Manual
ACRO CONTROL
AC-3X Version 3

Software 3.00

New in Version 3:

- New 6-axis sensor with high vibration resistance and enhanced measurement range to allow higher angular rates.
- CNC milled, anodized aluminum housing.
- Color Display with 96x64 Pixel (twice as large as AC-3X V2)
- Improved Setup menu: Option to switch between standard and expert settings to assure easy setup procedure.
- Handling of various receiver protocols: SBUS, Hott, Frysky SRXL, MPX SRXL V1 & V2, SPPM Spectrum Satellites and Standard PPM
- Integrated sensors for flight battery voltage measurement and potential free RPM measurement directly from the motor phases.
- Optionally use of external RPM sensor possible
- 200A Current sensor optionally available to record motor current and used battery capacity.
- AC-3X V3 can be mounted in various axis orientations, e.g. on the frames
- Datalogging on Mircro SD card (RC Input, Bec Voltage, Fail Safe state, RPM, Battery voltage, etc.)
- Easy firmware updates via Micro SD card.
- 135° Swashplate support
- Improved Algorithms with higher resolution on swashplate and tail.
- Pitch Pump function
- Active high speed tracking to suppress Dolphin effect.
- Powerful CPU with potential for future functional updates

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1. Introduction

ACRO Control V3 is a flybarlessystem designed to be used in electric helicopters, especially in small ones like Voodoo 400. For setup no additional equipment but transmitter and helicopter is needed. All parameters can directly be set via a three button user interface, the menu structure is displayed on the integrated coloured OLED display.

Version 3 of AC-3X has slightly increased outer dimensions than V2. Nonetheless, as the connectors are now oriented upwards, the needed space in the helicopter has not grown although V3 has more interfaces and twice the display size than V2. With its powerful CPU, V3 is ready for future SW updates which can be directly uploaded via the integrated micro SD card.

The highlights of AC-3X are the calibrated and axis decoupled sensors. The individual calibration of every AC-3X guaranties a superior flight performance, totally free of interactions between the axis (elevator, roll, tail). The sensors are temperature compensated and thus free of temperature induced drift effects.

The Swash- and Tail-Control algorithms have been improved. They are calculated with higher rate and resolution leading to remarkably improved flight accuracy. Especially at high speeds and high collective pitch, the active tracking algorithm leads to a very good elevator control. AC-3X handles high agility needed for 3D style, neutral, interaction-free, speed flight and stable hovering (F3C) in one flight condition.

AC-3X V3 has an integrated Micro SD-Slot. Setups can be saved to and read from the SD-card. Beyond this automatic datalogging is available: data can be recorded during flight and can be evaluated with Log View Studio afterwards.

AC-3X V3 has an integrated USB-Interface. Via PC SW, available soon, parameters as such can be set and also be stored on a PC.

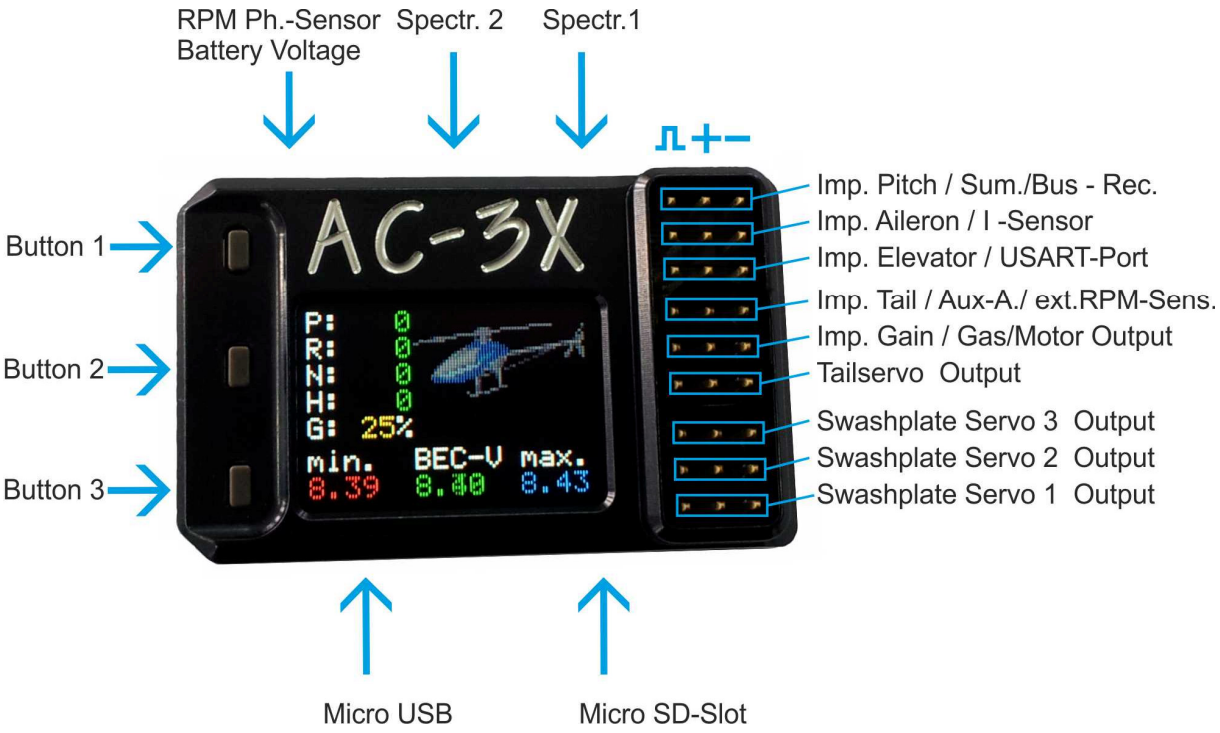
AC-3X shows the RX-Voltage including a Max and Min Voltage display. It has integrated sensors for flight battery voltage measurements and also for RPM measurement of brushless motors.

Optionally a potential free 200A current sensor is available to record current and used battery capacity (only available when using single wire receivers).

2. Technical Data AC-3X V3:

Weight	ca. 22g without cable
Dimensions Housing (LxWxH)	44mm x 27.5mm x 15,5mm
Powersupply voltage	3,5-10 Volts
Temperature range	-10° C to +45° C
Power consumption (typ.)	60 mA

Connectors and Display-Elements of AC-3X:



3. Important notes for users of prior AC-3X versions:

The sensors of AC-3X V3 have increased measurement ranges compared to prior versions which led to an adaption of the flight control algorithms. Thus the parameters of AC-3X V1 6 V2 cannot be transferred 1:1 to V3.

The tailrate at same stick input is increased by 30%. Therefore I recommend reducing the RX tail input to 75-80% in the AC-3X display to achieve the same tail rates as for 100% on V1&V2.
The same is valid for the Stick-Dynamic. It should be reduced by 20-30% in comparison to AC-3X 2.6.

On swashplate the parameters typically can remain unchanged.

Important: The directions of RC-inputs were redefined and are partly reversed in comparison to AC-3X V1&V2. Resulting from this, on most RC-systems the stick inputs need no longer to be inverted. Nonetheless, when changing from V1 or V2 to V3 adaptations are necessary, so please check all directions (stick and sensor) carefully!

4. Using the Setup menu

There are two ways to enter the AC-3X setup menu: One can either press T1 while AC-3X is starting and the Logo is displayed. After finalization of the calibration stick middle positions AC-3X then enter the setup menu. Or when AC-3X has already booted and is in flightmode, the user can enter the setup menu by pressing T1 for at least 3s.

To navigate in the setup menu, press the upper (T1) and lower (T3) buttons: the upper button leads to the next menu item, the lower push-button to the previous one. To enter the currently displayed menu item, press the middle button (T2). When you have reached the deepest menu level, T2 is used to select the parameter to be changed. A selected parameter can be increased with T1 (upper button) or decreased with T3 (lower button). When the desired value is reached, pressing T2 leads back to the menu level. To get further up on every menu level, an item “UPPER LEVEL” is existing. On the highest level the item “MENU EXIT” leads back to the flight mode.

Warning: Please do never try to fly in the setup menu! The control loops are inactive when the setup menu is activated and thus the helicopter is not controllable!

In the following I will describe the function of every single menu item of the setup menu. Before starting this, some more comments on the menu structure. In the setup menu there are some items which are marked with an (A). These items can be programmed for both flight phases separately. When you activate parameter switching, they appear twice: once for phase (A) and also for phase (B).

Furthermore the setup menu has two different modes: in the Tools Menu, expert parameters can be activated or hidden. Depending on this, parameters appear or disappear in the menu structure. Nonetheless, even when parameters are not visible, they might be automatically modified when they e.g. depend on the gain.

4.1. Swash Regler

Swash regul. Gain (only visible when Expert Menu "Off")

This factor is the general gain on swashplate. Typical values are 40% to 80%. The default value of 60% leads to good results with most helicopters. A higher value leads to more flight stability. When the gain is too high, oscillations on the elevator axis might appear. When the gain is too low, the stick feeling is very soft.

Swash regul. P-Gain (only visible when Expert Menu "On")

Proportional Gain produces a regulative action on the swashplate, which is proportional to the measured rate error on the swashplate and thus Proportional Gain makes the aileron and elevator rate follow the rate commanded on the swash sticks. A too high Proportional Gain can cause an oscillating tendency on elevator in fast forward flight and can also lead to a bad stopping behavior on elevator rate changes. Abrupt stops of flips should be free of high frequency shaking. If this is not the case the Proportional Gain is too high!
To setup Proportional Gain, one should increase the value until a wiggling tendency in fast forward flight can be noticed. From this value, one should decrease the Proportional Gain by a quarter. Normally the default value of 60% is a good compromise. With fast servos on swashplate, one can increase Proportional Gain.

Swash regul. I-Gain (only visible when Expert Menu "On")

Integral Gain is responsible that the helicopter keeps the direction under all circumstances. When wind forces the helicopter out of its direction, the Integral Gain is correcting this. Fast forward flight is also stabilized by the Integral Gain. Integral Gain must be setup so that the helicopter is stable during load changes on swashplate. When Integral Gain is set too high, the stopping behavior on swashplate is influenced negatively: the helicopter gets a tendency to slowly drift back after a hard stop. A too high Integral Gain has also bad influence on fast forward flight: The elevator control feeling becomes doughy and in extreme situations even slow oscillations (approx. 1 Hz) can appear. Thus, one should start the first flights with the default value of 60% for the Integral Gain which is working even with very slow servos.

