We perfect your setup so you can perfect your thumbs

Instructions v2.5
SOKO KIT

Tena rawa atu koutou mo te kowhiranga ā matou.
Putaiki kia whakapai ki ki whakahangu taua mea kia rekareka hoki.
(Māori - language of the native people of New Zealand)

(Thank you for choosing our products. All the best in using the tools.)

Kia ora (Hello),

Thanks again for buying our products. Ensure you are using the latest version of these instructions. Get the latest version at www.soko-heli-tools.com (Instructions).

Please read the whole document before you start. We use high resolution pictures throughout the document. Feel free to use the zoom function of your PDF reader to get a closer look at the pictures.

Have fun and keep flying.

Yours,
Soko Heli Tools Team

Table of Content

1. Do you need to read these instructions?

NO - if you own a mobile device with Android or iOS just go to the Google Play Store or Apple App Store and search for the **Soko Heli Toolbox** application.

This instructions-PDF has still its place though. It holds much more information and trouble shooting than the mobile application. So if you running into troubles or just want to know everything the Soko Kit can do for you have a look in here.

Finally our brief history of head geometry in the appendix is always worth a read.

2. Soko Heli Toolbox mobile app

Our **FREE** Soko Heli Toolbox mobile application gives you an even faster setup experience with its easy step-by-step guide through the whole setup process.

The optional Virtual Main Shaft feature simplifies and speeds up the setup even more by eliminating the need for a vertical aligned main shaft by calculating its tilt in 3D space.

For all the latest and greatest about the Soko Heli Toolbox app visit the store sites below.

ANDROID APP ON Google play

https://play.google.com/store/apps/details?id=com.sokohelitools.apps.android.toolbox

Download on the App Store

https://itunes.apple.com/app/soko-heli-toolbox/id947314316

3. What kind of hobbyist are you?

We are the first setup-tool company which attempts the balancing act to suit both extremes of helicopter pilots - and anyone between of course!

3.1. Beginner

If you are a beginner or even assembling your first helicopter we highly recommend **reading the whole document through before beginning**, even if you are an eager pilot!

3.2. Thorough hobbyist

You are a thorough or even meticulous hobbyist who likes to spend a lot of time to setup the helicopter. The assembling process is at least as important and fun as the flying itself.

We are sure we met your passion with Soko Kit and our highly detailed instructions. The most important point during development of the Soko Kit was to achieve the highest accuracy possible. Each procedure and each step of our instructions was rigorously analysed to give unprecedented and accurate results.

We hope you enjoy reading each page of this instructions as we did writing it.

3.3. Eager pilot

You are a eager pilot who likes to finish the setup as fast as possible. The primary goal is to be out and flying again. But still with the best setup possible for the time you like to invest. OK, don't let us waste time here.

Just look for the "FAST FORWARD" colour coded sections like this one:
RED: Read it! ORANGE: Should read it/skim through. GREEN: Still have time? Go for it.
The table of content gives an additional overview with the colour coded background.

Here is the summary and **best reading order** of the labelled sections:

1. If you haven't read the printout yet which comes with the Soko Kit:
   Section 4.2.3 on page 9 & section 4.2.4 on page 10:
   Get to know the Soko Kit.
2. Section 5.3 on page 17:
   Use the velcro instead of the screws for fast results.
3. Section 4.1 on page 7:
   This flow chart is probably all you need!
4. Section 5 starting on page 13:
   Fly over the two mounting positions.
5. We reckon you already got the idea behind Soko Kit from our website and you know exactly how to setup a helicopter, right?
   So go for it!
6. Setup done!

FAST-FORWARD FAST-FORWARD FAST-FORWARD FAST-FORWARD

FAST-FORWARD FAST-FORWARD FAST-FORWARD FAST-FORWARD

Finally have a look at section 4.2.2 on page 8 to see how to pack the Soko Kit securely so you can toss it in your toolbox.

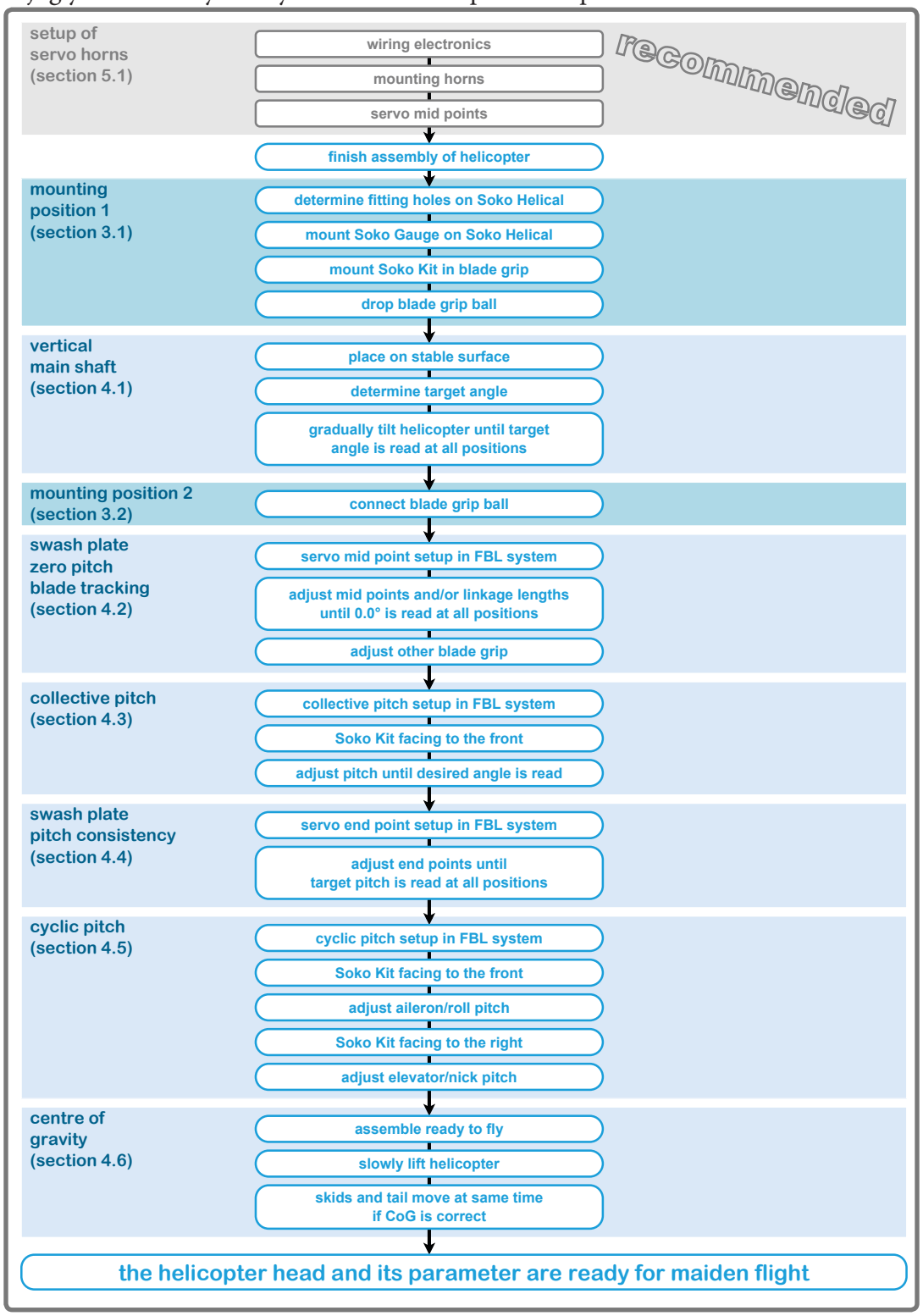
It can't go faster! If you still have time left fly over the pictures (and text) of the setup procedures of section 6 on page 18, especially section 6.1 on page 18 and section 6.6 on page 31. The next time you use the Soko Kit you won't have to read anything at all.

4. Introduction and special notes

Please read this chapter carefully to become familiar with the Soko Kit and terms that are used in this manual.

4.1. Overview of the setup process

The following chart gives an overview of the setup, the order of the processes and a basic sum up of each process. It is perfect for the first time you use the Soko Kit or to come back and jog your memory after you've done a couple of setups.



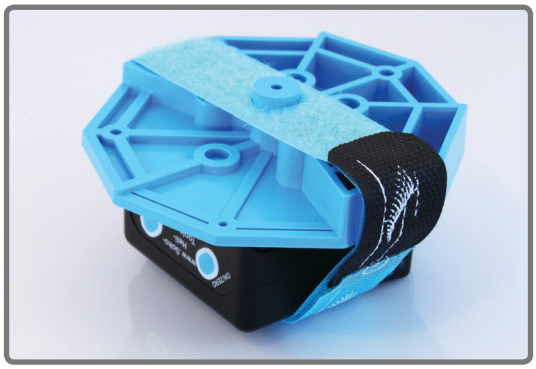
4.2. The Soko Kit

4.2.1. The components of the Soko Kit

The parts the Soko Kit consists of are as follows:

1x ... Soko Helical
1x ... Soko Gauge
2x ... AAA battery
3x ... M3x6mm screw
1x ... M2x6mm screw
1x ... M1.6x6mm screw
1x ... M2 washer
2x ... M3 washer
1x ... Special mounting velcro
1x ... Zipper bag

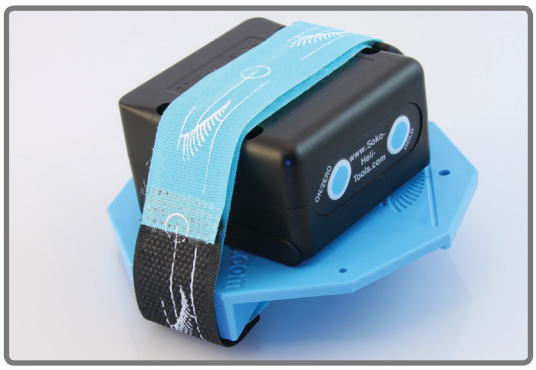
4.2.2. How to easily store the Soko Kit



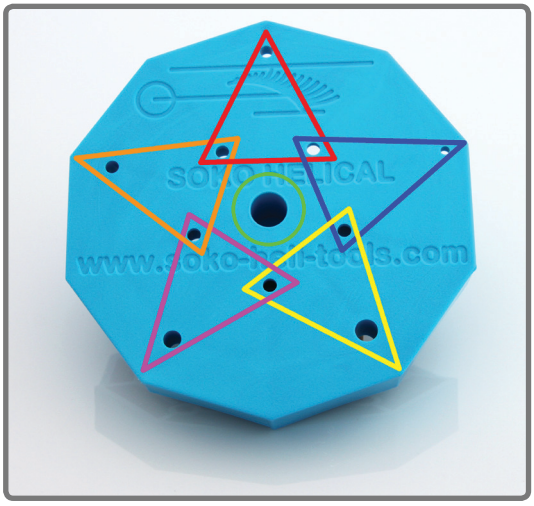
Wouldn't it be nice if you don't have to care about damaging or breaking the Soko Kit when you don't use it? Whereever you may store it.

The Soko Kit is a tool in the end - and tools like to be stored in the garage or in a toolbox.

1. The most compact and secure way to pack the Soko Kit is to place the Soko Gauge with the display on the Soko Helical.
2. Put the boss at the bottom of the Soko Helical through the hole in the special mounting velcro.
3. Wrap the velcro around the thickest part of Soko Helical and over the Soko Gauge.
4. Clamp the wrapped Soko Kit between thumb and forefinger while closing the velcro with the other hand.
5. Put this compact package into the zipper bag along with the screw bag.
6. Done!



4.2.3. Soko Helical



The Soko Helical is the most versatile mounting platform for gauges like the Soko Gauge. It fits all helicopter brands and sizes.

Depending on the size of the helicopter, you choose the right hole to mount the Soko Helical in place of a main blade.
The five holes around the centre are used to mount the Soko Gauge.
The five holes on the edge are used to mount it in place of a main blade.

