignments can be seen in the circuit diagram and layout in the KiCad project. The encoder for the throttle control is a linear potentiometer, which is installed in the control handle of the control line model.



2. Installation of the control components in the model

The controller board, power supply battery and servo can be installed in the wing or fuselage, depending on the space. The battery bay should be easily accessible. The MPU 6050 gyroscope unit should be installed at the pivot point of the transverse and longitudinal axis. The MPU 6050 sensor unit can optionally be mounted normally or inverted and suspended downwards. Be sure to mount the sensor unit vibration-damped, preferably using adhesive pads for helicopter gyroscopes! The encoder signal from the control handle is connected to the inner edge arch of the wing via micro banana bushings. To avoid a short circuit of the encoder cable, the control triangle of control line model must be made of non-conductive material such as Pertinax.

3. Schematic



4. Teach-in servo positions, time-of-flight timer and voltage monitoring

To avoid mechanical blockages, the control linkages from the servo to the throttle carburetor and, if used, to the retractable landing gear must be disconnected before the servo positions are taught for the first time. The front end position of the servo (full throttle) can be adjusted mechanically without blockage. The same applies to retractable landing gear retracted. To access the teach menu, press and hold the user button until the status LED signals the corresponding menu by flashing. The following main teach menu items are implemented:

teach servo throttle position	2 * flashing
teach servo end position (motor shut-off)	3 * flashing
teach servo direction	4 * flashing
encoder potentiometer end positions	5 * flashing
retractable landing gear	6 * flashing
voltage monitoring	7 * flashing
gyroscope – teach menu	8 * flashing
flight time – timer	9 * flashing

Position teaching is described in the following steps and should be done exactly in this order.

4.1. Teach-in of the encoder end positions (main menu 5 * flashing)

To do this, hold down the menu button until the status LED has flashed five times in a row.

In the submenu, the LED flashes once or twice for each end position. First, place the potentiometer in an end position and press the teach button briefly. LED now flashes twice to bring the potentiometer to the second end position and confirm with a short button click. The positions are now permanently stored in the E²Prom of the microcontroller.

4.2. Servo direction reversal, only when required (main menu 4 * flashing)

To do this, press and hold the menu button until the status LED has flashed four times in a row. This menu item can only be selected if the servo needs to be reversed depending on the mounting position in the model. In this menu item, no confirmation via the teach button is required. The servo activates or deactivates the reversal of the direction of travel. This position is also permanently stored in the E²Prom of the microcontroller.

3.3 Servo end position motor shut-off (main menu 3 * flashing)

Move the sensor to the middle position and hold down the menu button until the status LED has flashed three times in succession. Position the encoder potentiometer so that the throttle carburettor is in the end position for the engine shut-off without blocking. Confirm the position by briefly pressing the menu button. The position remains stored in the E²Prom of the microcontroller.

3.4 Servo Minimum throttle position (main menu 2 * flashing)

Move the encoder potentiometer to the middle position and hold down the menu button until the status LED has flashed twice in succession. Position the potentiometer so that the throttle carburettor is in the minimum throttle position. This position should be tested beforehand with the engine running and marked on the transducer stick. The same applies to all other throttle carburettor positions. Confirm the position by briefly pressing the menu button. The position remains stored in the E²Prom of the microcontroller.

3.5 Supply Voltage Single Cell Monitoring (Main Menu 7 * Flashing)

This function is used to calibrate the two analogue to digital converters inputs of the voltage monitor. To do this, fully charge the supply battery until a single-cell voltage of 4.2 volts is reached. Plug in the battery, press and hold the menu button until the status LED flashes seven times in a row. Further confirmation is not necessary in this teaching function. The calibration value is permanently stored in the E²Prom of the microcontroller. If one or both LiPo cells fall below 3.5 volts, the status LED signals the fault with continuous flashing.

3.6 Setting flight time timer (main menu 9 * flashing)

This function is used to set the flight time timer. Times of 1 minute – 10 minutes are possible depending on the tank volume and the resulting engine runtime. If the timer is active, the remaining flight time in minutes is signalled every minute during the flight by flashing the status LED. When the end of the flight time is reached, the status LED switches to continuous flashing and the engine throttles briefly for a second. End of flight time should of course signal before the tank is empty, so that you can still land safely with the throttle function.

To teach, press and hold the menu button until the status LED flashes nine times in a row.

You are now in the submenu and the LED flashes one to ten times depending on the number of flight minutes. You have to confirm the desired number of minutes with the menu button. This data is also stored permanently. The time-of-flight timer is started and stopped again by briefly pressing the menu button. The end of the flight time can also be confirmed by briefly pressing the menu button. When the timer is started, it immediately signals the set flight time with LED flashing.

5. Position-dependent throttle control via gyroscope accelerometer (main menu 8 * flashing)

The GCLA has an optionally activated position-dependent throttle control. The flight position is recorded by an MPU 6050 gyroscope – accelerometer sensor unit. For position control, the throttle positions for neutral and inverted flight (70 – 80% rpm) as well as the throttle position for dive (between 5 – 20% rpm) are taught. The speed positions should be set with a tachometer before teaching while the engine is running and marked on the encoder. This makes it easier to teach it later.