Swash regul. Look Ahead Gain

Look Ahead Gain is a parameter that determines the direct control of the swashplate. This parameter influences the stick feeling: it influences the acceleration and stopping behavior on cyclic inputs. The more Look Ahead Gain is used, the faster the helicopter corresponds to inputs. But be aware, very high Look Ahead Gain results in a wiggling tendency on cyclic stops.
A smaller value of Look Ahead Gain results in a softer stick feeling. Typically, values between 40-80% are used. This value depends on the agility of the used main blades. Heavy blades need higher Look Ahead Gain than light ones.

Swash regul. Stick D-Gain (only visible when Expert Menu "On")

The Stick Differential Gain determines how aggressive the helicopter reacts on fast changes on the swash sticks. A higher value results in harder acceleration but also leads to more stress for the mechanics and servos. A lower value leads to a softer reaction. The default value 40% is a good compromise.

Swash regul. Sens D-Gain (only visible when Expert Menu "On")

The Sensor Differential Gain is responsible for the damping of the swashplate and locking in. A too small value leads to bad stopping behavior, a too high value leads to stress on the servos (high servo temperature) and also limits the acceleration on swashplate. Typically, the D-Gain should be of similar value than the P-Gain. Default value is 60%.

Swash Setup Pitch Pump (only visible when Expert Menu "On")

This parameter enhances pitch reaction when pitch is moved very quickly. The higher the pitch pump parameter is, the more aggressive pitch behaves. At 0%, pitch pump is deactivated, 100% is maximum value. Higher values are leading to more stress of the helicopter and the servos on swashplate.

Swash regul. Elev. Control (only visible when Expert Menu "On")

This parameter suppresses actively the nose up tendency and prevents stall on the rotor blades. It must be individually adapted as it depends on many factors. To set it, one should start at 90% and then reduce the value in 5% and finally 2% steps. Fly forward at full pitch and full speed and give some elevator input. Normally the HC will pull the nose up immediately and will become uncontrolled. When Elevator Control is set properly, this effect will be avoided and the pilot keeps full elevator control. This parameter as such is very interesting for speed pilots, as even at very high speed the elevator stays precisely controllable. When Elevator Control is set too low, at low RPM a slow wiggling on elevator will be visible. The same wiggling might appear in “Krause” TicTocs. For my Voodoo Helicopters a value of 75-85% is optimum. When 125% is set, Elevator Control function is deactivated.

Swash regul. FIX Gain 100%

By activating this menu item, the swashplate gain is uncoupled from the gain channel and thus permanently set to 100%. Practically gain on Swashplate does not depend severely on RPM and thus can be locked. This is the default setting,

4.2. Tail Regler

Tail Reg. Gain (only visible when Expert Menu "Off")

This is the general gain on tail which should be typically between 30% and 100%. The default value of 60% leads to good results on most helicopters. When the gain is set too high, there is a high-frequency oscillation tendency when load is on the tail and during stops. To set the gain, increase the value until oscillations appear and then reduce the value again. When the gain is too low, the tail might become instable. The gain strongly depends on the RPM. Thus, the initial setup should always be done at an overall gain (RC-Gain) of 100% and medium RPM (e.g. 1800). For lower RPM (e.g. 1500) the (RC-)gain then should be increased (e.g. 115%), for higher RPM (e.g. 2000) decreased (e.g. 80%). Nevertheless, when the pilot does not want to use RPM dependent RC-Gain, he can use the “Fix Gain 100%” to set gain to 100% independent on the RC value.

Tail Reg. P-Gain (only visible when Expert Menu "On")

Proportional Gain generates a steering signal on the tail servo which is proportional to the rate error. The higher Proportional Gain is, the more direct the tail follows the stick. To setup Proportional Gain, one should increase the value until the tail has a high-frequency shaking tendency and then decrease it by one third. The default value is 60%, the Proportional Gain depends strongly on the individual tail setup and thus has to be adapted to the helicopter.

Tail Reg. I-Gain (only visible when Expert Menu "On")

The Integral Gain corresponds to the Heading Hold Gain of a normal gyro. It is used to produce an angular control of the tail. When Integral Gain is too low, the tail is unstable on heavy pitch inputs and cannot hold the position. Pirouettes in forward flight are not constant in rotation.
A too high I-Gain value will result in a bad stopping behavior with a back bouncing tendency. The integral factor is almost independent on the tail setup of the helicopter. 60% is a good starting value which normally does not need to be adapted.

Tail Reg. D-Gain (only visible when Expert Menu "On")

The Differential Gain additionally stabilizes the tail during load changes and against external impacts like wind. When D-Gain is set too high, this leads to additional stress for the tail servo or even sporadic uncontrolled moves of the tail. When the value is set too low, the tail is more nervous in load changes. Typically, 0.8-times the P-Gain is a good value for the D-Gain. The default value is 50%.

Tail Reg. Stick-Dyn.

This parameter is used to adapt the reaction of the helicopter on tail input changes. The larger the Tail Rotor Stick-Dynamic is, the faster the tail control tries to follow the tail input. When this parameter is too large, the tail will have a tendency to overshoot. When it is too small, the tail is creeping to the stopping position and the stop is very soft. The default value of 25% is adapted to 600&700 size helis. On helicopters with low performance tail rotors, it is recommended to reduce this value to get smooth stopping behavior! On small helicopters with

high power tail rotors it is possible to increase the Stick-Dynamic to make the tail more aggressive.

Tail Reg. Asymmetry

With this parameter the different stopping behavior from left- and right-hand rotation is compensated. The parameter can be set from -25 to +25. For many helicopters the default value of 0% already leads to a good stop. To adapt this value use steps of 2-5% and try to symmetrize the stopping behavior. For my Voodoo Helicopters 10-15% is convenient.

Tail Reg. DMA Value

This parameter generates a torque feed forward on cyclic and collective steering inputs. The tail has to compensate all torque changes resulting from steering inputs on the main rotor. To set up this parameter, one should hoover and then suddenly give hard pitch inputs and watch the tail of the helicopter. While pitching, the tail will follow the torque of the rotor head. One has to increase the value of DMA Gain until the tail movement on pitch inputs has a minimum. When the value is too high, it can happen that the tail even moves against the torque! DMA can be either positive or negative (-100% to +100%) depending on the tail geometry, the direction has to be set in the following way. When increasing pitch, the tail rotor is pushing in opposite direction to the main rotor torque. On my Voodoo helicopters the default value 50% is appropriate. On other helicopters this value has to be adapted individually.

Tail Reg. DMA-Dynamic (only visible when Expert Menu "On")

This parameter controls how fast DMA changes are transferred to the tail servo. Usually swashservos are slower than the tailservos and this parameter is limiting the tailservo reaction on DMA to achieve similar speeds on the servos. The faster the swashservos are, the higher this parameter can be set. 30% is a typical value for fast digital swash servos. When this parameter is set too high, the tail becomes nervous during fast pitch changes, e.g. in Tic-Tocs. When this value is too low, DMA is too late and the tail is following the torque when pitching.
This parameter is for a finetuning of the DMA which most pilots won´t need. Thus it is only activated in expert mode.

Tail Reg. FIX Gain 100%

As already mentioned above, by activating this menu item, the tail gain is uncoupled from the gain channel and thus permanently set to 100%. When the swashplate gain is locked as well, AC-3X can be operated without an RC gain input.

4.3. Swash Setup

Pitch Mixer

The Pitch Mixer determines the traveling path of the swash servos on pitch inputs. The default value is 80%. To change the pitch direction, the sign in the pitch mixer has to be changed. To change pitch values in AC-3X, one has to use the Pitch Mixer **and not** the Servo Travel adjustment!

Aileron and Elevator Mixer

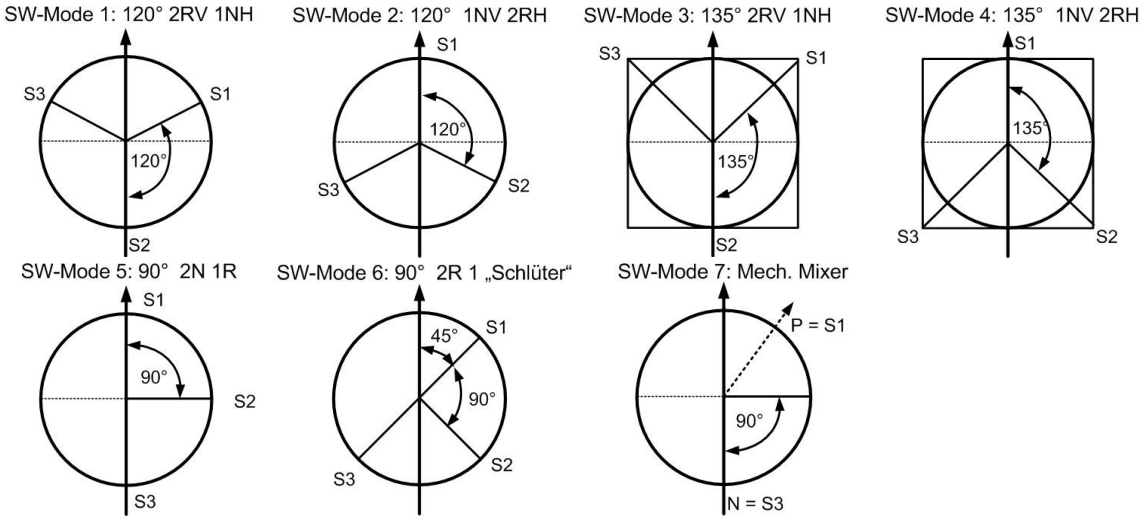
The Aileron and Elevator Mixers are used to setup the aileron and elevator rates of the helicopter. In difference to the Pitch Mixer, the Aileron and the Elevator Mixer doesn't influence the servo travel on the cyclic inputs. This must be done via travel adjustment and

the length of the servo levers. A change of sign in the Aileron and Elevator Mixer changes the direction of Aileron or Elevator. The default value on booth parameters is 80% and should be used for the first flights. 100% corresponds to relatively high agility comparable with a small helicopter with conventional rotor head.

Swash Typ

With this parameter the type swashplate configuration is selected. The following configurations are supported:

- 1 = 120° swashplate with 2 aileron servos in front and one elevator servo in the back (e.g. Voodoo)
- 2 = 120° swashplate with one elevator servo in front and 2 aileron servos in the back
- 3 = 135° swashplate with 2 aileron servos in front and one elevator servo in the back
- 4 = 135° swashplate with one elevator servo in front and 2 aileron servos in the back
- 5 = 90° swashplate with two elevator servos and one aileron servo
- 6 = 90° swashplate with one elevator servo and two aileron servos
- 7 = mechanically mixed swashplate: pitchservo = servo 1, aileron servo = servo 2, elevator servo = servo 3.