The coloured triangles show the corresponding holes for each size:

- Yellow: 800/770/700 size: 14mm blade grip opening
- Purple: 630/600/550 size: 12mm blade grip opening
- Orange: 500 size: 10mm blade grip opening
- Red: 360/450 size: 4.5mm blade grip opening
- Blue: 250 size: 3mm blade grip opening

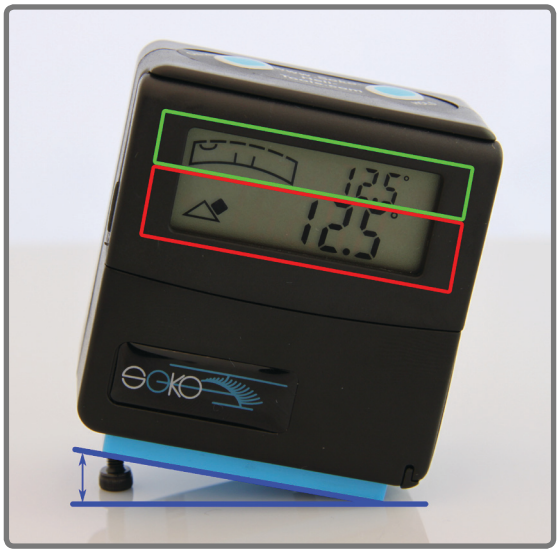
The hole in the middle (circled green) mounts the Soko Helical in place of the head stopper disc.

4.2.4. Soko Gauge

The Soko Gauge measures the tilting angle indicated by the blue lines with a resolution of 0.1°.

The green part of the display shows absolute (spirit) level relative to earth, also known as horizontal/vertical level/angle. We refer to this angle as **absolute level/angle** in this document. Instead of an algebraic sign (plus/minus) the symbol on the left is used which imitates a spirit level (water level bubble). We call them "inside" and "outside" values.

The first picture shows an **outside 12.5** and the one at the end of the page an **inside 0.3**.



The red part measures the angle relative to the last zero point. The zero point is set by pressing shortly on the ON/ZERO button. The HOLD button freezes the display.
Press the ON/ZERO button for more than 2 seconds to turn the Soko Gauge on or off.

Hint: To retract the display push it up - into the hinge - while rotating.

4.3. Preparations and hints

IMPORTANT SAFETY INFORMATION
Ensure at all times that the main rotor/motor does not spool up!
Disconnect the wires from the ESC to the motor.

To achieve optimal results use a stable and even surface. In addition, ensure stable positioning of the helicopter on the surface. **If your skids are too flexible, dismount or reinforce them for the setup procedure.**
The helicopter needs to be fully assembled and all linkage lengths need to be setup as described in the assembly manual.
Next ensure the FBL (flybarless) system and transmitter are set up. All servos need to move in the right direction when moving the transmitter sticks.

IMPORTANT
Do not overtighten the screws that mount the Soko Gauge on the Soko Helical.
Stop to tighten the screws when the Soko Gauge does not move anymore.
Overtightening may result in bending the contact surface (which leads to inaccurate measurements) or even damage of the Soko Kit.

4.4. Helicopter with a flybar

Setup of your flybar helicopter with the Soko Kit is as easy as the setup of a flybarless helicopter. Just follow the instructions in this document.
But each time you do a measurement, make sure your flybar is perpendicular to the main shaft. That is all you have to do. For most flybar helicopters, scanning that it is the right angle is enough.

Hint: This additional step has nothing to with the Soko Kit itself. It is a peculiarity of a flybar head itself. Therefore it is necessary for every measurement on the blade grips with any tool available on the market.

4.4.1. Testing the sensitivity of a flybar input

To test how accurate you have to be just mount the Soko Kit in Position 2 (section 5.2 on page 16) and make sure the servos don't move (i.e. by powering them up).

Now bring the flybar in at a right angle to the main shaft and read the Soko Gauge display. Slowly move the flybar out of the right angle position. Once the displayed angle of the Soko Gauge changes you've gone too far.

4.4.2. Additional things you can do

Depending on the type of your flybar head you can build yourself a "structure" which keeps the flybar in a stable position during the whole setup (example by CPO).

4.5. Final notes

About our helicopter

We are using a 550 sized helicopter throughout this document. It is equipped with a FBL (flybarless) head, two main blades and a 120° (3-point/servo) swash plate. If your heli has another head type you need to customise some procedures accordingly.

Ensuring accuracy

Every part of a RC helicopter complies with quality standards in production. However slack in the assembled heli is unavoidable, especially on the path from the servo to the main blades.

The Soko Kit displays the angle with a resolution of 0.1°. However, the slack in the assembled helicopter may not allow for perfect accuracy every time. Therefore, closely follow the instructions below in order to get your helicopter as accurate as possible.

5. Mounting positions

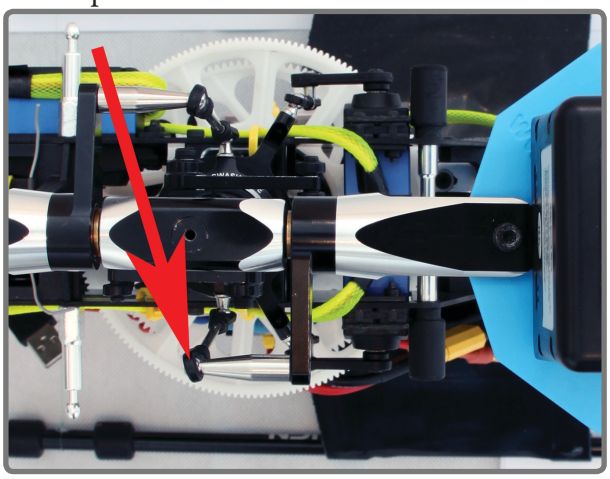
To setup your helicopter, the Soko Kit must be mounted in two positions, Position 1 and Position 2.

5.1. Position 1

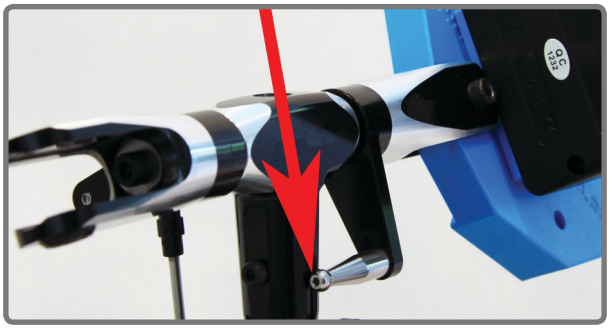
The preferred way to mount the Soko Kit when your helicopter is option 1. It is easier and faster.
Use option 2 only when you are not able to fully turn the head in option 1 due to contact with other parts of the helicopter. This can happen on small helicopters or low rotor heads.

Option 1

1. Mount the Soko as main blade (see section 5.2 on page 16).
2. Open the linkage (red arrow) which connects the blade grip with the mounted Soko Kit to the swash plate.



3. Turn the Soko Kit counter clockwise until the ball of the blade grip rests on the side of the rotor head.

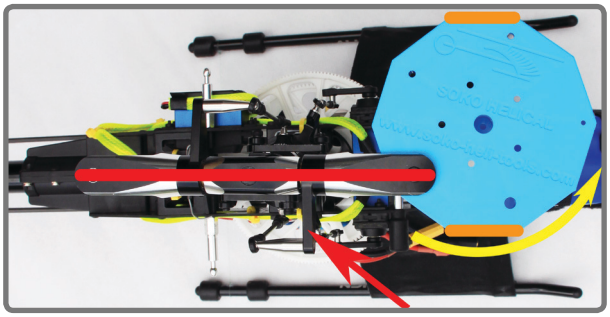


It is important, that this resting position is stable and the ball does not change its position (the blade grip itself does not rotate) during a full turn of the head.

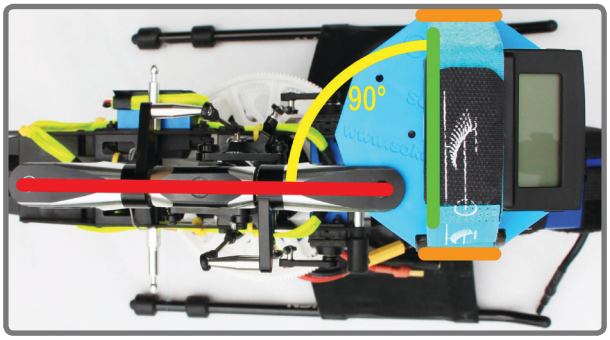
4. The weight of the Soko Kit is enough to keep this stable position of the blade grip. You can use a cable tie to secure the ball to the rotor head but usually it is not necessary.

Option 2

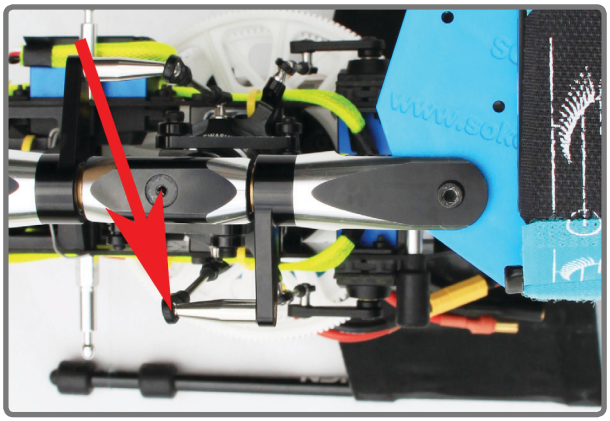
1. Loosely mount the Soko Helical in one of the main blade grips by using one of the main blade screws. Turn the Soko Helical (yellow arrow) away from the blade grip horn (red arrow) so that the two edges of the Soko Helical (orange) are parallel to the main blade axis (red line).



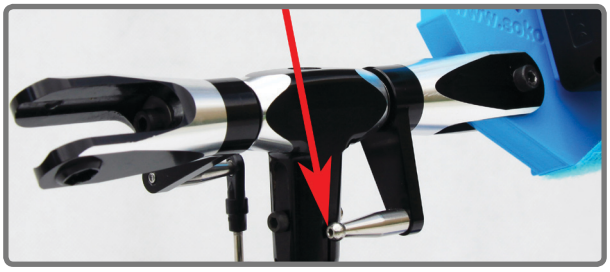
2. Mount the Soko Gauge on the Soko Helical using the special mounting velcro. Be sure to put the boss at the bottom of the Soko Helical through the hole in the velcro.
   It is important to wrap the velcro around the parallel edges (orange). Ensure that the Soko Gauge axis (green) is perpendicular (yellow) to the main blade axis (red).



3. Open the linkage (red arrow) which connects the blade grip with the mounted Soko Kit to the swash plate.



4. Turn the Soko Kit counter clockwise until the ball of the blade grip rests on the side of the rotor head.



It is important, that this resting position is stable and the ball does not change its position (the blade grip itself does not rotate) during a full turn of the head.

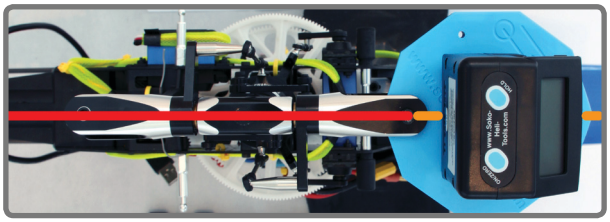
5. The weight of the Soko Kit is enough to keep this stable position of the blade grip. You can use a cable tie to secure the ball to the rotor head but usually it is not necessary.

Troubleshooting

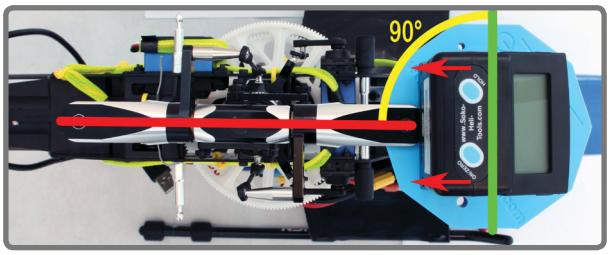
Problem	Solution
The opening of the blade grip of the helicopter is an odd size and it seems no corner of the Soko Helical fits.	First try to use suited washers to mount the Soko Kit in the blade grip. They were probably delivered with the helicopter kit or the main blades (i.e. on Blade helicopters). Only if the shims (try even only one) are too thick try the following but be careful not to damage the blade grip: There is also SOME! flex in the blade grip itself which you can utilize with the blade screw when mounting the Soko Kit.
I can't open the linkage because it is bolted to the blade grip (i.e. as on most DFC style heads)	Just open the connection of the linkage to the swash plate. Flip the linkage upwards and turn the Soko Kit counter clockwise until the upper part of the linkage rests on the side of the rotor head.