The position control can be switched on or off at any time during the flight by briefly throttling the engine. This is indicated by the status LED. Blink briefly twice = position control active. The optional deactivation allows the model to be started without position control and at full throttle. Otherwise, only the learned 70 – 80% speed would be active in neutral position. It should be full throttle for the start. Below is the description of the position control teach submenu

To access the Position Control Teach submenu, press and hold the menu button until the status LED flashes eight times in a row. You are now in the submenu of the position control.

The following submenu items are implemented:

sensor unit normal mounting position	1 * flashing
sensor unit hanging mounting position	2 * flashing
calibrate sensor unit	3 * flashing
throttle position normal flight	4 * flashing
throttle position dive	5 * flashing
expo	6 * flashing
position control on / off	7 * flashing

servo sensitivity	8 * flashing
position control leave teach menu	9 * Flashing

4.1 Normal mounting position gyroscope accelerometer unit (submenu 1 * flashing)

Select this option if the gyroscope accelerometer sensor unit is normally mounted from above. Depending on the space in the model, it can be mounted normally from above or suspended from below. The sensor unit should be mounted at the pivot point of the transverse and longitudinal axis in a vibration-damped manner. For this purpose, adhesive pads of helicopter gyroscopes can be used. For this function, after a single LED flash, briefly confirm with the menu button. The option will be saved and you will immediately be back in the Gyro - Teach - submenu.

4.2 Hanging mounting position gyroscope accelerometer unit (submenu 2 * flashing)

Select this option if the gyroscope accelerometer sensor unit is suspended mounted. Function is otherwise analogous to menu item 4.1. Confirm the teach after blinking the status LED with the menu button.

4.3 Calibration of the gyroscope accelerometer unit (submenu 3 * flashing)

This menu item is used to calibrate the gyroscope accelerometer unit. To do this, confirm after flashing the LED three times by clicking on the menu button. Calibration takes one minute. During this time, the model should be rotated in all axes so that the sensor comes into all possible flight positions. After one minute, the calibration data is permanently stored and you are automatically back in the Gyro – Teach – submenu.

4.4 Position control normal flight - throttle position (submenu 4 * flashing)

This is used to teach the throttle position for normal flight / inverted flight. This should be between 70 and 80% speed. It is best to determine beforehand with a tachometer and mark it on the encoder. To teach the position in the submenu, after flashing four LEDs, confirm with the menu button, move the encoder to the desired position and save it by pressing the teach button again. After that, you are back in the Gyro – Teach – submenu.

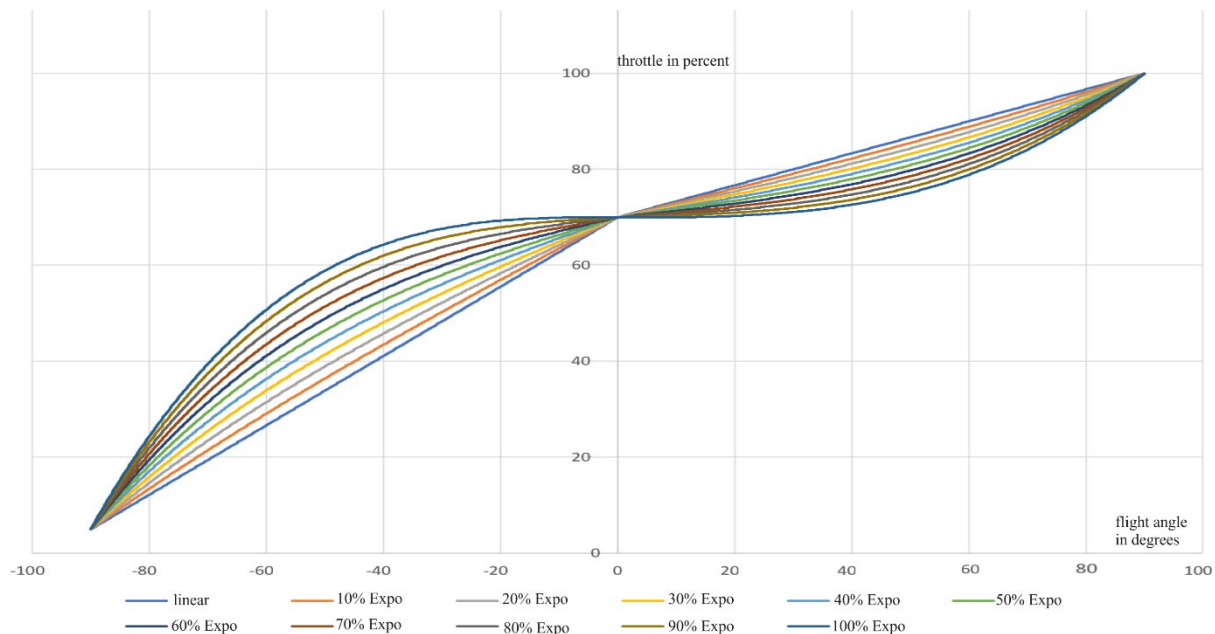
4.5 Position control dive - throttle position (submenu 5 * flashing)

This is used to teach the throttle position for diving. This should be between 5 and 15% speed. It is best to determine beforehand with a tachometer and mark it on the encoder. To teach the position in the submenu, after flashing the LED five times, confirm with the menu button, move the encoder to the desired position and save it by pressing the teach button again. After that, you are back in the Gyro – Teach – submenu.