Pitch-Asym. (only visible when Expert Menu "On")

Pitch Asymmetry can be used to compensate mechanical imperfections which lead to asymmetric pitch travels. 20% deviation can be compensated. At positive values the positive pitch is increased, the negative pitch will be decreased. At negative values it is vice versa.

SW-Rotation (only visible when Expert Menu "On")

With this parameter the swashplate can be rotated as a whole by +-60° to compensate mechanical rotations of the linkage e.g. on multi-blade rotor heads.

TS-Swash Ring (only visible when Expert Menu "On")

This parameter limits the maximum cyclic travel, the swashplate can do in flight mode. Standard value is 130%. When the helicopter shall be flown at low rpm and high cyclic agility, it might be useful to increase the swash ring parameter to get sufficient cyclic travel. But please check whether the rotor head mechanically allows this high travels without blocking. Please keep also in mind that high cyclic travels on swashplate might lead to a situation where the tail rotor can no more compensate the induced torque and thus the tail might slip in high load situations.

4.4. Servo Setup

Servo Zero Position

This parameters influence the neutral positions of the servos. The levers should be mounted to the servos with this parameters set to 0.
The levers must be oriented as good **perpendicular to the leverage** (not necessarily to the servo housing) to the swashplate or to the tail rotor as possible. Fine corrections can be done with the neutral position parameters for each servo individually.

Servo Reverse

This parameters change the servo directions for each servo.

Servo Travel Adjust

This parameters scale the travel of the swashplate servos. The default value is 1000. If possible, try to adapt the mechanical setup of the rotorhead in a way that **in setup menu with default Elevator and Aileron Mixer (Elevator=80, Aileron =80, Stick inputs are forwarded 1:1)** the Elevator and Aileron pitch travel is approx. 7°. If this is not possible, the travel can be adjusted electronically by the travel adjust parameter. This parameter can also be used to compensate individual servos travel variations. For electronically mixed swashplates it is important that all servos do exactly the same travel (check this via pitch).
When the value is more than 300 deviating from the default value 1000, it is needed to achieve the 7° cyclic travel. Then the servo lever length should be adapted. The swash control works better the nearer the standard value of 1000 is met.

Servo Limits

This parameter sets the maximum limit for servo travel in both directions. As orientation the currently active direction of the servo is displayed in brackets.

Swash Servo 1-3 Limit A

This parameter limits the swash servo travel in direction A. These limits must be set in a way that the servos cannot block mechanically. Default is 1400. When necessary due to mechanical constraints, the limit can be reduced.

Swash Servo 1-3 Limit B

This parameter limits the swash servo travel in direction A. These limits must be set in a way that the servos cannot block mechanically. Default is 1400. When necessary due to mechanical constraints, the limit can be reduced.

Tail Limit A

This parameter limits the tail servo travel in direction A. This limit must be set in a way that the servo cannot block mechanically. The lever length should be selected in a way that servolimits are within 900-1200. Default value at delivery is 1000.

Tail Limit B

This parameter limits the tail servo travel in direction B. This limit must be set in a way that the servo cannot block mechanically. The lever length should be selected in a way that servolimits are within 900-1200. Default value at delivery is 1000.

Swash-Servo Frequenz

This parameter controls the framerate of the swashplate regulator algorithm and the swash servo signals are updated. Values from 65-200 Hz are possible. Most digital Servos can handle 200 Hz (e.g. Futaba). With analog servos the SWSH frequency should be limited to 65-80 Hz. The update frequency has a big influence on the grade of the swashplate stabilization. The higher the frequency the better the swashplate is stabilized. The default value is 200 Hz.

Tailservo Typ 1-3

With this parameter the neutral pulse length and the framerate of the tail servo is chosen. Typ 1 should only be used when other types are not supported as the performance is limited. The following types are supported:

	Framerate	**Center Impulsewidth**	**Example Servos**
Type1	160Hz	1520 µs	Digital Standardservos
Type2	320Hz	1520 µs	Digital Gyroservos (Futaba 9253/4/7...)
Type3	320Hz	760 µs	Futaba 9251/9256/BLS251

4.5. Stick Setup

Swash Expo

This parameter is used to adjust expo feeling on cyclic inputs. With the default value of 70%, the stick feeling is similar to a normal Bell Hiller Head without Expo. The higher the value, the less cyclic reacts around midstick. Typically 30%-100% are used.

Tail Expo

This parameter is used to adjust expo feeling on the tail stick. The higher the value, the less the tail reacts around midstick. The default value is 90%. Typically 30%-100% are used.

Deadband (only visible when Expert Menu "On")

The stick Deadband sets a limit on the stick inputs below which the input are ignored (except on pitch). The default value of 15 corresponds to 1.5% of a full stick travel. When the transmitter has no poti drifts, one can reduce this parameter considerably.

Cal Precision (only visible when Expert Menu "On")

The calibration of the middle position of the sticks on cyclic and tail works in the same way as the sensor calibration: two values are taken on each channel and compared with each other. The maximum acceptable deviation is set with this parameter. The Default value is 10%. With good transmitter potis it can be lowered. But be careful, a too low value will lead to very long calibration times or will even cause an RC-calibration failure.

4.6. Gyro Sensor Setup

Aileron Sensor Norm/Rev

This parameter will change the direction of the sensor on the aileron axis. The sensor direction must be set in a way that the regulator compensates the swashplate movement when the helicopter is tilted around the aileron axis. In this menu, all stick inputs in AC-3X are deactivated so that the servos only react on the sensors. The servos do not automatically go back to the center position!

Elevator Sensor Norm/Rev

This parameter will change the direction of the sensor on the elevator axis. The sensor direction must be set in a way that the regulator compensates the swashplate movement when the helicopter is tilted around the elevator axis. In this menu, all stick inputs in AC-3X are deactivated so that the servos only react on the sensors. The servos do not automatically go back to the center position!

Tail Sensor Norm/Rev

With this parameter one can invert the direction of the tail stabilization. It must be set in a way that tail movements are damped. When the helicopter is rotated around the main shaft, the tail blade rear ends must move to the same direction in which the tail is moving. In this menu all stick inputs in AC-3X are deactivated so that the servos only react on the sensors. The servos do not automatically go back to the center position!

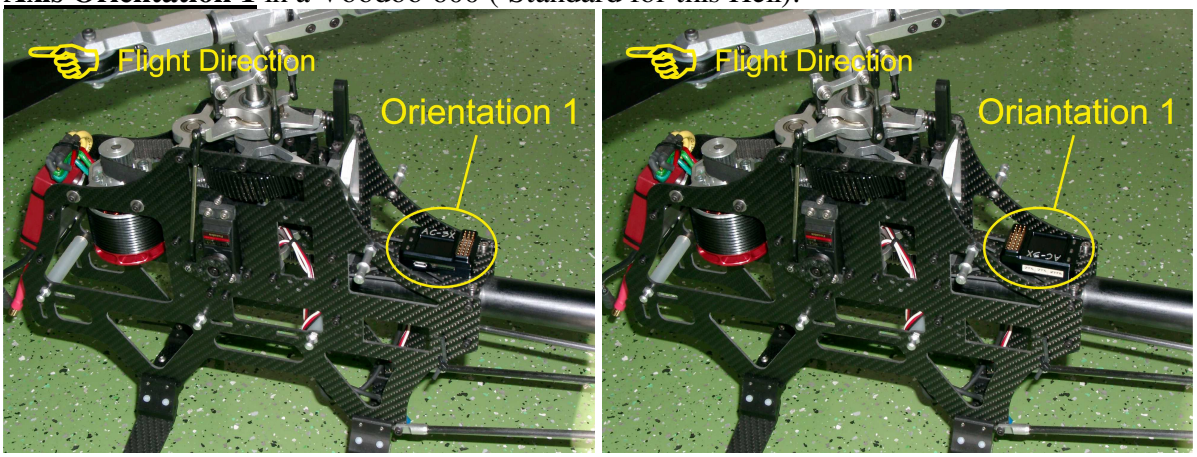
Axis Orientation

This parameter defines the orientation of the AC-3X in the helicopter:

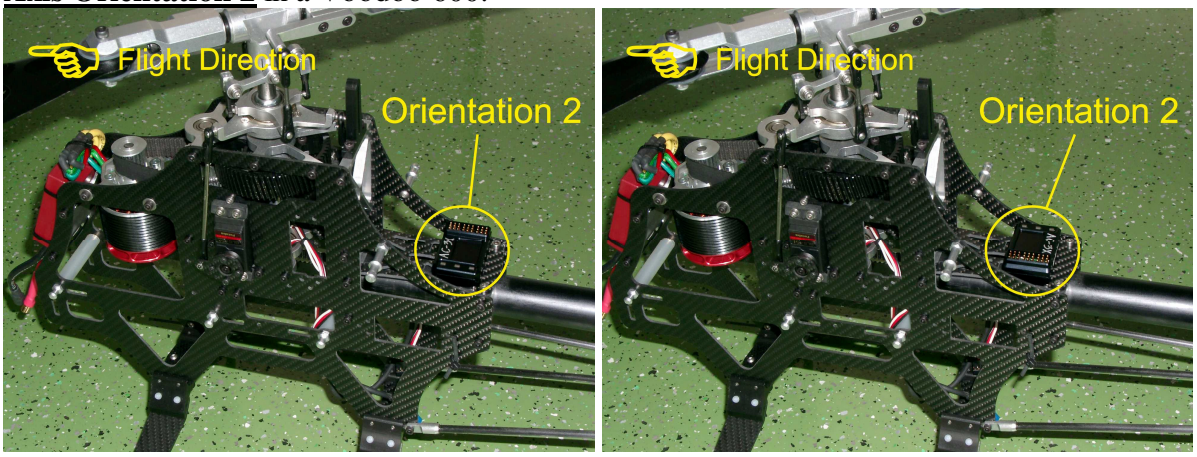
- 1 = Display shows up and the servo connectors are in front or in the back relative to flight direction (this is standard orientation).
- 2 = Display shows up and the servo connectors are in right or left relative to flight direction.
- 3 = Display shows to right or left and the servo connectors are up or down relative to flight direction

4 = Display shows right or left and the servo connectors are in front or in the back relative to flight direction.