5.2. Position 2 (as main blade)

1. Fasten the Soko Helical with the loose mounted Soko Gauge in one of the main blade grips by using one of the main blade screws.
2. Ensure that the Soko Helical alignment (orange) follows the main blade axis (red).



3. Now move the Soko Gauge as close as possible to the blade grip (red arrows), ensure that the Soko Gauge axis (green) is perpendicular (yellow) to the main blade axis (red) and screw it tight.



4. The Soko Kit is now mounted as main blade.

5.3. Using the special mounting velcro instead of screws

In almost all positions the Soko Gauge is screwed to the Soko Helical. This is the preferred and most secure way to connect them.

However, some of you may not like to fiddle with the screws.
Moreover, if you like to setup different sized helicopters you will have to unscrew the Soko Gauge from the Soko Helical and screw it again.

So if you'd like to, go ahead and use the special mounting velcro instead of the screws to secure the Soko Gauge on the Soko Helical throughout the instructions. Just skip the screwing steps but make sure to put the boss at the bottom of the Soko Helical through the hole in the velcro and mount the Soko Gauge as shown in the pictures.

Hint: If the instructions tell you to use the velcro it is not an option to use the screws. The use of the velcro is mandatory for that procedure.

5.3.1. Do you use your own gauge?

The special mounting velcro is optimized for the Soko Gauge. With some other gauges the velcro may easily slip off the gauge. In this case, just use some adhesive velcro.

Stick the adhesive velcro on top of the gauge. Now put the gauge in position on the Soko Helical and wrap the special mounting velcro around it. Carefully remove the special mounting velcro again.
You end up with one part of the adhesive velcro sticking on the gauge and the other part sticking on the special mounting velcro. Press on the both adhesive velcros to make sure they stick well onto the gauge and the special mounting velcro.
Now the special mounting velcro won't slip off your gauge anymore.

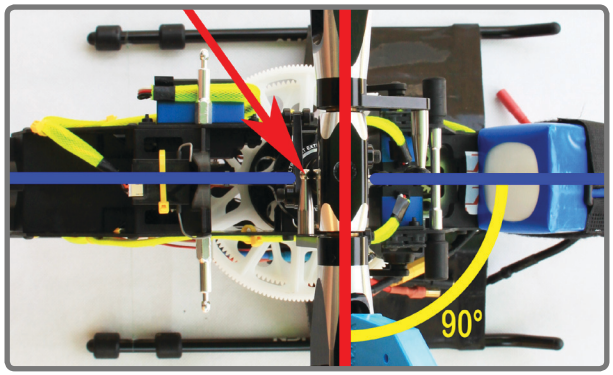
6. Setup procedures

6.1. Absolute vertical alignment of main rotor shaft

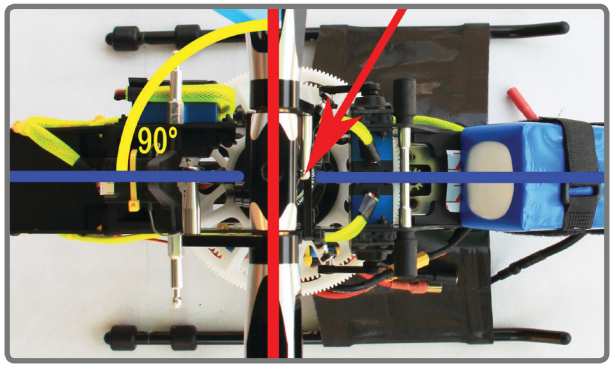
To bring the main rotor shaft of your helicopter in an absolute vertical position the Soko Kit must be mounted in Position 1 (see section 5.1 on page 13).

If your skids are too flexible, reinforce them for the setup procedure.
In most cases two strings or a rubber band, one at the front and one at the back, to pull both skids together are enough. In addition you can put a piece of wood or metal between both skids.

1. Place your heli on a stable and even surface.
2. Be sure that you can read the display of the Soko Gauge at every position of the rotor head during a full turn. Use a workbench in the middle of the room or place the heli on the floor.
3. Turn the head, so the main blade axis (red) is perpendicular (yellow) to the longitudinal axis of the helicopter (blue). In addition the ball of the blade grip with the Soko Kit (red arrow) needs to face backwards.



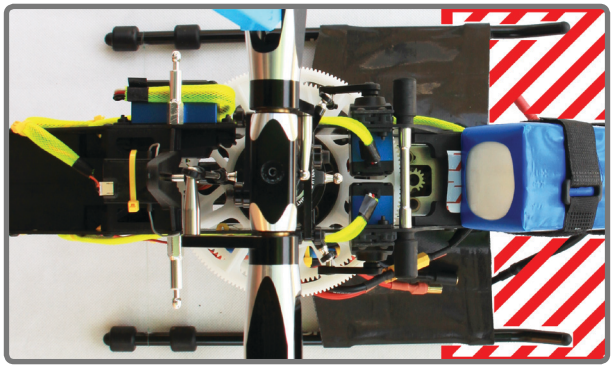
4. Note the absolute angle the Soko Gauge displays. In our example it is 66.3°.
5. Turn the head 180° so the main blade axis (red) is again perpendicular (yellow) to the longitudinal axis of the helicopter (blue). But now the ball (red arrow) faces to the front.



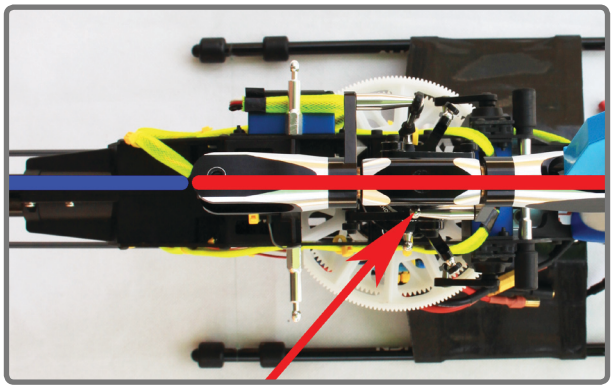
6. Note the absolute angle the Soko Gauge displays. In our example it is 70.1°.

7. Calculate the target angle by adding the angles of step 4 and 6 and dividing the result by 2.
   In our example the target angle is 68.2° (calculation: (66.3 + 70.1) / 2 = 68.2).

8. If your angle of step 4 is greater than the target angle you have to raise the helicopter at the back. If your angle of step 6 is greater than the target angle, as it is for our example, you have to raise the helicopter at the front.
   One way to achieve small changes of the angle is to put sheets of paper (red hatched area) under the skids or chassis (under the front in our example) until you read the target angle. Be sure the head does not rotate as you place the sheets of paper. If so, reposition the head after you put the sheets of paper under the helicopter.

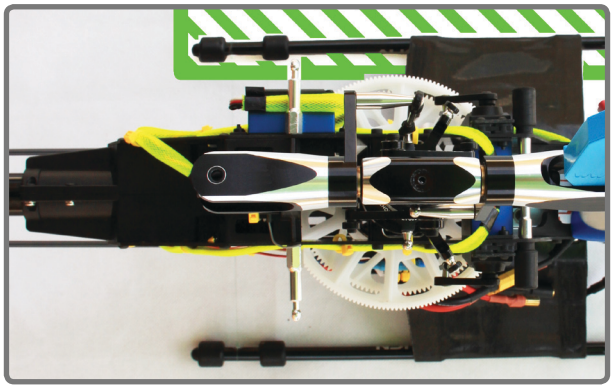


9. Turn the head 90° so the main blade axis (red) is in a line/parallel with the longitudinal axis of the helicopter (blue) and the ball (red arrow) faces to the right.

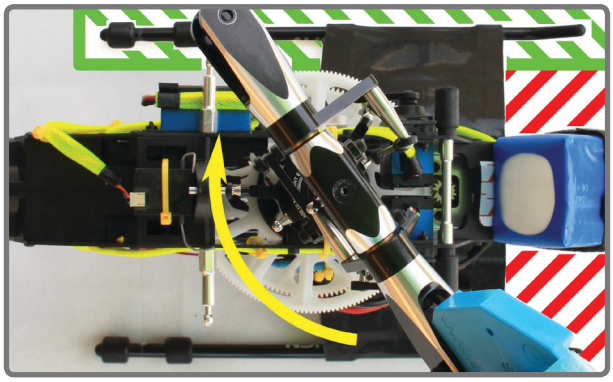


10. Note the absolute angle the Soko Gauge displays. In our example it is 67.8°.

11. If the angle of step 10 greater than the target angle, you need to raise the right side of the helicopter. If the angle less than the target angle, as it is in our example (67.8 < 68.2), you need to raise the left side of the helicopter. Use sheets of paper under the skids (green hatched area) or chassis until you read the target angle.



12. Finally, turn the rotor head slowly (yellow arrow) one full turn. The display should ideally read the target angle at any position you stop the rotation.



13. The main rotor shaft is now in vertical level.

Depending on the slack in your helicopter the calculation in step 7 can give a result with two decimal places. The same can happen if the values of step 4 and step 6 are on the cusp of the next value.
Use common sense in such situations. The final goal is reading the same angle in step 12. It is OK if you read an angle which is slightly off from the calculated target angle. As long as it is the same value (as close as possible).

If your FBL system has a self-level feature, it's a good idea to recalibrate the sensors.

Finally, if you remove the Soko Kit from its position, be careful to not alter the alignment of the heli on the surface.

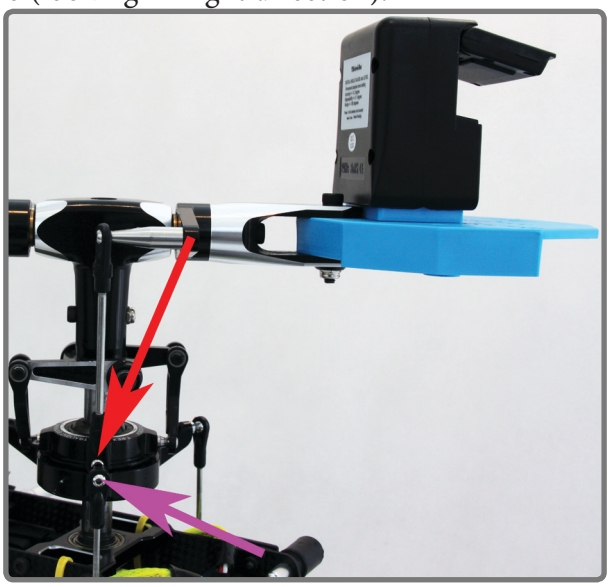
Troubleshooting	
Problem	**Solution**
I don't read the same target angle in the final step.	Watch your skids when you put the Soko Kit in the different positions. Are they moving? If yes reinforce them (see beginning of section 6.1 on page 18).
	If you have to use a lot of paper try to push gently on the helicopter to stabilize the skids on the paper.
	The Soko Gauge is a high precision inclinometer. Depending on the size of your helicopter and the quality of your components (including the servos) a deflection of a few tenth of a degree is unavoidable. Just try to keep it as small as possible.

6.2. Setup of swash plate, zero pitch and blade tracking

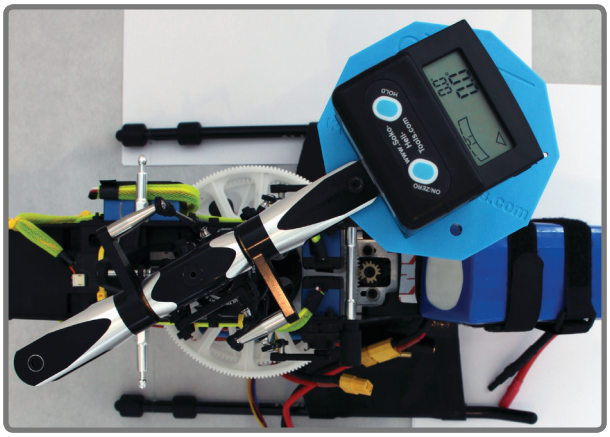
The main rotor shaft must be in an absolute vertical position (section 6.1 on page 18) and the Soko Kit must be mounted in as main blade (see section 5.2 on page 16).