4.6 Expo position control (submenu 6 * flashing)

With this function, you can overlay the position-dependent throttle control with expo. This works in a similar way to how you use expo on the RC models.

Confirm with the menu button after status LED has flashed six times. You can now choose between 0% = linear control curve and 100% = maximum exponential superposition in steps of ten. The following control curves were recorded directly with the controller and illustrate the application of expo to throttle control:



X-axis shows flight angle of -90° = vertical descent flight, 0° = normal/invert flight, 90° = vertical ascend flight

Y-axis shows throttle position (0 - 100 percent of maximum speed)

In the Expo – Teach menu, the status LED flashes from one to ten times briefly for the selection of the expo in percentage. One flash = 10% Expo, two flashes = 20% Expo.....ten flashes = 100% Expo. After flashing the desired percentage expo, confirm briefly with the menu button. For linear curve, i.e. no expo, the status LED flashes once long after the maximum expo position.

Whether and how much expo is needed has to be flown. This data is also stored permanently.

4.7 Flight control on / off (submenu 7 * flashing)

This option activates (1 * flashing) or deactivates (2 * flashing) position control. The position control in active state can be switched on or off by briefly throttling the engine during the flight. It only regulates when the throttle encoder potentiometer is at the set value for neutral flight or above in the direction of full throttle. This means that you can throttle the engine and end the flight at any time, even with active position control. The effect of the position control is shown in the following short video clip with a maximum expo, i.e. 100% superimposed. [Video GCLA Position Control](#)
To select function in the submenu, confirm with menu button if LED has flashed one or two times. This will save the option permanently and you are back in the Gyro – Teach – submenu.

4.8 Flight control servo sensitivity (submenu 8 * flashing)

This option starts teaching the servo sensitivity. Between single (fast) to five (slow) LED flashes, you can choose how quickly the servo reacts to the position control. If the LED flashes six times, the delay is deactivated and the servo reacts directly to the position control at maximum speed. By confirming with the menu button, the option is permanently saved and you are back in the gyro teach submenu.

4.9 Flight control leave teach submenu (Submenu 9 * Flashing)

With this option you leave the Gyro – Teach – submenu and are back in the normal control menu. To select function in the submenu, confirm with menu button if LED has flashed nine times.

6. Retractable landing gear and additional functions (main menu 6 * flashing)

The GCLA has three additional digital functions as well as the control of a retractable landing gear. These can be switched during flight operation by means of short throttle pulses. Two short throttle pulses control the retractable landing gear. Three, four and five short throttle pulses switch the additional digital functions. Additional function 1 can optionally be linked to the retractable landing gear to control a landing light. In this option, the function switches on automatically when the landing gear is extended and automatically switches off when the landing gear is retracted. The following subchapters describe the teach menu for the retractable landing gear function.

5.1 Servo end position retractable landing gear extended (submenu 1 * flashing)

This menu item is used to teach the servo end position of the retractable landing gear when extended. The position is set with the throttle sensor potentiometer. By confirming with the menu button, the position is permanently stored. The position for retracted landing gear must be adjusted mechanically at maximum deflection of the servo.

5.2 Retractable landing gear servo revers (submenu 2 * flashing)

This option inverts the direction of control of the retractable landing gear servo. Single LED flashing = normal, flashing LED twice = inverted direction. Pressing menu button saves the option permanently and the teach menu of the retractable landing gear is active.

5.3 Retractable landing gear servo speed (submenu 3 * flashing)

This submenu changes the actuation speed of the retractable landing gear servo. Options are available from single flash (fast) to five flashes (slow). The maximum positioning speed is activated with six flashes. Here, too, the selected option is permanently saved by pressing the menu button and switched back to the teach menu of the retractable landing gear.

5.4 Link additional function landing lights (submenu 4 * flashing)

This submenu optionally links the digital additional function 1 with the retractable landing gear. This can be used, for example, to switch a landing light. The following options are available: single flashing = additional function 1 linked (landing gear extended and landing lights on), double flashing = additional function 1 inverted linked (landing gear extended and landing lights off), triple flashing = no linking of additional function 1. With the menu button, the option is permanently saved and switched back to the teach menu of the retractable landing gear. Even if the link is active, the additional function 1 can be switched in parallel with three throttle pulses.

5.5 Leave teachmenu retractable landing gear (submenu 5 * flashing)

With confirmation of this option via the menu button, the teach menu of the retractable landing gear servo is closed.