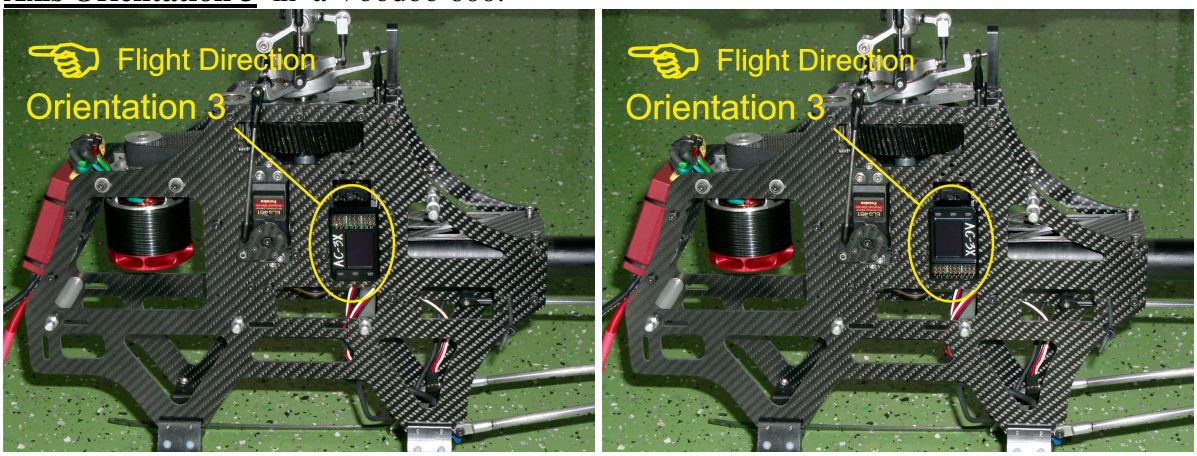
Axis Orientation 1 in a Voodoo 600 (Standard for this Heli):



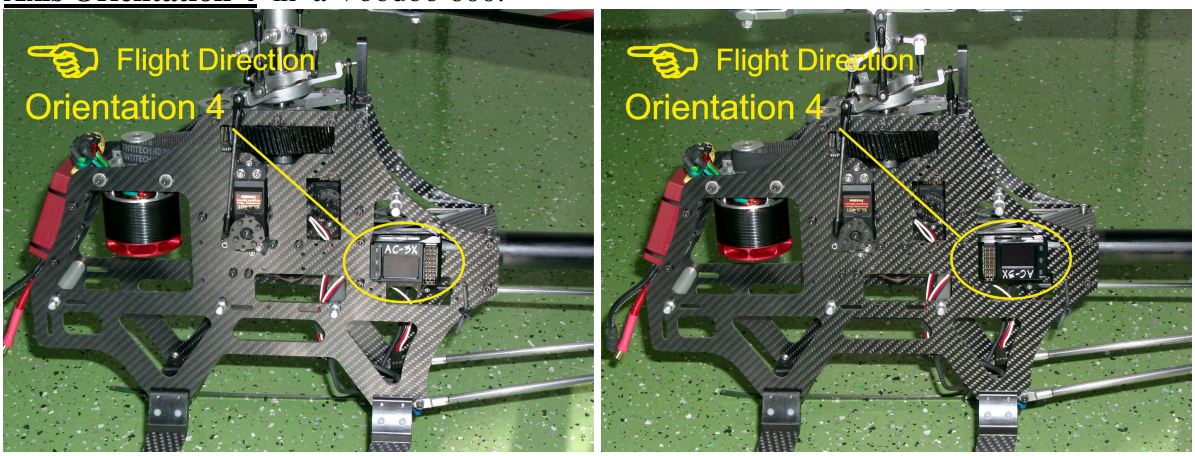
Axis Orientation 2 in a Voodoo 600:



Axis Orientation 3 in a Voodoo 600:



Axis Orientation 4 in a Voodoo 600:



Axis Rotation Nor./ Off/ Rev.

This parameter controls the rotation direction of the swashplate in pirouettes. When entering to this menu item, all stick inputs are deactivated and the swashplate tilts into forward or backward direction (depending on the servo geometry). When the helicopter will be turned by 90° around the rotor axis, the swashplate tilt should rotate to the opposite direction then the helicopter. E.g. rotating the helicopter counterclockwise, the swashplate tilt should rotate clockwise so that in principle the position of the swashplate doesn't change with respect to the room. The swashplate rotation in this menu can also be deactivated.

Linear Sensor Cal (only visible when Expert Menu "On")

In this item it is possible to recalibrate the zero signals of the linear acceleration sensors of the AC-3X. To do so, the AC-3X must be lie on a horizontal table and then the middle button should be pressed. To leave the menu please press the middle button a second time.

4.7. Receiver Setup

At first an important advice regarding the receiver setup menu: please disconnect the speed controller or remove the motor belt when the receiver settings are changed. This avoids injuries due to undesired starting of the rotor.

Receiver Protocol Typ

This parameter is used to determine which receiver type is connected to the AC-3X. Seven modes are currently supported:

- Typ 0 = Standard PPM Receiver (each channel connected with a single cable)
- Typ 1 = SPPM Single Wire, Channels are submitted sequentially e.g.: Futaba R6107 SP, “Summensignal”
- Typ 2 = Futaba SBUS Protocol
- Typ 3 = Graupner Hott "SUMD" Protocol
- Typ 4 = FrySky Futaba SRXL Protocol
- Typ 5 = MXP SRXL V1 and V2 Protocol
- Typ 6 = Spectrum DSM2 Satellite Connection
- Typ 7 = Spectrum DSMX Satellite Connection

When changing the receiver type, the standard channel presets for this receiver type are set. These settings must be checked and maybe changed afterwards.

Pitch Channel

This parameter defines the pitch channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick.

Aileron Channel

This parameter defines the aileron channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick.

Elevator Channel

This parameter defines the elevator channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick.

Tail Channel

This parameter defines the tail channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one

can immediately recognize whether the correct channel is selected by moving the transmitter stick.

Gain Channel

This parameter defines the gain channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick.

Throttle Channel

This parameter defines the throttle channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick. The throttle channel is forwarded to the 5th connector from the lower side of the AC-3X where the motor controller has to be connected.

AUX Channel

This parameter defines the AUX channel when using Single Wire PPM or Bus-receivers. The small number on the left in the third line shows the current value of the channel. Thus, one can immediately recognize whether the correct channel is selected by moving the transmitter stick. The AUX channel is forwarded to the 6th connector from the lower side of the AC-3X and can be used for various purposes, e.g. for a landing gear.

Throttle F/S Pos.

In this menu item the throttle position for F/S mode is programmed. This impulse length is transmitted on the ESC output when no valid RC-Signal is available on the throttle channel of a single wire or bus receiver. The transmitter should be set to motor off position and this position should then be saved by pressing T2. **This procedure is very important, the programming should be done in any case!**

Failsave Time

Failsave Time is the time, AC-3X waits before transmitting the programmed „Throttle Failsave Position" when there is no more RC-Throttle Signal. The default value is 2s.

Automatic Receiver Type Detection

When this function is activated, AC-3X automatically searches for the connected receiver. For this function, receiver and transmitter have to be switched on. Normally the automatic detection of supported receiver types works fine. When the receiver is detected, the AC-3X assigns the default channels also automatically with the default values of the receiver manufacturer. **Nevertheless the channel assignment has to be verified by the user**. In case of miss-assignment it has to be corrected. All channels should be controllable from -100% to +100%.

Spectrum Sat Binding

Some important remarks regarding the use of Spectrum Satellites:

- Never use a mixture of DSM-2 and DSM-X satellites. Use either two DSM-2 or two DSM-X satellites!

- The use of only one satellite is possible. When doing so, keep in mind that the transmission range might be reduced severely in comparison to two receivers. This should only be done on small models and the pilot should not fly too far.
- When the satellites have been bound successfully, you should test the RC-connection for some time (> 15 minutes) without switching off. When no binding issues appear during this test, you are ready for flight.
- DSM-X satellites always have to be bound with the DSM-X menu, even when the transmitter only supports DSM-2.
- When satellite binding is initiated, the AC-3X automatically sets the default channel assignment.
- There have been several discussions that there might be binding issues with satellites when not using spectrum receivers. Thus, I cannot guarantee that binding is working with any satellite on the market.
- It is possible to connect satellites to the AC-3X which have already been bound to a transmitter, re-binding is not necessary.
- When using Spectrum Satellites, it is very important that the receiver voltage does not drop below 4 Volts. Below this voltage, the satellites might loose their binding to the transmitter.

Binding DSM-2

When this menu item is activated, the connected Spectrum DSM-2 satellites are set to DSM-2 Binding Mode, the receiver type is also set on DSM-2 and the corresponding Spectrum default channel assignment is done.

Binding DSM-X

When this menu item is activated, the connected Spectrum DSM-X satellites are set to DSM-X Binding Mode. The receiver type is also set on DSM-X and the corresponding Spectrum default channel assignment is done.
When the satellites are bound in DSM-2 Mode, it would lead to only +-50% channel travel. The receiver type has to be set to DSM-2 manually.

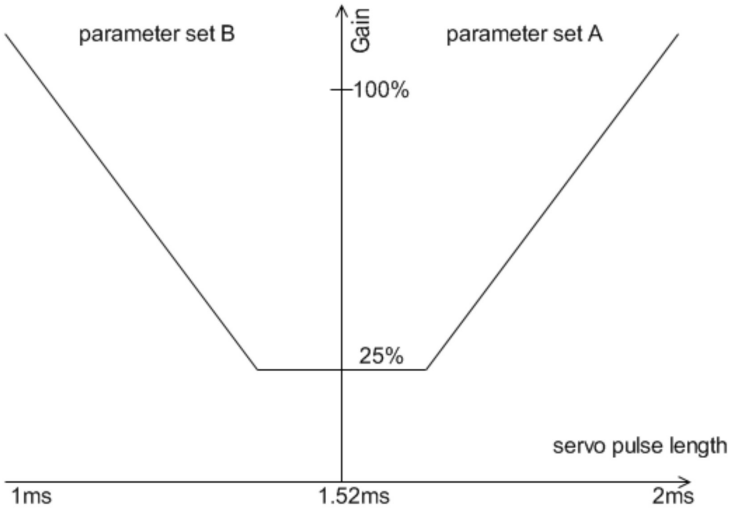
4.8. Tools Menu

Expert Menu On/Off

This parameter determines, whether AC-3X shows all available parameters in the menu structure or will suppresses only some parameters which most users won´t need to change. Especially for pilots who are new to AC-3X, it would lead to an easier handling while experts can use various parameters to fine tune the setup. Per default Expert Menu is switched off.

Parameter Switch On/Off

In this menu item, a mode can be activated in which one can choose between two sets of control parameters by switching the gain input (see figure below). When it is activated, all menu items marked by (A) appear a second time marked with (B), once for the parameter set A and once for the parameter set B. When activating parameter switching, all parameters from set A are copied to parameter set B. This is done in order to avoid that non-fitting parameters can cause a damage of the helicopter. The parameters then can be edited individually. But be careful: by deactivation of parameter switching, all changes done on set B will be lost as with the next activation of parameter switching, set A will be copied to set B once again! The figure below shows which Gain values correspond to which parameter set. When parameter switching is activated the currently activated parameter set is indicated by an A or B following the % sign of the Gain channel.