IMPORTANT SAFETY INFORMATION
Ensure at all times that the main rotor/motor does not spool up!
Disconnect the wires from the ESC to the motor.

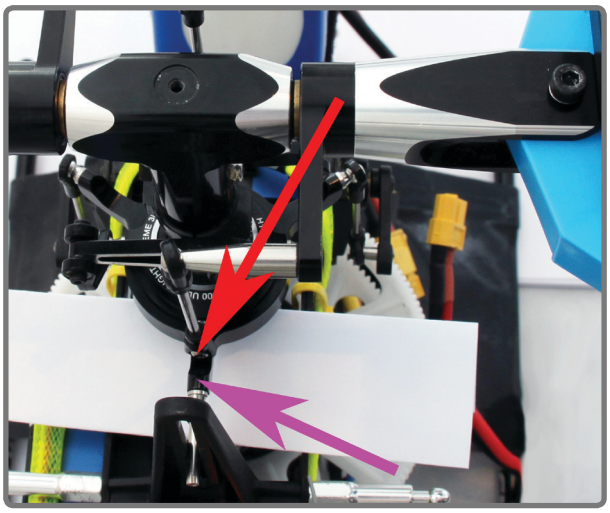
1. Power on your transmitter and power on the FBL system and the servos. Wait until the FBL system has initialized and is connected to the transmitter.
2. Activate the servo midpoint (servo trim) setup on your FBL system. Have a look in the user manual if necessary. Be aware, for some FBL systems the pitch value of the transmitter is important as well to centre the servos.
3. Turn the rotor head until the Soko Kit faces to the front, right, back and left and read the absolute angle at each of the four positions. The average value of all four should be around 0.0° (i.e. 1.2, 0.7, -0.9 and -0.8). If all values are below or above 0.0° (i.e. 1.2, 1.5, 0.9 and 1.0) your linkage from the blade grip to the swash plate is too long or too short.
   Adjust the length accordingly to get an average value around 0.0°.
4. Turn the rotor head until the inner ball of the swash plate where the Soko Kit is mounted (red arrow) aligns with the outer ball of the first servo (purple arrow). In other words align the linkage of the blade grip with the Soko Kit with the linkage of the first servo. Which servo is first does not matter. We chose the front-right servo (looking in flight direction).



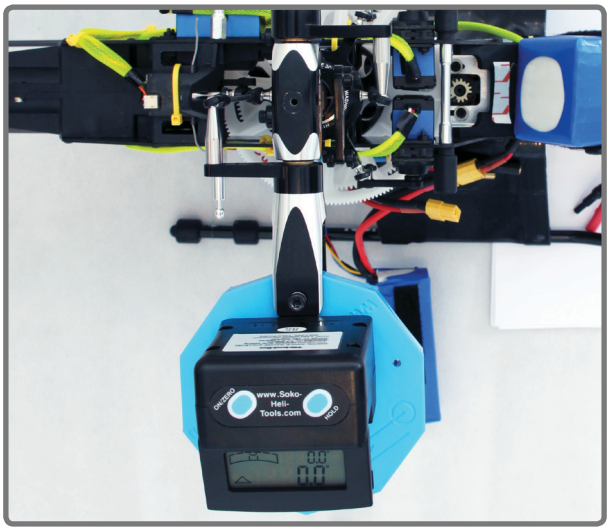
5. Change the servo trim for the first servo until the Soko Gauge reads 0.0°. If you have to highly adjust the midpoint, try to lengthen or shorten the linkage from the servo to the swash plate instead. A mechanical adjustment is always a better choice than an electronic one.



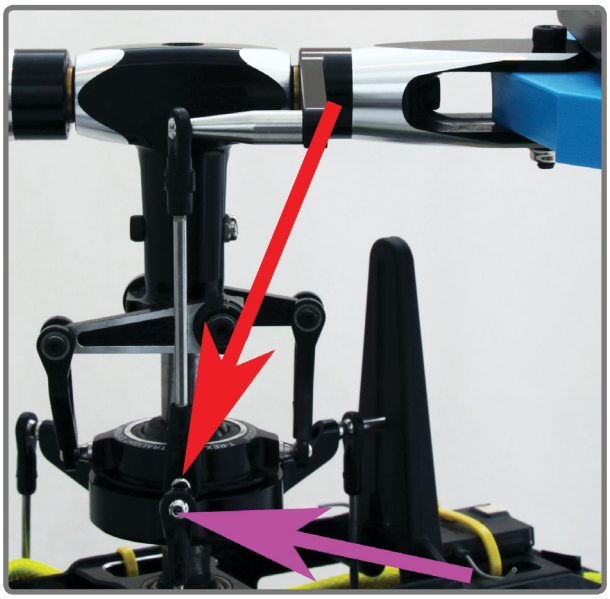
6. Turn the rotor head to align the Soko Kit linkage with the second servo linkage.



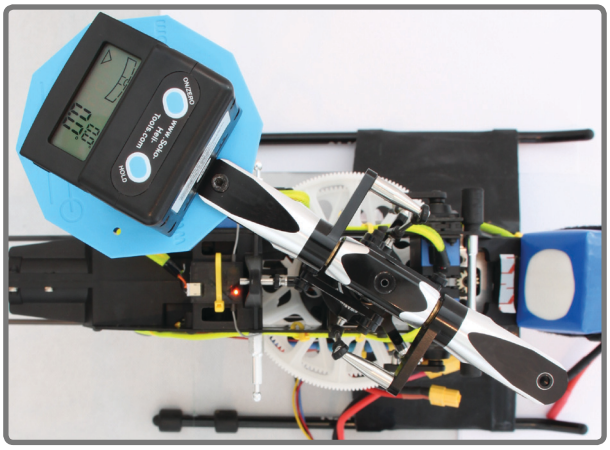
7. Change the servo trim or linkage length for the second servo until the Soko Gauge reads 0.0°.



8. Turn the rotor head to align the Soko Kit linkage with the third and last servo linkage.



9. Change the servo trim or linkage length for the third servo until the Soko Gauge reads 0.0°.



10. Repeat steps 4 to 9 until no adjustment is needed anymore and the Soko Gauge reads absolute 0.0° during one whole turn of the rotor head.
11. The swash plate is now perpendicular to the main shaft.
12. Mount the Soko Kit in the other/second blade grip.
13. Ensure the Soko Gauge reads absolute 0.0°. If it doesn't, adjust the linkage from the second blade grip to the swash plate MECHANICALLY until it reads 0.0°.
14. Both blade grips now have 0° pitch and your swash plate is 90° to the main shaft at zero pitch. Your blades are tracked as well if your blades are equal (same weight and same centre of gravity).

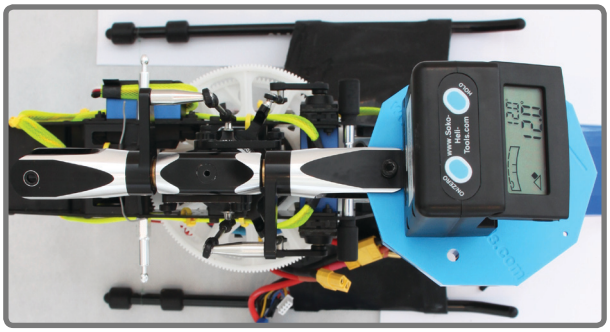
Troubleshooting	
Problem	**Solution**
I have a multi rotor head (more than 2 blades) on my helicopter. How do I setup my helicopter?	It's easy. All you have to do is to repeat steps 12 and 13 for all blade grips. Nothing else needs to be done.
This whole process doesn't seem to work at all. Any changes on the servo trim lead to an undefined movement or no movement at all.	Be sure you have disabled any third party unit between the FBL system and the servos (i.e. DJI Wookong).

6.3. Setup of collective pitch

The main rotor shaft must be in an absolute vertical position (section 6.1 on page 18) and the Soko Kit must be mounted as main blade (see section 5.2 on page 16).
It is necessary that the swash plate level and 0° pitch (see section 6.2 on page 22) are already adjusted.

The setup procedure of maximum pitch levels is highly dependent on your FBL system type. For the right setup mode and how to adjust the angles see the manual of your FBL system. The Soko Kit supports this setup by measuring the pitch angle.

1. Activate the setup of the collective pitch angles in your FBL system.
2. Turn the rotor head so that the display is facing to the front of the helicopter.
3. Now setup the desired maximum negative and maximum positive pitch. The Soko Gauge displays the current pitch angle.



Troubleshooting	
Problem	**Solution**
The absolute values for maximum positive and negative pitch are far off (i.e. 11.5° and -10.4°)	Make sure your pitch curve on your transmitter is a flat 45° line.
	Make sure your pitch-end-points on the transmitter are the same (i.e. 100%) for positive and negative pitch and dual-rate is disabled (if your transmitter supports this feature).
	Make sure your pitch-end-points in the FBL unit are the same (if your FBL unit supports this feature). Different pitch-end-points happen especially if you re-setup an old heli. You may have changed these values at some point in the past.
	INFO: The points above ensure the same relative rotation angle of the servos on full positive and full negative pitch.

	If your values are still far off it's probably caused by the head geometry of your helicopter. You can adjust it electronically by adjusting the pitch-end-points for positive and negative pitch separately (see your FBL system manual).
	As an option you can setup your swash plate at full pitch (see section 6.4 on page 28) as well.
	For more information about head geometry see section 8.3 on page 44.

6.4. Setup of swash plate at full pitch and pitch consistency

The main rotor shaft must be in an absolute vertical position (section 6.1 on page 18) and the Soko Kit must be mounted as main blade (see section 5.2 on page 16).
It is necessary to adjust the swash plate level and 0° pitch (see section 6.2 on page 22) as well as set up the collective pitch (see section 6.3 on page 26).

1. Activate the setup of the servo end points (sometimes called servo travel or servo throw) in your FBL system.
2. Apply full positive pitch.
3. Follow the steps 4 to 10 in section 6.2 on page 22 of the basic procedure with two alterations:
   - Your target angle is the full positive pitch angle of section 6.3 on page 26.
   - Instead of adjusting the servo mid-points you are adjusting the upper servo end points (positive travel or positive throw).
4. Once you read the same positive collective pitch at any rotation position of the head apply full negative pitch.
5. Follow the steps 4 to 10 in section 6.2 on page 22 of the basic procedure with two alterations:
   - Your target angle is the full negative pitch angle of section 6.3 on page 26.
   - Instead of adjusting the servo mid-points you are adjusting the lower servo end points (negative travel or negative throw).
6. Once you read the same negative collective pitch at any rotation position of the head you are done.
7. Your swash plate is now 90° to the main shaft at full positive and full negative collective pitch.

Troubleshooting

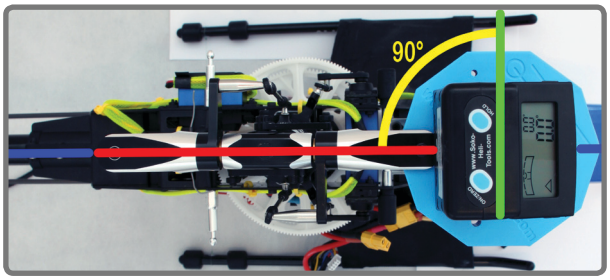
Problem	Solution
I cannot find the spot to change the servo end points in my FBL system setup software	Almost all setup software of FBL systems has different modes, like a basic and an advanced mode. The setup for servo end points is mostly only visible in the advanced mode.

6.5. Setup of cyclic pitch

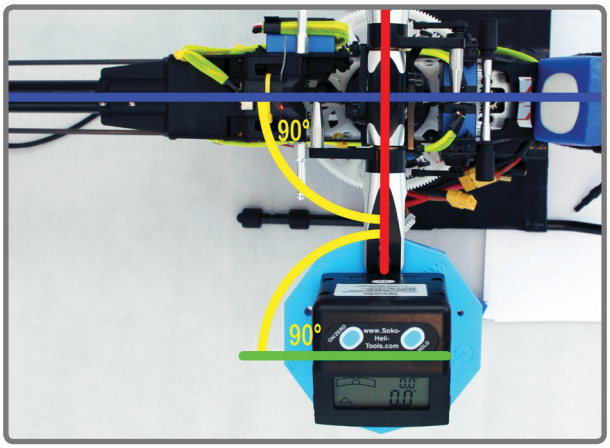
The main rotor shaft must be in an absolute vertical position (section 6.1 on page 18) and the Soko Kit must be mounted as main blade (see section 5.2 on page 16).
It is necessary that the swash plate level and 0° pitch (see section 6.2 on page 22) are already adjusted.

This setup procedure is highly FBL system dependent as well. See your FBL system manual for details. The Soko Kit supports this setup by measuring the pitch angle.

1. Activate the setup of the cyclic pitch angles in your FBL system.
2. To read the aileron (roll) angle rotate the main rotor (red) so that the Soko Gauge display faces to the front. In other words the Soko Gauge axis (green) is perpendicular (yellow) to the longitudinal axis (blue) of the helicopter.



3. Now setup the desired aileron pitch. The Soko Gauge displays the current pitch angle.
4. To measure the nick (elevator) angle, rotate the main rotor so that the Soko Gauge display faces to the side. The Soko Gauge axis (green) is parallel to the longitudinal axis (blue) of the helicopter. In addition the main rotor axis (red) is perpendicular (yellow) to them.



5. Now setup the desired nick pitch. The Soko Gauge displays the current pitch angle.

Troubleshooting	
Problem	**Solution**
The displayed value doesn't change much or not at all when I apply full elevator/nick or aileron/roll	Make sure you move your transmitter stick in the right direction for the current axis. To measure aileron/roll you need to move the right stick of your transmitter full left and right (on a mode 2 transmitter). To measure elevator/nick you need to move the right stick full up and down (on a mode 2 transmitter).
The absolute values of the two sides of one axis (elevator/nick or aileron/roll) are far off (i.e. 9.5° and -8.4°)	Make sure your pitch-end-points on the transmitter are the same (i.e. 100%) for positive and negative pitch and dual-rate is disabled (if your transmitter supports this feature).
	Make sure your axis-end-points in the FBL unit are the same (if your FBL unit supports this feature). Different end-points happen especially if you re-setup an old heli. You may have changed these values in the past.
The values per axis are close enough but the two axis are far off (i.e. 9.5° and -9.4° for elevator/nick and 11.3° and -11.5° for aileron/roll)	A mechanical cause or setup error is unlikely in such a situation. Especially if all other values during the setup were OK. Did you change some values in the FBL unit? Consult your FBL unit manual for cyclic mixing settings and try to change the appropriate values.

6.6. Setup of centre of gravity (CoG)

We highly recommend adjusting the CoG as the last step of your setup process, but before you lose the position of the vertical aligned main rotor shaft. Just follow section 6.6.1. below.

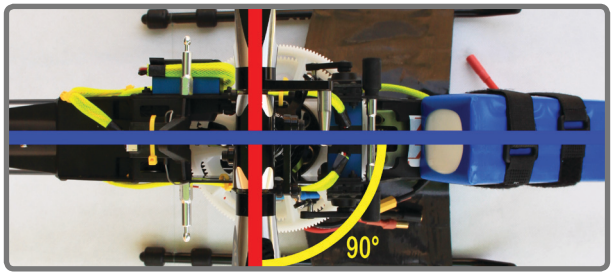
The easiest way to (re)check your CoG with no vertical main shaft is section 6.6.2.

If you are able to lift your helicopter in a stable way or you can hang it from the ceiling have a look at section 6.6.3.

6.6.1. With vertical aligned main rotor shaft

The main rotor shaft must be in an absolute vertical position (section 6.1 on page 18) and the Soko Kit doesn't need to be mounted anymore.

1. Turn the rotor head so the main blade axis (red) is at right angles (yellow) to the longitudinal axis of the helicopter (blue).



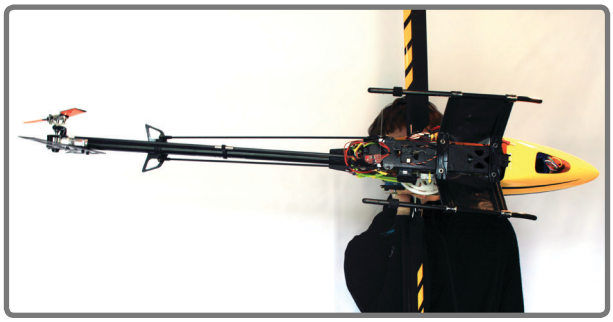
2. Now prevent the rotor head from rotating. This is highly dependent on your brand and size of heli. For example, use a tape or cord to tie the tail gear to the main gear.
3. Assemble everything (batteries, canopy, etc.) ready-to-fly.
4. Slowly lift the helicopter vertically by the two main blade grips. Be sure the heli can nick as freely as possible. Another and more accurate way to do this is to build a handle out of strings which attaches on the blade grips.
5. Before the helicopter/skids lose contact to the surface, observe if the tail moves towards the surface or away. Just watch the distance of the tip of the tail fin.
6. Place the helicopter back on the surface and adjust the centre of gravity accordingly. The common way to do that is to slightly change the position of the main battery.
   If the tail moved towards the surface, the helicopter is tail-heavy:
   Move the battery more to the front.
   If the tail moved away from the surface, the helicopter is nose-heavy:
   Move the battery more to the back.
7. Repeat the step 4 to 6 until the skids and tail fin are starting to move at the same time. Don't forget to mark the final position of the battery.
8. The centre of gravity is now adjusted.

6.6.2. Rechecking the CoG

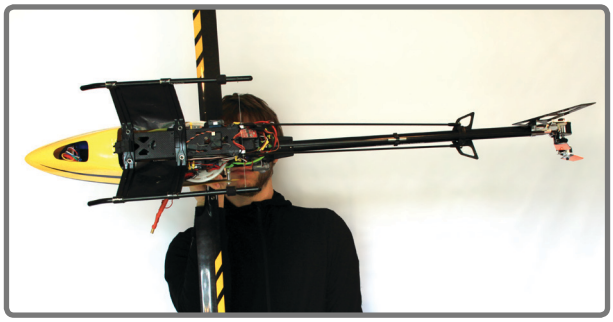
There is an easy way to check the centre of gravity in any situation and anywhere without the need of a tool. This way is not new but worth mentioning in this section for sure.

1. Assemble everything (batteries, canopy, etc.) ready-to-fly.
2. Grab the helicopter on the rotor head and lift it into a vertical position.

3. Turn the tail to your right with your other hand, let go again and observe if the tail is moving.



4. Turn the tail to your left with your other hand, let go again and observe if the tail is moving.



5. If the tail drops in step 3 or 4 the helicopter is tail-heavy:
   Move the battery more to the front.
   If the tail raises in step 3 or 4 the helicopter is nose-heavy:
   Move the battery more to the back.
6. If the tail stays in position in any orientation the CoG is perfect.

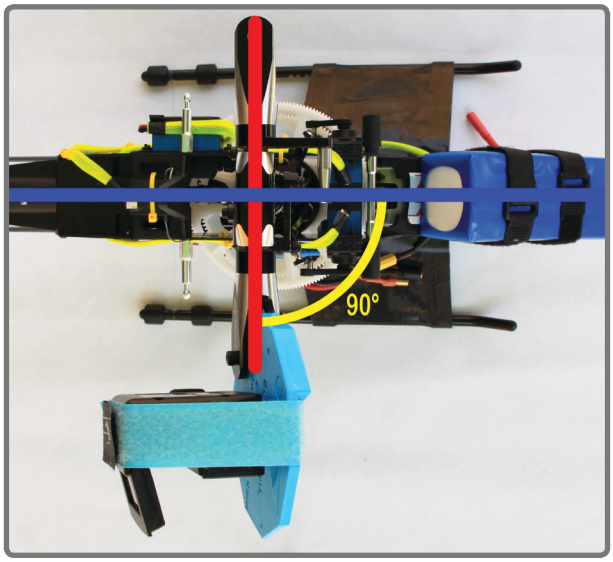
Troubleshooting

Problem	Solution
Why do I have to turn the tail to the left and to the right to check the CoG?	The auto rotation bearing in the helicopter just works in one rotation direction. Rotation to the other side is blocked by the resistance of the motor. You feel it when you moving the tail from facing right to facing left. Just one direction puts up a resistance against the rotation.

6.6.3. A third way to check the CoG

To setup the centre of gravity the Soko Kit must be mounted according to section 5.1 on page 13 and you must know the final target angle of the setup procedure of section 6.1 on page 18 ("Absolute vertical alignment of main rotor shaft").

1. Turn the rotor head so the main blade axis (red) is at right angles (yellow) to the longitudinal axis of the helicopter (blue).



2. Recall the final target angle. In our case it is 68.2° when the main shaft is in absolute vertical position.
3. Now prevent the rotor head from rotating. This is highly dependent on your brand and size of heli. For example, use a tape or cord to tie the tail gear to the main gear.
4. Assemble everything (batteries, canopy, etc.) ready-to-fly.
5. Lift the helicopter by the rotor head. Be sure the heli can nick as freely as possible. Another and more accurate way to do this is to build a handle out of strings which attaches on the rotor head or hang it from the ceiling.
   If the blade grip with the Soko Kit tends to rotate use a cable tie to fix it.
6. Read the absolute angle on the Soko Gauge. The target is the final target angle of step 2 (68.2° in our example).
7. Place the helicopter back on the surface and adjust the centre of gravity according to the angle. The common way to do that is to slightly change the position of the main battery.
8. Repeat step 5 to 7 until the final target angle is achieved (as close as possible to the angle of step 2). Don't forget to mark the final position of the battery.
9. The centre of gravity is now adjusted.

7. Additional setup procedures

The following setup procedures are separated from the above because they are not needed in all situations. Nevertheless depending on your helicopter, your flying skills, your components, etc. you might want to use them.

7.1. Setup of servo horns

Once you are ready to setup with the Soko Kit your servo horn setup is already done and most of you set it up the way as described below. It's mainly included here to aid the explanations in section 8.3 on page 44.

The easiest way to setup the servo horn is actually before you mount them into the frame. In general it's a good idea to setup and test the whole electronic (FBL system, servos, ESC, motor, etc.) before you install it in the helicopter.

1. Wire your receiver/satellite(s), FBL system and servos and bind it to your transmitter.
   Look into your FBL system manual for the proper order to do this. Most FBL systems require some basic setup before you connect anything to it.
2. With wiring the cyclic servos to your FBL system you choose their spot in the helicopter. Make sure you know afterwards which servo has to go to which position.
3. Check the manual of your helicopter to determine which way each servo is mounted in the helicopter. This includes:
   - the orientation of the servo case (vertical or horizontal)
   - the position of the servo horn mounting point (i.e. for a vertical servo if the mounting point is in the upper or lower part of the servo case)
   - the direction the servo horn itself has to face
4. Activate your servo mid-point setup of your FBL system and/or apply 0° pitch on your transmitter. The servos will move into their default middle position.
5. Mount the servo horns on all three servos according to step 3. Try to get as close as possible to 90° (for vertical oriented servos) or 0° (for horizontal) between servo horn axis and servo case longitudinal axis as possible.
6. Setup the swash plate type and servo moving directions in your FBL system (see the manual).
7. Go back to the servo mid-point setup.
8. Adjust the mid-points of each servo so the angle between the servo horn axis and the longitudinal axis of the servo case is 90° (for vertical) or 0° (for horizontal). Use a ruler or any other object with a right angle.
9. Your servo horns are now 90° (respectively 0°) when zero pitch is applied.

7.2. Setup of tail pitch

7.2.1. When is it necessary?

The topic of measuring the tail pitch is quite misleading, especially for beginners and intermediate pilots in our great hobby who do not fully understand the physics, aerodynamics and background of it.
We want to try to point out the situations when a measurement and setup of the tail pitch could be viable.

In short: You probably won't need it! But let's think about the tail setup for a moment and investigate the needs and possibilities.