Auto Trim (On/Off)

In this menu item, the auto trim function of AC-3X can be activated. In the auto trim mode, AC-3X optimizes the trim parameters for all function automatically. The activation of auto trim is indicated by „Trim“ in the left upper corner of the AC-3X status screen. When activated, AC-3X optimizes trim parameters right away from the start of the helicopter. A trim flight should be performed at low wind condition and should last at least 30s with minimum steering inputs. After the trim flight, set the helicopter back on the ground **and leave pitch around 0° (to avoid erroneous offsets of the trim values resulting from steering inputs on the ground)**. Then press the lower AC-3X button to store the optimized parameters. The storage of the parameters is indicated by a „Save“-symbol in the right upper corner of the AC-3X status screen. By saving the parameters, the auto trim function is automatically de-activated. After restart of the AC-3X you will immediately fly with the new trim values. The saved trim parameters are only erased by activating the trim function once again.

BEC V Warning

In this item, the user can set a voltage level. Below such level, the voltage value monitored in the AC-3X display will start blinking in order to indicate, that this level was under-run. If this was the case the blinking is re-setted by restarting or opening the setup menu.

Calibrate I - Sensor

This function is needed to calibrate the offset of the optional available current sensor. This has to be done once after the first connection of a new current sensor. The sensor has to be connected on the 8th connector counted from the lower side of AC-3X. During calibration, it must be assured that there is no current on the sensor. If no sensor is available, an error message "I - Sensor not found!" will appear. The current sensor can only be used when a single wire receiver is used.

Motor Poles

This item is only relevant when the RPM measurement is used. To display and log RPM correctly, AC-3X needs information on the number of magnetic poles of the used motor.

M. Gear-Rate

This item is only relevant when the RPM measurement is used. To display and log RPM correctly, AC-3X needs information on gear ratio Motor : Rotor.

RPM-Sens. int. (On/Off)

In this setting, the user can determine whether the RPM measurement is done with the AC-3X integrated phase sensor or via an external RPM Sensor (e.g. Hyperion Phase Tach Sensor). The external sensor has to be connected to the sixth connector from the lower side of AC-3x. "On" means using the internal sensor. RPM measurement with external sensor is only possible when single wire receivers are used. In this case the AUX-servo port is deactivated.

Auto-Menuexit

In this menu item, a time can be entered after which the AC-3X leaves the setup menu automatically. The default value is 120s! I recommend changing this value after the initial setup, to a time less than the speed controller speeding up time (e.g. 10s). This prevents starting in setup mode.

Menu Language

With this parameter the language can be changed from German to English and vice versa. 0 is German, 1 English.

Save Data to SD-Card

When this function is selected while an SD card is inside the slot, AC-3X saves all settings in a file called "AC3X_PAR.SAV". This file can be read with the following function to restore the settings.

Read Data from SD-Card

This menu item is used to read a setup-file from SD card. **Please be careful: This function erases all AC-3X parameters with the parameters from the file!** There is no way back, thus only choose this function if you are really sure. Only when AC-3X gives a feedback **"Read Data from SD OK !" all parameters where saved successfully. Nevertheless a check of parameters is obligatory!**
When reading a file from SD-Card, also the trim- and servo parameters are restored from the file. Thus when reading parameters from a file saved with an identical helicopter, one should nevertheless check servo zero positions, servo Limits and one should perform a new trim flight.

Factory def. Data load

This function sets all parameters to factory data. **All configurations will be lost!**

Data logging

AC-3X can log data of various parameters during flight. Logging is automatically activated when an SD-Card is inserted during start-up.
The AC-3X data format is adapted to Logview Studio, in the current release an import filter will be included. Every time AC-3X is connected to power, it starts a new log file. The files are numbered sequentially up to AC3X999.LOG starting from AC3X000.LOG. As result, AC-3X can log 1000 files without erasing an old file. Parameters included in the log are:

- BEC-Voltage

- Flight-Battery-Voltage (when JST cable is connected)
- Motor Current (when external current Sensor is connected)
- Headspeed (when JST cable or external RPM-sensor is connected).
- Used capacity (when external current Sensor is connected)
- Pitch stick Position
- Aileron stick Position
- Elevator stick Position
- Tail stick Position
- Gain value
- Motor position (when using single wire receivers)
- Frames per second, delivered by the receiver. This is an indicator for the link quality.
- Hold (only single wire ppm receivers)

Voltage- and Motor-RPM measurement for Data logging

The 4-pin JST cable delivered with AC-3X (40 cm standard length) can be used to record and display flight battery voltage and motor RPM.
Optionally, a cable with 60 cm length for big helicopters is available.

The color code of the cable is as following:

Pin 1 black wire	: flight battery minus
Pin 2 red wire	: flight battery plus
Pin 3 white wire	: Motorphase 1
Pin 4 white wire	: Motorphase 2

Flight battery voltage can be logged up to 70V, thus 14s Lipo batteries can be logged.

The sensor wires to the motor phases can be connected to any two phases of brushless DC motors operated with a voltage between 3s and 14s. They are optically decoupled. There is no electrical connection to the power circuit.
It might appear with some controllers, that due to an individual motor control technique, the RPM measurement with the internal sensor is not working. In these cases an external RPM sensor has to be used!

When installing the cables, take care that they are fixed tight. They are directly connected to the flight battery voltage or the motor phases. I recommend using the shrinking tube to isolate the cables.

The BEC voltage is also continuously logged down to 3.6V. When the voltage drops lower, AC-3X will be operative down to 2.7V but the voltage measurement won´t be precise anymore. The minimum and maximum BEC voltages are displayed, and those values are an important indication on the quality of the RC-supply. Voltage increases due to current feedback of brushless servos can also be monitored!

Current Measurement and logging with current sensor

The optional current sensor can only be used with receiver types different to Type 0 (PPM receiver). The current sensor is connected to 8th connector from the lower side of AC-3X, which is for receiver input when using Type 0 PPM receivers.
The current sensor is a Hall sensor which is measuring inductively without electric connection to motor circuit. This simplifies the wiring effort and enhances safety. The measurement range of the sensor is up to 200A but it can also handle short peaks (2s at 400A). The measurement tolerance of an inductive sensor is a little bit higher than for a shunt sensor. The AC-3X has a tolerance of 3% which is sufficient for our purpose.

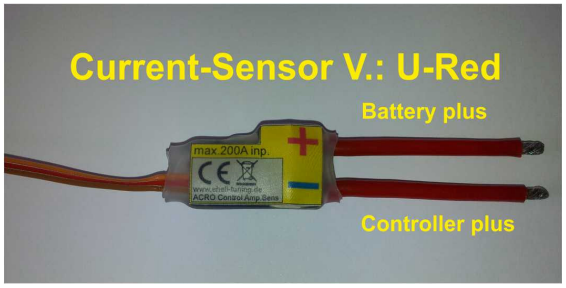
When a new current sensor is connected to the AC-3X for the first time, the zero offset of the sensor has to be stored in the "Tools Menu". For this purpose no current should pass the sensor cables. In case the helicopter is flown with BEC, please use a conventional receiver battery for zero offset calibration.

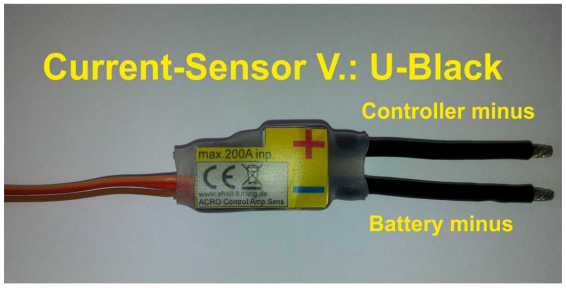
When the current sensor is connected to the AC-3X and correctly calibrated, the AC-3X will display and log the used battery capacity of the current flight automatically.

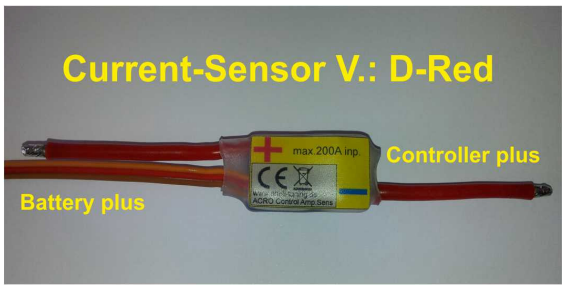
The leads of the current sensor can either be connected to the plus or minus cable of the motor controller. The only important thing is the direction of the current: The sensor can only measure in one direction, when it is connected in the wrong direction the sensor doesn't work but is not damaged. The sensors are available with red or black leads, depending on where you want to connect it (plus or minus cable). Please note the color in your order.

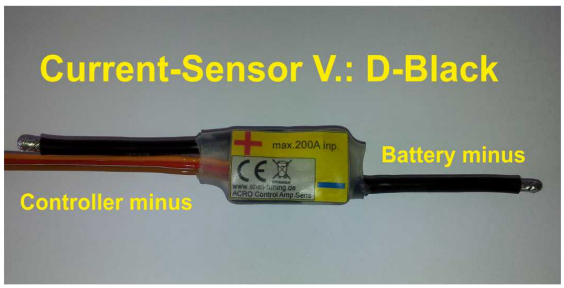
The sensor price is 49,00 Euro including 19% vat.