Everyone knows the one and only thing you have to setup on the tail: you have to tell the FBL system the mechanical end points of the tail. Some FBL systems need to know the zero pitch position as well.

Other than the main rotor pitch, the tail rotor pitch has no swash plate, just one servo and a quite simple mechanism with no way to adjust anything. So there is neither a need to measure the tail pitch of each blade separately nor a need to know when the tail pitch has an angle of i.e. 2.3°.
Getting the zero pitch position is quite easy to do by folding both blades on one side and moving the tail slider until both blades are in line.

You see that so far measuring or even using a tool is unnecessary and won't give you a better setup or even a better flying helicopter!

There is one thing though, that some of you might want to setup on the tail which includes measuring the tail pitch. It has to do with the maximum tail pitch, and tells the FBL system not the maximum mechanical end points of the tail but a tail slider position that is less than the mechanical maximum.
In other words: Not allowing the tail to go over a certain pitch angle (maximum pitch angle), even if mechanically a higher angle would be possible.

The reason to this is to prevent the tail from stalling (to get stalling tail blades). A lot of pilots don't know what this means which is OK, especially if you are a beginner/intermediate pilot. Wikipedia describes it as "a reduction in the lift coefficient generated by a foil as the angle of attack increases."

Without going into much detail, the critical term in its definition is "angle of attack". The angle of attack is not the pitch angle of the tail (which is called angle of incidence in our case) although the angle of attack is a result of the angle of incidence in addition to other parameters.

To keep a long and quite technical story short: The angle of incidence (=tail pitch) your tail will stall is practically not possible to predict and not feasible to calculate.

In a nutshell: Even if you know all necessary parameters from your helicopter it highly depends on the manoeuvre you are flying at a particular moment in addition to the wind conditions on the flying day.
For example, on the same day and the same flight your tail will start to stall at 25° pitch on one manoeuvre while on another manoeuvre the blades won't stall at 45° pitch (keep in mind that we are talking about high speed 3D manoeuvres).

In conclusion there is not much a point in reducing the maximum tail travel and therefore the maximum tail pitch. Provided that the tail mechanic itself has no issues on its maximum positions (i.e. get stuck at the end points).

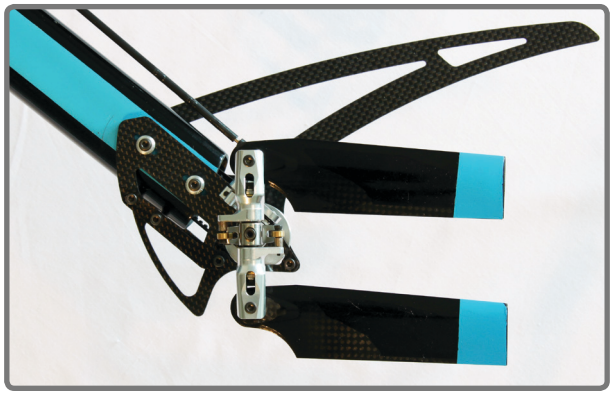
Even if you are keen to do it there is no need for accuracy here due to the physics involved. This means it doesn't matter if your maximum tail pitch is 30.3° or 30.5°, or even 29° or 31°. In reverse it doesn't matter if the setup method calculates 30° but due to reduced accuracy in the process it really is 29°. Moreover most of the tail mechanics, even on a SAB Goblin, are designed with a play in their tail (i.e. blade grips) which makes an accurate setup impossible.

To setup the maximum tail pitch we developed the following setup procedure.

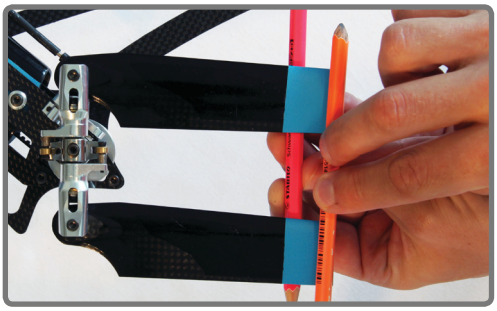
7.2.2. Setup the maximum tail pitch

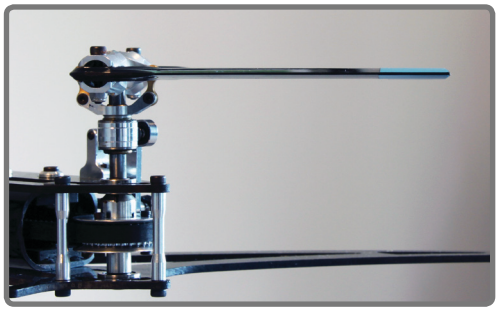
The following steps illustrate an easy way to calculate the tail pitch of a certain tail throw or setup the tail throw to get a certain tail pitch - of course for all helicopters of all sizes and all brands.

1. Fold the tail blades to the same side.

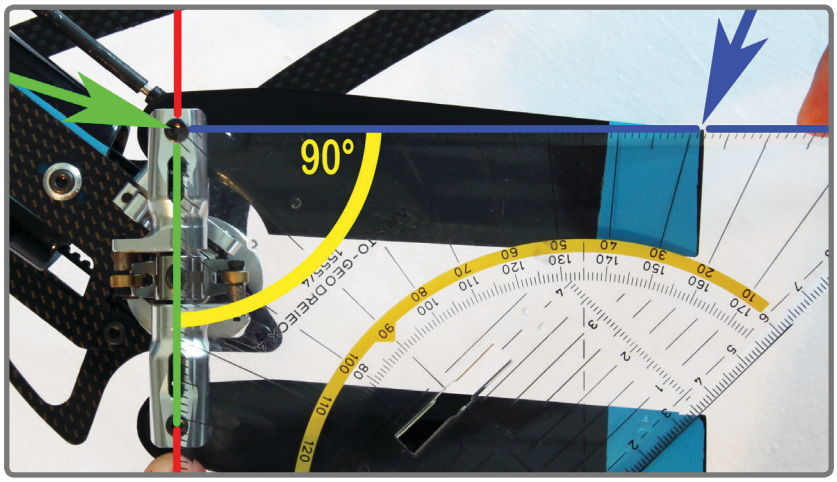


2. Ensure you have zero pitch by pressing two flat objects on both sides of the blades (left picture) and scanning their alignment (right picture).

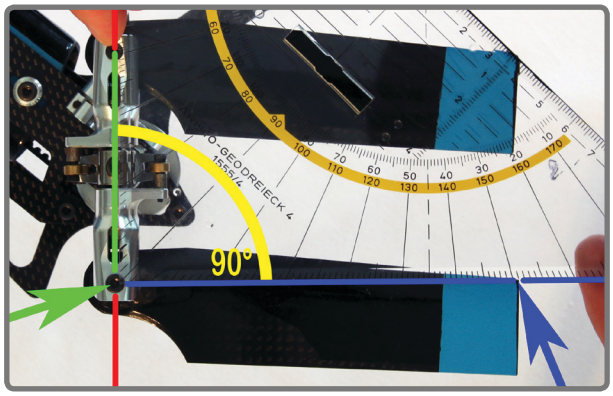




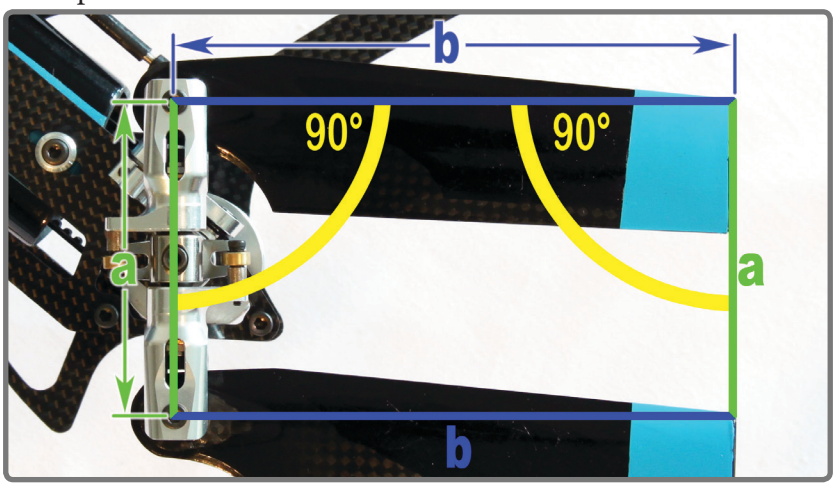
3. Take a ruler or any other object with a right angle.
4. Align one edge of the right angle (green line) along the tail rotor shaft (red line) at tail screw-height and the corner of the right angle on the middle of the tail blade screw (green arrow).
   Fold the tail blade so its tip corner (blue arrow) is on the other perpendicular edge (blue line) of the ruler.



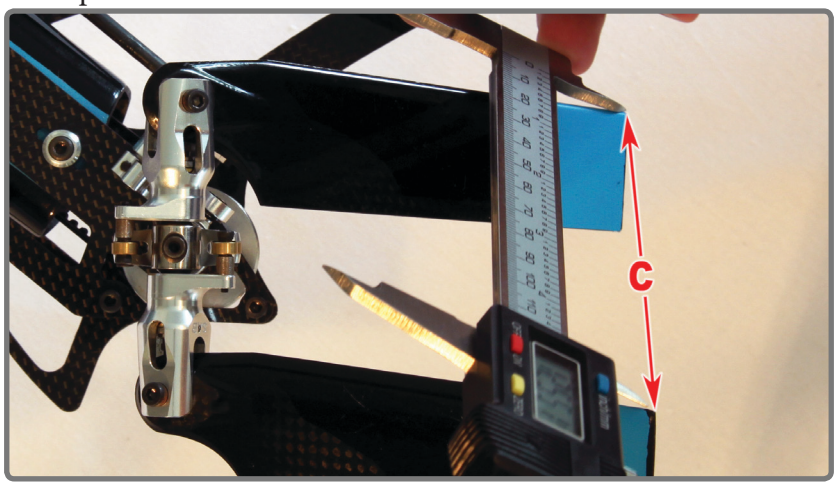
5. Do the same with the second tail blade.



6. Measure the distance between the centre of the two tail blade screws (a) and the distance from the screw to the aligned corner on the tip of the blade (b). Due to the perpendicular tail alignment the formed shape is a rectangle. In our example a=66.5mm and b=115mm.



7. Move the tail slider to the position you want to know the angle of.
8. Measure the distance between the two corners off the tips of the tail blade (c). At zero pitch this distance is equal to (a) but when pitch is applied the two tips move away from each other. In our example c=125.5mm.



9. Enter all three dimensions into our calculator on our website (Usefull stuff - Tail pitch calculator) to get the tail pitch angle. In our example the tail pitch angle is 27.5°.

In addition you can calculate the distance (c) for a given tail pitch as well.

Don't get caught up in decimal places of the numbers. Due to the play of each tail mechanic and the possible accuracy of measuring (a) (b) and (c) there is no point of dealing with fractions here.

8. Appendix

8.1. General FAQ and troubleshooting

Some questions are frequently asked via email or in forums. Find answers to the most frequent one below. If you like to get more information or you don't find the answer you are looking for please don't hesitate to contact us. We are happy to help!

FAQ & troubleshooting	
Question | Problem	**Answer | Solution**
I like to use the Soko Kit a lot but I kinda dislike the paper method. Is there an alternative?	Yes. With a few simple items you can build yourself a levelling table. There are a lot of samples on the internet and in forums. Two very simple but effective ones are by Luvmyhelis and TBur. CPO did a great build video of a more sophisticated version.
The opening of the blade grip of the helicopter is an odd size and it seems no corner of the Soko Helical fits.	Use suited washers to mount the Soko Kit in the blade grip. They were probably delivered with the helicopter kit or the main blades. There is also some flex in the blade grip itself which you can utilize with the blade screw when mounting the Soko Kit.
Do I have to put the main shaft into vertical position each time I want to measure the pitch?	No. Just use the Soko Kit as any other pitch gauge: After your first full setup with the Soko Kit you do not need to bring the main shaft into vertical position if you didn't change the head geometry (i.e. rebuild after a crash) or the servo points in the FBL unit. Just mount the Soko Kit in Position 2 and rotate the head to measure the desired pitch. Apply 0° pitch on your transmitter and/or in the software of your FBL unit. Ignore the absolute angle on the Soko Gauge because it won't show 0°. Just use the relative angle of the Soko Gauge for your measurements by pressing the ZERO button to reset the relative angle. Now you can apply pitch, nick or roll to get your angles using the relative angle on the Soko Gauge.

During the setup procedures I noticed that the whole heli tilts to the side where the Soko Kit is mounted. Is this a problem?	No. We are proud NOT to use electronic sensors for the measurement in our Soko Gauge because all of them suffer from temperature and age drift. It uses a mechanical system and just displays the result digitally. The Soko Gauge may cause tilting especially on little helicopters. First of all make sure your skids are not the problem (see beginning of section 6.1 on page 18). Even if the heli still tilts, it won't influence the measurement. The measurement axis is always perpendicular to the tilt direction and therefore doesn't affect the measurement at all. Have a look how Bobb setup his TRex 250.
I have a multi rotor head (more than 2 blades) on my helicopter. How do I setup my helicopter?	It's easy. All you have to do is to repeat steps 12 and 13 of section 6.2 on page 22 for all blade grips. Nothing else needs to be done.
Are there any other useful resources?	We provide a lot of other information for the hobby on our website. Under "Useful stuff" you find a LiPo calculator, PSU and charger calculator and the tail pitch calculator. We will add more sections in future so check back frequently.

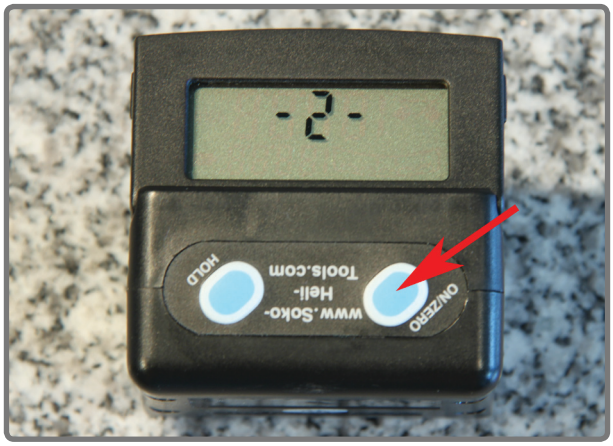
8.2. Calibrating the Soko Gauge

The absolute horizontal spirit/bubble level of the Soko Gauge is already calibrated when it comes to you. Nevertheless you might find yourself in a situation where you want to recalibrate the Soko Gauge.
The recalibration doesn't need to be done in our factory. You can do it at home. All you need is a stable and horizontal surface which is already in spirit/bubble level.

1. Remove the battery cover of the Soko Gauge.
2. Press and hold the ON/ZERO button while replacing the battery cover. The whole display is lit up.
3. Release the ON/ZERO button. The display shows "-1-".
4. Place the Soko Gauge on the stable horizontal surface and press the ON/ZERO button once.

5. The "-1-" will flash a few times and then change to "-2-".
6. Turn the Soko Gauge 180° so the display faces on the other side.

7. Press the ON/ZERO button once. The “-2-” will flash a few times.



8. The display changes to normal operation mode (0.0° is shown).

9. The Soko Gauge is now calibrated.

If the display shows “-1-” again instead of going back to normal operation mode in step 8 the surface you are using is not in spirit/bubble level. Re-level the surface with a third party tool and start all over.

8.3. A brief history of head geometry

This section goes into detail about head geometry and why a 90° servo horn is not as important as you might think. This is due to different reasons and has some limitations of course. For example all information below assumes you setup your helicopter with the Soko Kit and as described in this instructional PDF.

But in a nutshell: An eyeballed 90° servo horn using a ruler is all you need (see section 7.1 on page 35).

This section is in the appendix on purpose. With the setup procedures above you will get an awesome flying helicopter. This section is designed to help you capitalize on the very last possibilities of getting an even more mechanically precise setup.
As with all things put to the extreme it takes much more effort to get from 99% to 99.9% as from 90% to 99%.

But let's start from the beginning...

DISCLAIMER
This section is based on our research on the given topic and one unit of the helicopter size and brand mentioned. We did not receive any information or data from the manufacturers. Although thoroughly investigated, the following may not be representative for the brand or size itself or be free of errors.

8.3.1. Terms and basics

A servo horn setup like in section 7.1 on page 35, a FBL system with default servo throws and a 45° pitch curve in your transmitter, lead to a linear relation between your throttle stick position on your transmitter and the rotation angle of the servo horn:

- When the transmitter stick is in middle position, the servo horn angle is 0°.
- When the transmitter stick is in full upper position, the servo horn has a positive angle (i.e. 25°).
- When the transmitter stick is in full lower position, the servo horn has the same angle like in the full upper position, but just negative (i.e. -25°).
  In other words: At full upper and full lower position the absolute angle is the same.

The term "**transmitter pitch**" is defined as the collective pitch you apply on your transmitter with the throttle stick.
You will see the transmitter pitch is not the same as the main blade pitch.
In addition the term "**servo horn angle**" refers to the angle relative to the servo horn neutral position (equal when 0° transmitter pitch is applied).
In respect to section 7.1 on page 35 this neutral position is 90° (vertical oriented servo i.e. on a Warp 360) or 0° (horizontal oriented servo i.e. on a Goblin 700) in relation to the servo case.

On a flybarless rotor head, a change of the servo horn angles leads directly to a change in the main blade pitch. There are no other factors involved (i.e. like a flybar mixing):

- The servo horn is connected to the servo-linkage
- The servo-linkage is connected to the swash plate
- The swash plate is connected to the blade-linkage
- The blade-linkage is connected to the main blade grip

The ideal head geometry

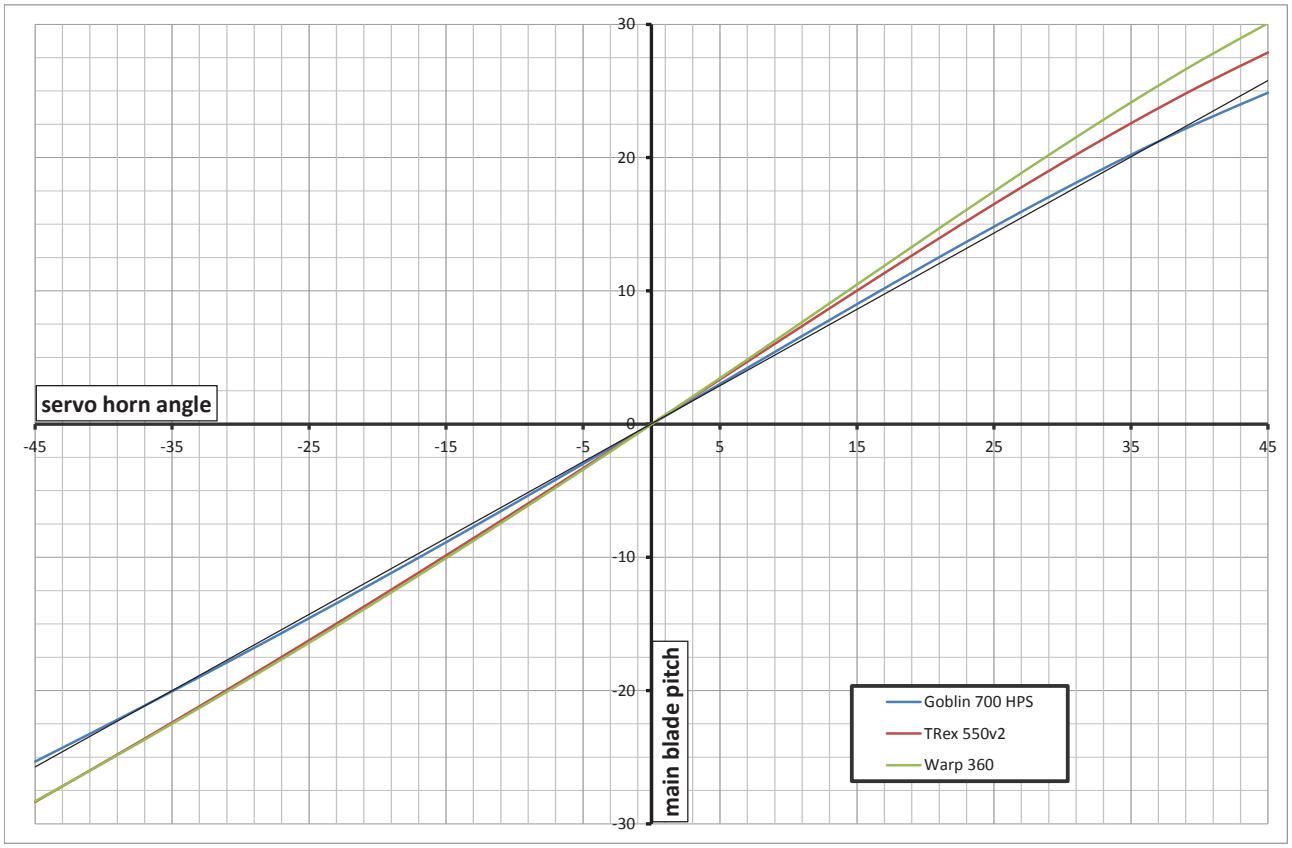
Let's start by examining just one servo and with the head positioned like this:

A rotation of the servo horn causes a direct change of the blade pitch. The way the servo horn angle and the main blade pitch are related depends on the helicopter and its head geometry. Some factors are unalterable for us (i.e. the distance of the main blade grip horn or the swash plate dimensions) and some can be changed (i.e. the lengths of the linkages).

An ideal head of a helicopter at 0° transmitter pitch has the following attributes:

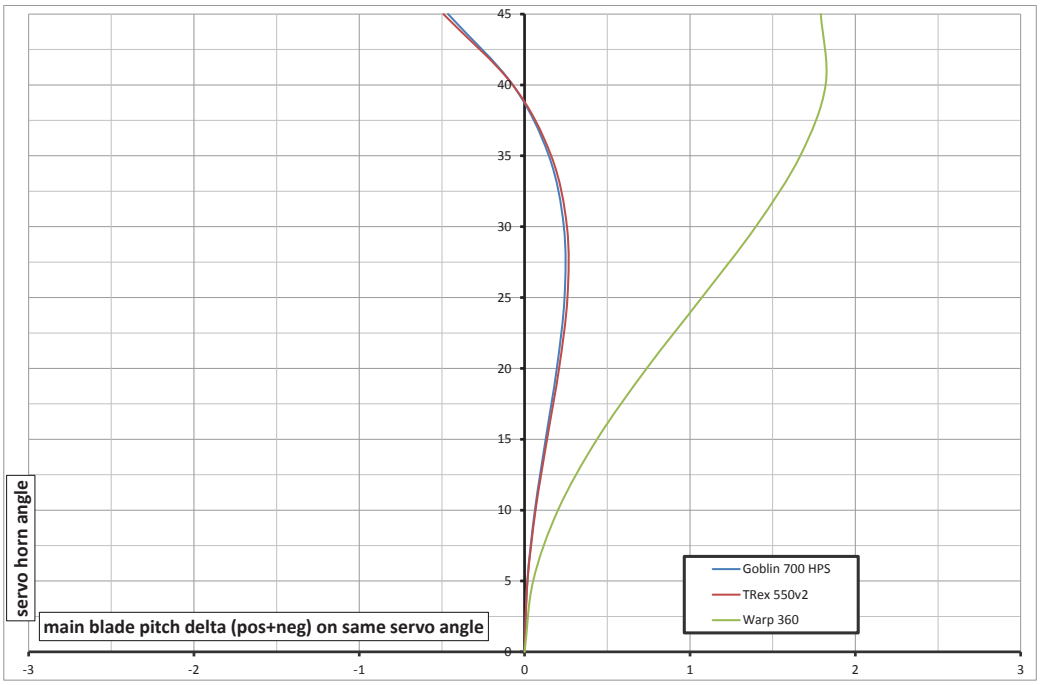
- 90° between main shaft and the servo horn
- 90° between the servo horn and the servo linkage
- 90° between the servo linkage and the swash plate plane
- 90° between swash plate plane and main shaft
- the correct blade linkage length to get 0° blade pitch

The following graph shows the relationship between the servo horn angle and the main blade pitch for different helicopters with ideal heads when applying transmitter pitch:



The linear trend line (black) for the Goblin 700 HPS shows clearly a non-linear relation.