In the following some pictures of the four available sensor-variants:









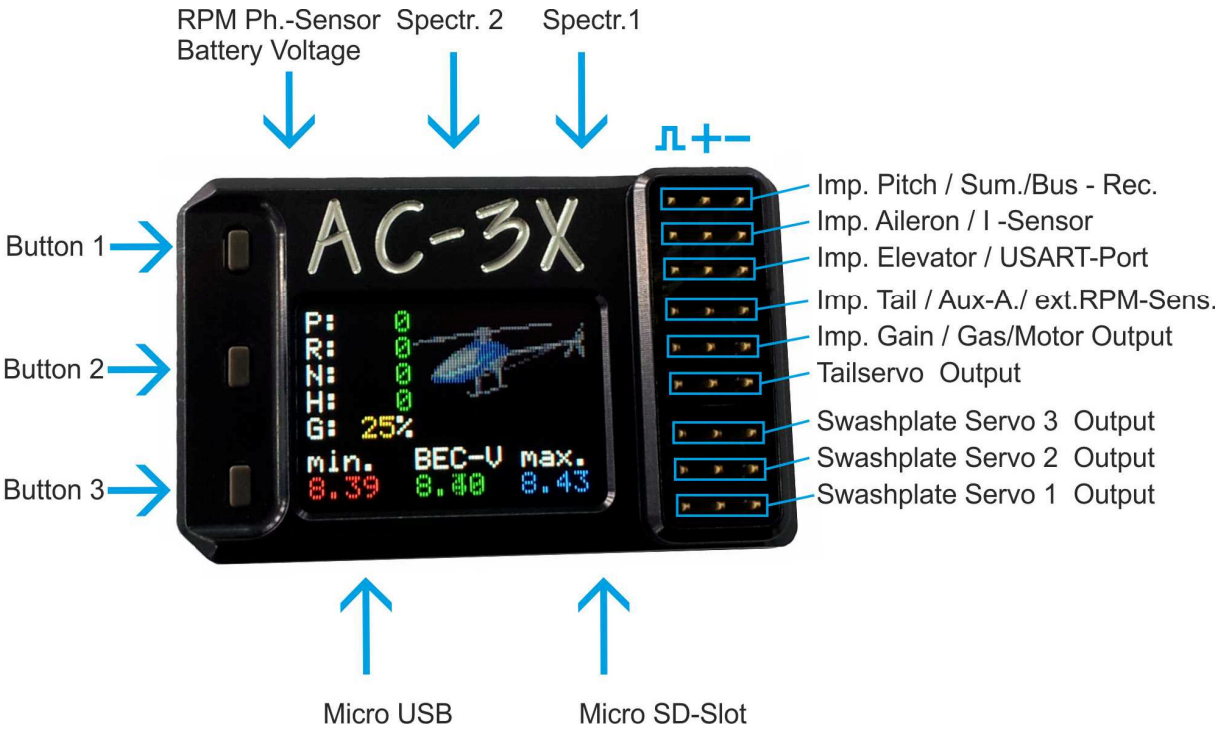
5. Integration into the Helicopter

The place to mount AC-3X should be chosen in a way that it is as free of vibration as possible and it should be rigidly connected to the helicopter chassis. The length of the servo leads shouldn't be too long. Most recent, helicopters have already an adequate place for the flybarlessystem foreseen.

AC-3X should be mounted on the platform with the delivered double sided tapes. It should align precisely to the helicopter axis. The surfaces of AC-3X and the platform should be cleaned prior to gluing the tape.
Keep in mind to leave some space to be able to insert the SD-card into the card slot without dismounting AC-3X. This is necessary to remove the card for analyzing the logfiles.

On some helicopter, especially when they have a fuselage, it might be convenient to mount AC-3X on the side frames of the helicopter, the possible mounting orientations have already been explained in the Gyro Setup chapter above.

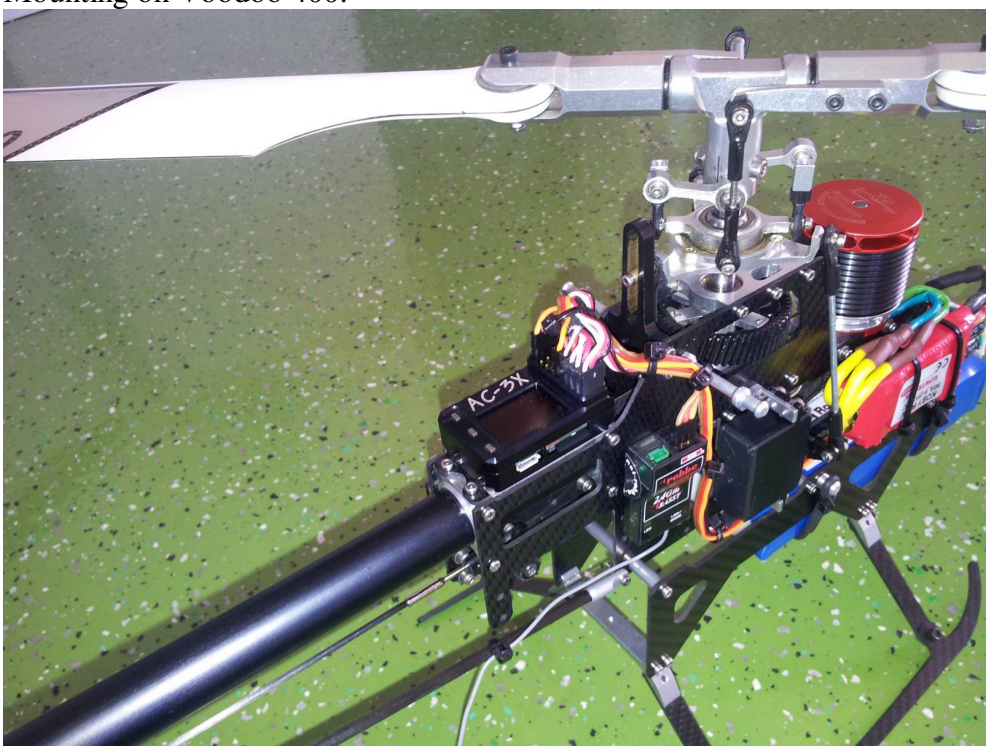
The connector assignments for servos, receiver etc. you can see in the following figure:

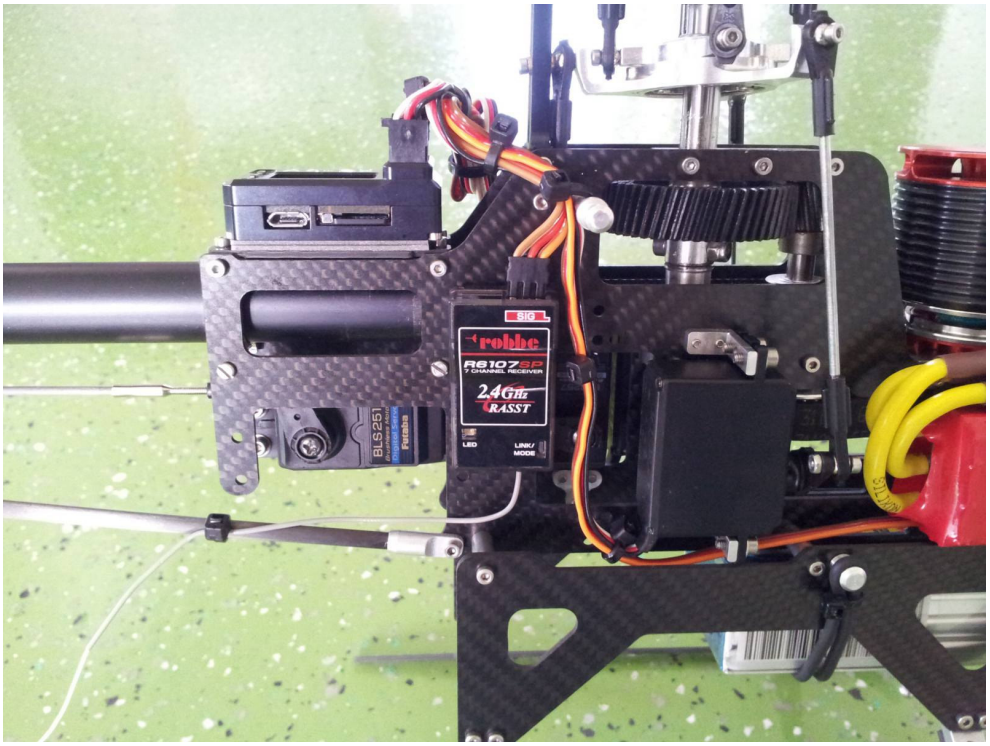


Here two mounting examples: one for my Voodoo 400, one for Voodoo 600/700:

On my Voodoo 400, **two tapes** should be used on top of each other to achieve enough separation from the screws holding the sensor platform and to allow to mount AC-3X close to the swashplate guidance.

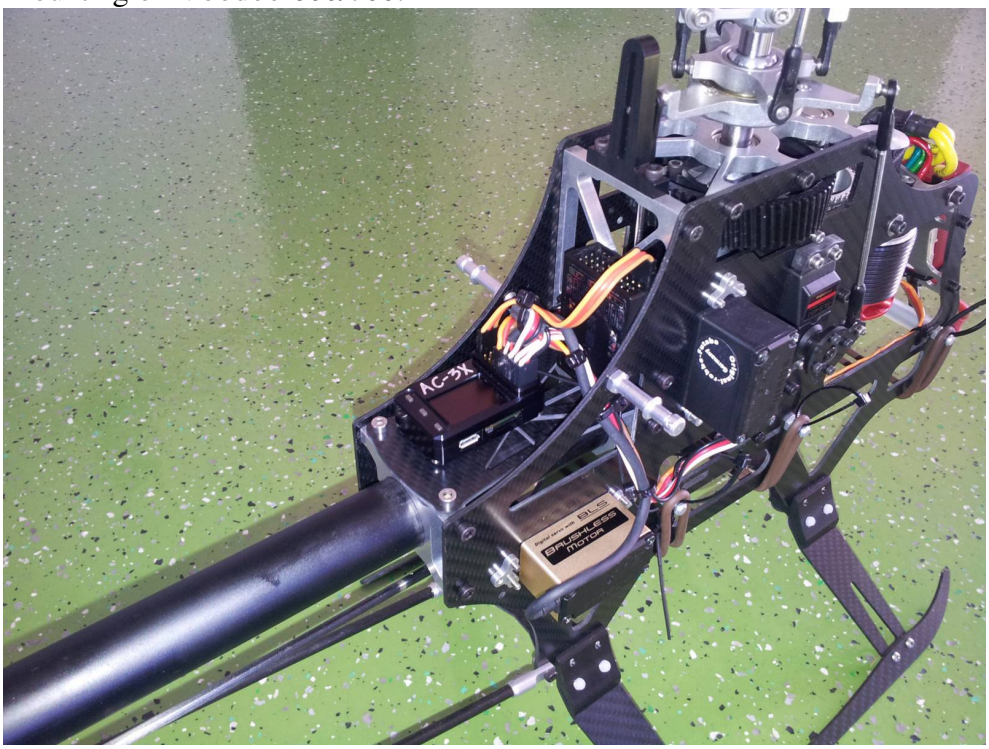
Mounting on Voodoo 400:





On Voodoo 600/700 AC-3X should be mounted a little bit shifted to the left in order to allow to reach the micro SD-slot easily.

Mounting on Voodoo 600/700:



You can request parameter files with basic Setups for Voodoo 400/600/700 via Email to:

stefanp@eheli-tuning.de

This parameter files can be copied on the micro SD-card and then read into AC-3X. To finish your setup, you only have to check servo directions, servo zero positions and the Servo Limits. **Furthermore you have to assure that you are using the standard mounting directions to assure that gyro sensor directions are correct!**

6. Basic Setup for the first flight

In this chapter I describe how to set up AC-3X in a helicopter for the first flight. To reach optimum flight performance with minimum setup effort outside on the flight line, the basic setup at home should be done very painstakingly. Thus follow the steps described in this chapter as stringent as possible.

I recommend to use a receiver battery for the setup and to avoid using a BEC. The procedure how to setup parameters is described in chapters above (e.g. choosing the receiver type...). In this chapter I only give advice what principally has to be done.

To start, connect the receiver to the AC-3X and choose the correct receiver type and channel assignment. Then go to the sensor menu and select your sensor axis alignment. Switch on your transmitter and then cycle power on the receiver. AC-3X will display the startup screen with the starting logo and the AC-3X serial number. This will be followed by the sensor calibration. During sensor calibration please avoid moving the AC-3X. After finishing the sensor calibration, AC-3X will do the stick calibration. During this time do not touch the transmitter sticks as otherwise the calibration procedure will take remarkably longer or even fail. AC-3X measures the reference pulse lengths on aileron, elevator and tail channel. If there are any issues during calibration, AC-3X will display a corresponding error. In this case the user has to acknowledge the error by pressing T1.

When this start up procedure is finished, the normal AC-3X status screen will appear. The control loop will be activated and AC-3X is in flight mode. Now the servos react on stick inputs which was not the case during start up.

The status screen displays the current RC values P=pitch, R= Aileron, N= Elevator, H= Tail, the gain value and the selected flight phase when phase switching is activated in the tools menu. Additionally the lower line of the status screen displays the receiver battery voltage with min and max values.

The next step in the setup procedure is the basic setup of the transmitter. **First select a helicopter program with mechanical mixing in your transmitter. All mixers including DMA have to be inactive. Mixing of swashplate and tail rotor is done by AC-3X itself.** To check whether all mixers are inactive, move the transmitter sticks axis by axis and check in the AC-3X display that with every stick axis only one of the parameters displayed in the AC-3X status screen is modified.

Now switch off the AC-3X, wait 10s and restart it to recalibrate. In case that mixers were active, these might have influenced the stick neutral positions and thus the recalibration might be necessary.

For all channels (P, R, N, H) **we now set the minimum and maximum values to +-100% displayed on the AC-3X status screen**. This is done via travel adjust in the transmitter. For the Pitch channel, which has no middle calibration, you should adjust the stick middle position first: put the pitch stick in middle position and then adjust the transmitter output pulse length via transmitter servo zero position adjustment in a way that AC-3X displays P=0%. Check also the channel directions. **Positive pitch has to result in positive pitch values, negative pitch in negative pitch values**.
For aileron steering, right shall lead to positive values and for elevator steering forward is positive. If this isn´t the case, please invert the channels in your transmitter and **finally check once again that you have +-100% travel displayed by the AC-3X.**

Now set the gain channel to 100%. Use the transmitter gyro menu or the travel adjustment of the transmitter for this purpose.

The next step is to select the tail servo type in the AC-3X servo setup.

When no setup at all exists for your type of helicopter, the gains for the tail and swashplate control loop setup should be reduced by 15-25% for the first flight to avoid oscillations.

When this is done, the helicopter swashplate configuration has to be selected. My Voodoos use type 1, 120° swashplate with two aileron servos.

For the basic setup, check if the Pitch-, Aileron- and Elevator-mixers in the swash menu are set to 80%.

Now switch off the AC-3X and connect the servos like indicated in the figure with the connector setup. The first swash servo is always the servo which is, seen in flight direction, the first servo clockwise (e.g. right aileron servo). The second servo is the second servo clockwise and so on. Do not put the levers on the servos now. For many helicopters there are recommended servo arm lengths. If this is not the case, select an appropriate length and it will be checked or corrected later in the setup.

Connect the RX-battery to the AC-3X, after initialization all servos will be in neutral position. **Pitch stick shall be in middle position. Now activate the setup menu to avoid that the control loop is influencing the servo positions.**

In the next step, the levers are put on the servos in a way that the levers are as perpendicular as possible to the linkages. When a swashplate reverence tool for your helicopter is existing, apply it to assure that the rotor head is at 0° pitch position. Typically, the servo middle positions do not fit exactly in a way that the levers are perpendicular to the linkages. The fine adjustment needs to be done via the servo zero position setup of the AC-3X now.

Check the servo direction of the tail servo. In setup menu the tail stick input is forwarded directly to the servo. If the servo direction is incorrect, change it in the servo direction menu.

To set the direction of the swashplate, set the servo direction of all three swashplate servos in a way that the swashplate moves in the correct direction when steering pitch. When this is done, check the directions of aileron and elevator. In case that they are not correct, leave the servo setup and go to the swash mixer. Here you can change the aileron direction in the aileron mixer by changing from +80% to –80% and vice verso. The same procedure can be done for elevator until the swashplate is moving into the correct direction on all steering inputs.

Now an important setup step is following. We will check whether the helicopter has a linkage geometry fitting to the servo travel. **For this step, the setup menu has to be active** (active control loops would influence the results) and in the swash mixer the aileron and elevator mixer **have to be at + or - 80%**! The cyclic travel on the rotor head should be around 6°-8° when steering full travel on one axis, e.g. aileron. You can adjust this via the servo travel adjustment of the swash servos. Nonetheless take care that you do not change the travel by more than 300 units. If this is the case, you should reduce the lever length when you have too much travel on the rotorhead or increase the lever length when travel is not sufficient.

Example: 7° cyclic travel on full aileron stick input in setup menu and with aileron and elevator mix at 80%. Pitch input is at P=0%:

The next step to the basic setup is, to check that the swashplate is moving exactly horizontally leveled on pitch inputs. Even when the swash servos are bought together, it might happen that they have different travel. When this is the case and thus the swashplate is not moving properly, it can be compensated by travel adjustment of individual swash servos until all three servos do exactly equal travel.

Now we check that none of the swashplate servos will mechanically block in the end positions. If there are any positions where a servo might block, the servo travel needs to be limited in the servo limits menu. The same we have to check for the tail servo. The servo should use the whole available travel of the tail pitch slider but it should not block. This has to be achieved by adjusting the tail servo limits properly.

The pitch travel is now adjusted in the swash menu by adjusting the pitch mixer. 10-12° should be used for the first flight.

After adjusting the servo travels according to the helicopter geometry, the next step is to check the sensor directions for the control loops. This will be done in the sensor menu. In the sensor menu, the feed forward of the stick inputs to the servos is disabled and thus the servos only follow the integrated sensor signal.
For better visualization of the sensor directions, the servos stay in position, the integrator depletion is deactivated.

First we activate the aileron sensor setup, lift the helicopter and turn it around the aileron axis. The sensor direction is correct when the swashplate is tilting in opposite direction. Which means that relative to the surrounding remains unchanged in space. When this is not the case, the sensor direction has to be inverted.
The next step is the elevator sensor menu. Activate it and turn the helicopter around the elevator axis. The swashplate has to turn in opposite direction relative to the rotation. Which means it stays almost unchanged in position relative to the surrounding. When this is not the case, the elevator sensor direction has to be inverted.
Finally we check the tail sensor direction. Turn the helicopter around the rotor shaft. The tail servo must compensate this rotation. The tail blade rear edge must move into the direction where the tail moves during rotation. When this is not the case, the tail sensor direction has to be inverted in the tail sensor menu.

Now we have to check the direction of the torque compensation on tail (DMA): When increasing the main rotor blade angle, the DMA has to push the tail against the induced torque. **Take care:** there are helicopters on the market e.g. Align and Logo 500/600 where you have to change DMA to negative direction to get the right effect!

Before finally starting the first flight, check that the direction of the axis rotation which is integrated in AC-3X is correctly set. Activate "Sensor menu → Axis Rotation" for this purpose. The swashplate will tilt forward or backward. Now turn the helicopter 90° around the main shaft. The swashplate shall remain unchanged in space. To achieve this, the swashplate must rotate in opposite direction when you turn the helicopter. If this is not the case and the swashplate has turned in the same direction like the helicopter, it will now be oriented in opposite direction than prior to the 90° rotation. In this case, invert axis rotation. You can also deactivate the axis rotation by inserting 0 in the menu.

Now check once again the sensor directions! When they are inverted, the helicopter is uncontrollable and a risk for the pilot and other people around. Also keep in mind, do never fly in setup menu! When setup menue is activated, the helicopter is also almost uncontrollable.
After this final check and flight menu is actived, you can start to the initial flight.

Attention, one important note for the first flight:
An electronic swashplate control behaves different during take-off than a conventional Bell-Hiller rotor head. When you give inputs on the transmitter sticks, but the helicopter cannot move as it is still on ground, the swashplate will tilt up to the maximum angle. When pitch is increased in this condition, the helicopter will suddenly tilt and the main blades might touch the ground. **Thus, after switching on the AC-3X and until the helicopter is put on the ground at the starting position, please leave the pitch around 0° Pitch** (+-10%). After switching on the motor, try to give only small steering inputs to the helicopter to align the swashplate horizontally. When the correct RPM is reached, lift off quickly by increasing pitch. For the first flight, use a relatively low RPM (e.g. 1600 on Voodoo 400). When everything is o.k., the RPM can be increased.

With this setup, the helicopter should hover stable and have no oscillation tendency. If there are oscillations, reduce gain on swashplate or tail control loop. If the helicopter is indirect on swash or tail, increase the gain until a convenient stick feeling is reached.

The angular rates on aileron and elevator should be adapted to the personal requirements. This will be **done in the aileron- and elevator-mixer in the swashplate setup**. Decreasing these mixers, reduces the rates. Increasing makes the rates grow. Changes should be done in steps of 5%. The adaption of the tail angular rate is done differently, here **you should use the tail travel adjust of your transmitter to control the rate**.

Final setup step is a trim flight, using auto trim at low wind conditions. In auto trim mode, AC-3X optimizes the fine trim of all servos to achieve optimum flight behavior. When auto trim is active, the AC-3X status screen displays "Trim" in the right upper corner. As soon as the helicopter hovers in this condition, the trim optimization is starting. After at least 30s of hovering with minimum steering inputs, the trim values needs to be stored. For this purpose, land the helicopter and leave the pitch stick close to p=0% and then press the lower button T3 for 3s until a "Save" notification is shown in the right upper corner. Now auto trim has been automatically deactivated and the trim values are stored until auto trim is activated again.

7. Firmware Updates

An AC-3X firmware update can be done from the micro SD-card. To perform an update, you need the serial number of the individual AC-3X unit which is displayed on the left lower side of the AC-3X Display for approx. 5s after power on.

To achieve an individual update file, note this number and send me an Email to my Email-address: "stefanp@eheli-tuining.de" with subject: "AC-3X V3 Updateanforderung" and indicate your serial number and your full name in the Email. When an update is available, you will soon get a firmware file via Email. It will be named "xxxxxxx.bin" where "xxxxxxx" is the serial number of your AC-3X. Please copy this file on a micro SD-Card into a folder called "Firmware". When such a folder does not exist, please generate it first. Then enter the micro SD-card into the card-slot of the AC-3X with contacts oriented upwards.

Now switch on AC-3X. A message will appear asking whether a firmware update shall be performed. Confirm this with the upper button T1. The update status then will be displayed.

Do not switch off AC-3X while the update process is running. You can power the unit off when the update has been finished and the AC-3X has started into normal operational mode. Remove the SD-Card afterwards.

When you want to use the card for data logging further on, please remove the firmware file "xxxxxxx.bin" from the card. Otherwise AC-3X will ask on every start up whether a firmware update shall be performed.

When something did not work during the update, this is no issue. You can redo the update. An origin of problems during the update might be an issue with the SD-card, so try a second one if you have an indication of issues.

The firmware file is encrypted and is only valid for an individual AC-3X. If you have several AC-3X, each AC-3X requires an individual file for update.

When AC-3X does not start after an erroneous flash and the serial number is not known anymore, you can press T1 during start up. AC-3X then will display the serial number until T1 is released.

8. Example Setups

In this chapter, AC-3X setups for different helicopters with different servo types are listed. I only list the gyro parameters for the swash plate and tail gyro but not the servo and sensor parameters which are specific to helicopter and installation and thus, need to be setup individually in the workshop. I also do not list the stick parameters which have to be adapted to the pilot's preferences.
With every setup, a headspeed with the parameters which have been flown is given. When a higher headspeed shall be used, the overall gain in the AC-3X has to be reduced and when you want to use a lower headspeed you usually can increase the overall gain above 100%.

During my test flights I observed that unfortunately there are some servos on the market which have a certain spread in their parameters. Especially the servo travel might be different, even though the servos are of the same type. This has also an effect on the setups as if a servo is doing a larger travel one effectively has a larger gain than with a servo with smaller travel. But when the basic setup described in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** is done carefully the mechanical necessities for a good setup should be met and thus, with the setups below good flying should be reached. It might be, that with the own individual servos the swash plate travel adjust values after the basic setup of the helicopter are different from those in the tables. In this case please use your own individually adapted values.

The tail gyro parameters are listed for tail servo limit of 1000 units. Is the tail linkage done in a way, that you can use larger tail servo limits, than this means that the parameters listed for P- , I- and DMA-gains should be increased by the same factor. When the Servo limits are e.g. 1300 instead of 1000, this means that the gains above need to be multiplied by 1.3.

Voodoo 400:

This setup is for my Voodoo 400 with HT Plöchinger Spezial mainblades and the stock CFK tail blades. Basis headspeed is 2000 at a Gain of 100%. In speedflight at 2200 RPM the overall gain should be reduced to 80%. At low RPM the gain should be increased to 115%.

Setup:	**Voodoo 400 & Futaba BLS153 & BLS251**			
Setup Swashplate:			**Setup Tail:**	
Servos	Futaba BLS153 200Hz		Servo	Futaba BLS251
Lever	13 mm		Lever	13,5 mm
Travel Swash	**850**		Gain	50
Gain	65		Stick Dynamic	30
Lock Ahead gain	65		Asymmetry	15
Fix Gain	yes		DMA	50

Setup:	**Voodoo 400 & Savox SH-1250MG & BLS251**			
Setup Swashplate:			**Setup Tail:**	
Servos	Savox SH-1250MG 200Hz		Servo	Futaba BLS251
Lever	13 mm		Lever	13,5 mm
Travel Swash	**800**		Gain	50
Gain	60		Stick Dynamic	30
Lock Ahead gain	65		Asymmetry	15
Fix Gain	yes		DMA	50

Voodoo 600:

This setup is for my Voodoo 600 with Edge 603mm Flybarless mainblades and the Edge 105mm tail blades. Basis headspeed is 1800 at a Gain of 100%. In speedflight at 2000 RPM the overall gain should be reduced to 80%. At low RPM the gain should be increased to 115%.

Setup:	**Voodoo 600 & Futaba BLS451**			
Setup Swashplate:			**Setup Tail:**	
Servos	Futaba BLS451 200Hz		Servo	Futaba BLS251
Lever	16 mm		Lever	13,5 mm
Travel Swash	**1000**		Gain	65
Gain	60		Stick Dynamic	25
Lock Ahead gain	55		Asymmetry	10
Fix Gain	yes		DMA	50

Voodoo 700:

This setup is for my Voodoo 700 with Radix 710 standard mainblades and the Edge 115mm tail blades. Basis headspeed is 1650 at a Gain of 100%. In speedflight at 1800 RPM the overall gain should be reduced to 80%. At low RPM the gain should be increased to 115%.

Setup:	**Voodoo 700 & Futaba BLS452**			
Setup Swashplate:			**Setup Tail:**	
Servos	Futaba BLS452 200Hz		Servo	Futaba BLS251
Lever	16 mm		Lever	13,5 mm
Travel Swash	**1000**		Gain	70
Gain	60		Stick Dynamic	25
Lock Ahead gain	50		Asymmetry	10
Fix Gain	yes		DMA	50

Henseleit TDR:

This setup is for Henseleit TDR with DH 711 mainblades and the DH 107 mm tail blades. Basis headspeed is 1700 at a Gain of 100%. In speedflight at 1900 RPM the overall gain should be reduced to 85%. At low RPM the gain should be increased to 115%.

Setup:	**TDR & Futaba BLS351 & BLS256 HV @ 8V**			
Setup Swashplate:			**Setup Tail:**	
Servos	Futaba BLS351 200Hz		Servo	Futaba BLS256
Lever	18.5 mm		Lever	10.5 mm
Travel Swash	**800**		Gain	60
Gain	60		Stick Dynamic	25
Lock Ahead gain	60		Asymmetry	10
Fix Gain	yes		DMA	60

9. Error Messages during Operation & FAQs

Like with every technical device also with AC-3X malfunctions are possible. To avoid that the helicopter is damaged due to some error of AC-3X during the initialization of AC-3X several self tests are done. AC-3X only goes to the operative state when all of them have been passed without problems. In case that a test failed, AC-3X gives a note in the display. Possible error messages are:

RC-Calibration Error: When AC-3X cannot calibrate the midstick positions correctly, AC-3X indicates this by a RC-calibration error. Normally the origins of this error message are incorrect receiver pulses. So the user should check all connections to the receiver and then switch on AC-3X again. The RC-calibration error message can be suppressed by pressing on the upper button. By doing this, one can go to the setup menu without transmitter. **But be careful**: when RC-Calibration did not succeed (the error message appeared and was acknowledged by the button!) no correct flight operation is possible!
If the RC-calibration doesn't work although all cables to the receiver are connected correctly, then it might be than the "Stick-Cal. Tolerance" in the Stick menu is to low and it should be increased.

Error during Sensor calibration: When the helicopter is moving in the initialization phase it might happen that the sensor calibration screen is not disappearing. Thus, the helicopter should be left on the ground after switching AC-3X on for at least 10 seconds until all sensors finished calibration properly.

Drifting of the helicopter:
When the helicopter is drifting on one or even several axes although a trim flight was performed, this typically is induced by high frequency vibrations. To overcome this issue you either can try to mount AC-3X in a different way (e.g. with a different tape). This helps in many cases but the better way is to find the origin of the vibrations.
Another possible reason for drifting can be issues with the potentiometers in the transmitter which cause that in stick middle position the AC-3X does not see the calibrated "zero-positions". This, you can directly see in the AC-3X status display. Aileron, Elevator and Tail inputs should be 0.
A third possible origin for slow drift effects might be that the helicopter has been moved during calibration.

Why do the servos move so slow when being in flightmode?

This is due to the control algorithms working in AC-3X. When the helicopter is on the ground and cannot follow the steering inputs, the swash servos will travel slowly to their maximum limits when giving steering inputs. The tail servo will also behave "strange". It is not moving at constant speed and might even stop in the middle of the travel range. BTW: On a 120° swashplate the elevator is doing more travel on ground than the aileron servos. To check for correct servo function, please go to the setup menu where the control algorithms are disabled!

10. Important Security Notes and Disclaimer

Do a preflight check prior to every flight: check that swash- and tail-servos react normal on movements of the helicopter. This is necessary to check that sensors and control loops work properly.
AC-3X may only be operated when it is assured that due to the operation of an AC-3X equipped helicopter neither persons nor things are endangered.
When flying with an AC-3X equipped helicopter an adequate safety distance to persons, animals or buildings must be kept.
Keep always in mind that a component of the helicopter might fail and the helicopter gets uncontrollable! For damages resulting from such a situation, I have to disclaim the liability. The responsibility for the save operation of AC-3X takes the user!

Keep AC-3X dry otherwise a safe function of the electronics inside cannot be guaranteed

When using AC-3X in helicopter with nitro engine, take care that no exhaust pollutes AC-3X as otherwise the function of AC-3X might be affected.

When AC-3X is damaged due to a crash, please do not operate it anymore. You can send it back to me for a function check.

AC-3X is intended to operate in an area without electrostatic discharges! On helicopters with belt driven tail measures like adequate grounding have to be done to avoid electrostatic discharges.

Any damages due to failure of AC-3X cannot be claimed!

For personal injury or damages of things and their consequences resulting from my delivery or work, I cannot accept any liability as I have no control on the usage and handling of my product.

General:

This manual represents my current state of experience with AC-3X. It might be updated to include new experiences. The current version of the manual will be downloadable at www.eheli-tuning.de.

EG-Konformitätserklärung

For AC-3X I approve that is in line with the following EMV-regulations:

2004/108/EG
EN 61000-6-3:2007+A1:2011
EN 61000-6-1:2007

ROHS conformity according to: EN 2011/65/EU

The registration number at EAR for the brand ACRO Control (AC-3X) is:

WEEE-REG. Nr.: DE29755000

Recycling

Electronic equipment may not be disposed in the domestic waste, but must be correctly disposed in accordance with regional and national regularities and separate from normal domestic waste.

Firma Stefan Plöchinger
Modellbautechnik u. Elektronik
Gewerbering 2
D-94161 Ruderting
Tel: 08509/9360879
Fax: 08509/9369798
stefanp@eheli-tuning.de
www.eheli-tuning.de

Ruderting, 01.04.2014 Stefan Plöchinger Geschäftsführer

Ort, Datum Name / Unterschrift