A more interesting graph is the delta (difference) of main blade pitch when applying the same transmitter pitch to the positive and to the negative.
In other words: when applying the same absolute servo horn angle.

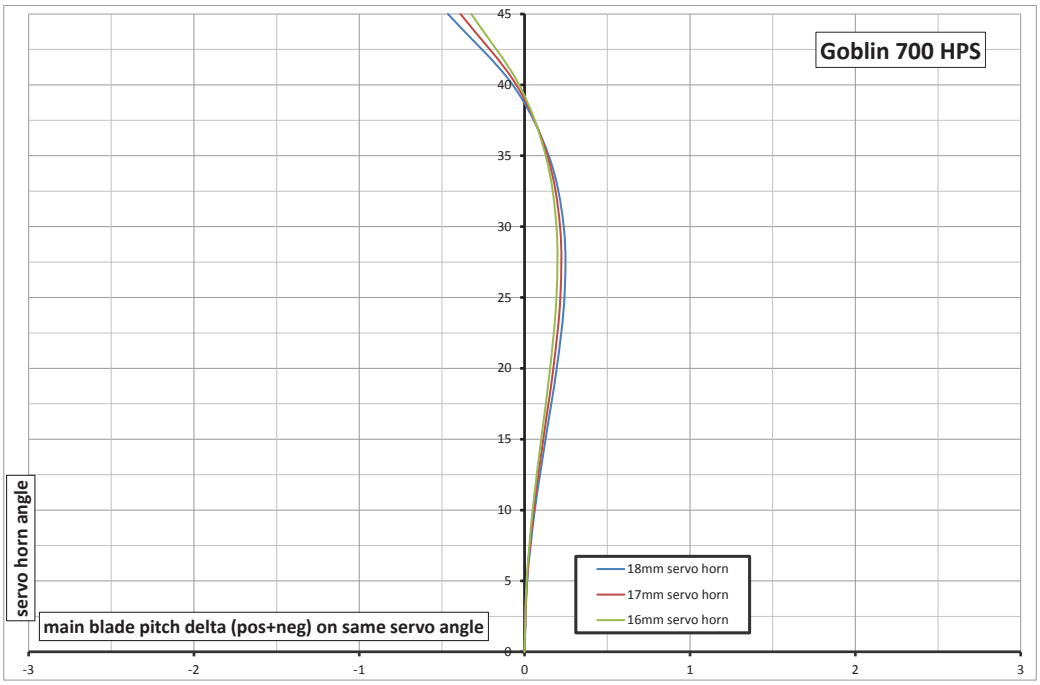


When applying the same amount of transmitter pitch in the positive and the negative direction, the resulting positive and negative blade pitch is not the same absolute value. The difference follows the line in the graph.
For example:
When the full transmitter pitch (positive/negative) results in a 25°/-25° rotation of the servo horn, you will get 0.25° more positive main blade pitch than negative on a Goblin 700 HPS and almost the same on a TRex 550v2. The head geometry of the Warp 360 leads to 1.0° more positive pitch than negative.

Analysing the delta graph

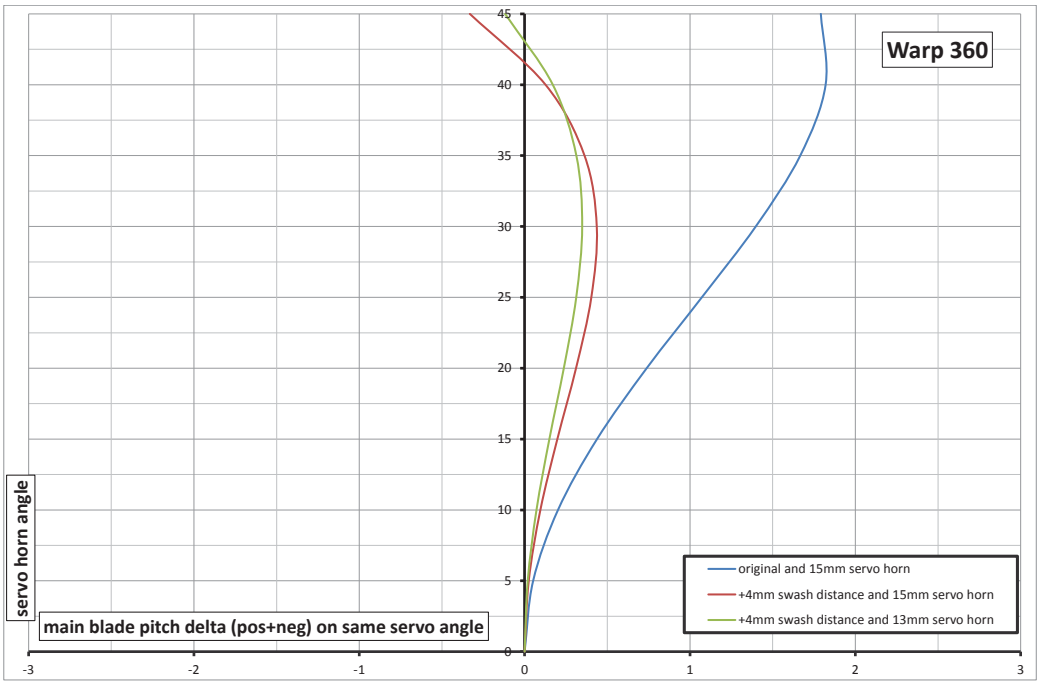
A perfect delta curve would be a vertical line through the origin of the graph.
Changing the servo-linkage length or the blade-linkage length does not significantly change the shape of the curve. If just one linkage length is changed, the curve moves out of centre. If you lengthen one and shorten the other accordingly the curve stays the same.

One way to improve the shape is to change the servo horn length. An example for the Goblin 700 HPS is shown in the following graph:



It doesn't improve much though. Keep also in mind when shortening the servo horn length, the servo position itself needs to change as well to keep the ideal head geometry valid.

For the Warp 360 the delta is too big to get a good compensation with shortening the servo horn. We identified the angle of the blade-linkage as the reason for the high delta. The blade-linkage on the Warp 360 isn't as vertical as on the bigger sized helicopters. When we increase the distance between the ball on the swash plate (swash distance) and main shaft by 4mm and shorten the servo horn as well we get close to the curve of the other helicopters:



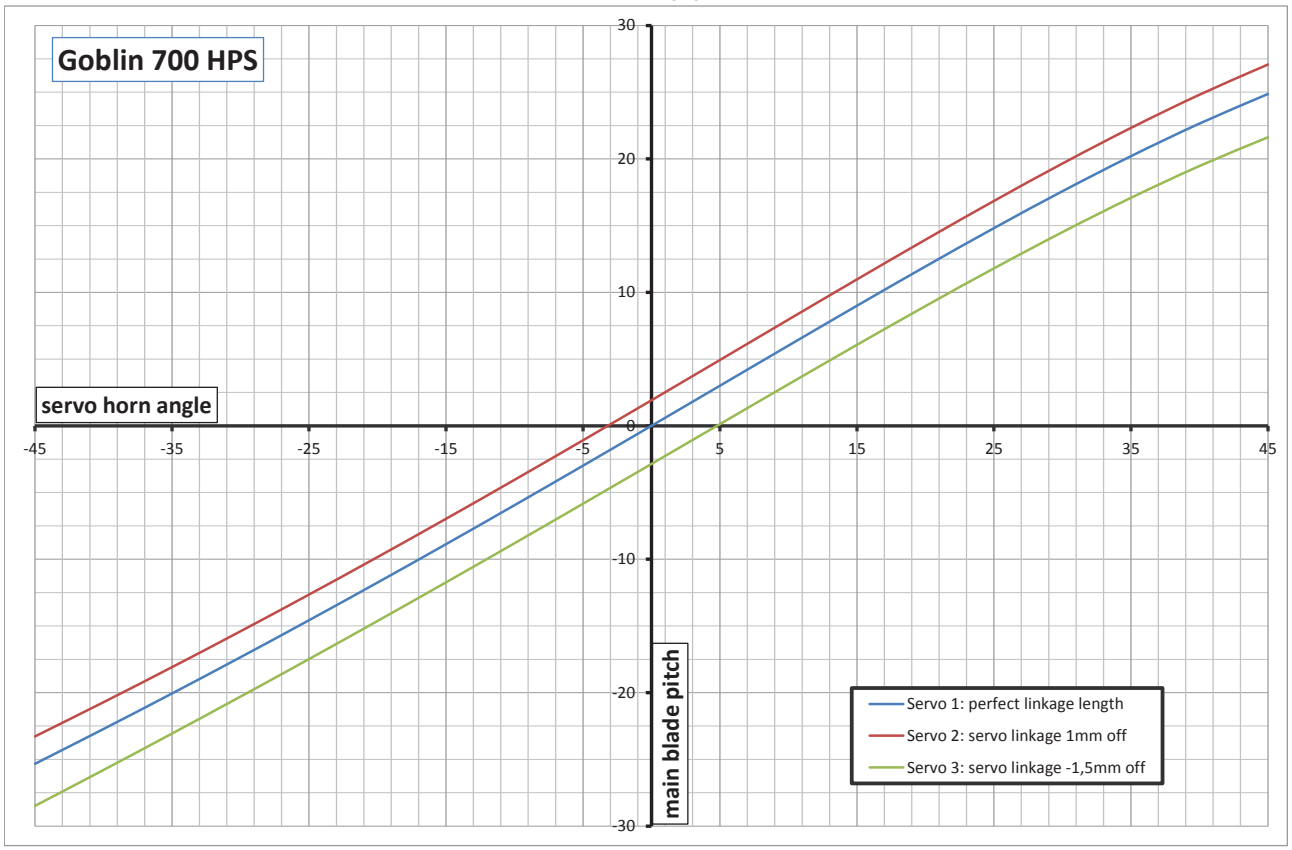
This is of course just theoretically possible. An increase of just the swash distance is not possible due to mechanical binding.

In practice you can compensate by telling the FBL system to throw the servo arm further when applying full negative transmitter pitch than on full positive transmitter pitch (see section 6.4 on page 28).

8.3.2. Involving all three cyclic servos

When moving through the whole range of transmitter pitch we assumed the same relationship between the servo horn rotations and main blade pitch on all three cyclic servos. In other words all three servos "use" the same curve.

In real life though this isn't the case. Just minor differences in the linkage lengths lead to different curves for each servo. In the following graph each line is one servo on the head:



The blue curve is the same as in the first graph in section 8.3.1 on page 44 and represents the ideal head from the servo horn up to the main blade.
The red curve shows the relation between servo horn angle and main blade pitch when the servo-linkage is just 1mm too long.
The green curve represents a servo-linkage that is 1.5mm too short.

Remember the servo horn angle is linear related to the transmitter pitch. In other words the chart also represents the relation between transmitter pitch and main blade pitch.

You see just 1.5mm of linkage-length-difference leads to ~2.5° difference in main blade pitch.
Or the other way around:
You need to get the servo horn ~5° out of the neutral position to get 0° main blade pitch.

The three different servo geometries in the graph lead to a tilted swash plate at any transmitter pitch value including 0° transmitter pitch.

From servo horn angle to servo throw angle

With the setup procedure in section 6.2 on page 22 you compensate these errors by changing the servo mid-points.
What this does is (still talking about the green curve in the last graph), tell the FBL system to put the servo ~5° off neutral position when it receives 0° transmitter pitch.
But this change of the servo mid-point also shifts the servo end points!

Here is an example:
Let's say with 0° transmitter pitch the servo horn angle is 0°, with full positive transmitter pitch at +25° and with full negative transmitter pitch at -25° servo horn angle.

By changing the servo mid-point value in the FBL system, the servo horn moves to an angle of 5° when 0° transmitter pitch is applied. In addition, the servo horn angle is +30° for full positive and -20° for full negative transmitter pitch.

The "**servo throw angle**" though is still the same:
The servo horn moves +25° for full positive and -25° for full negative transmitter pitch.
So the servo throw angle is the angle or distance the servo horn moves in relation to its mid-point.

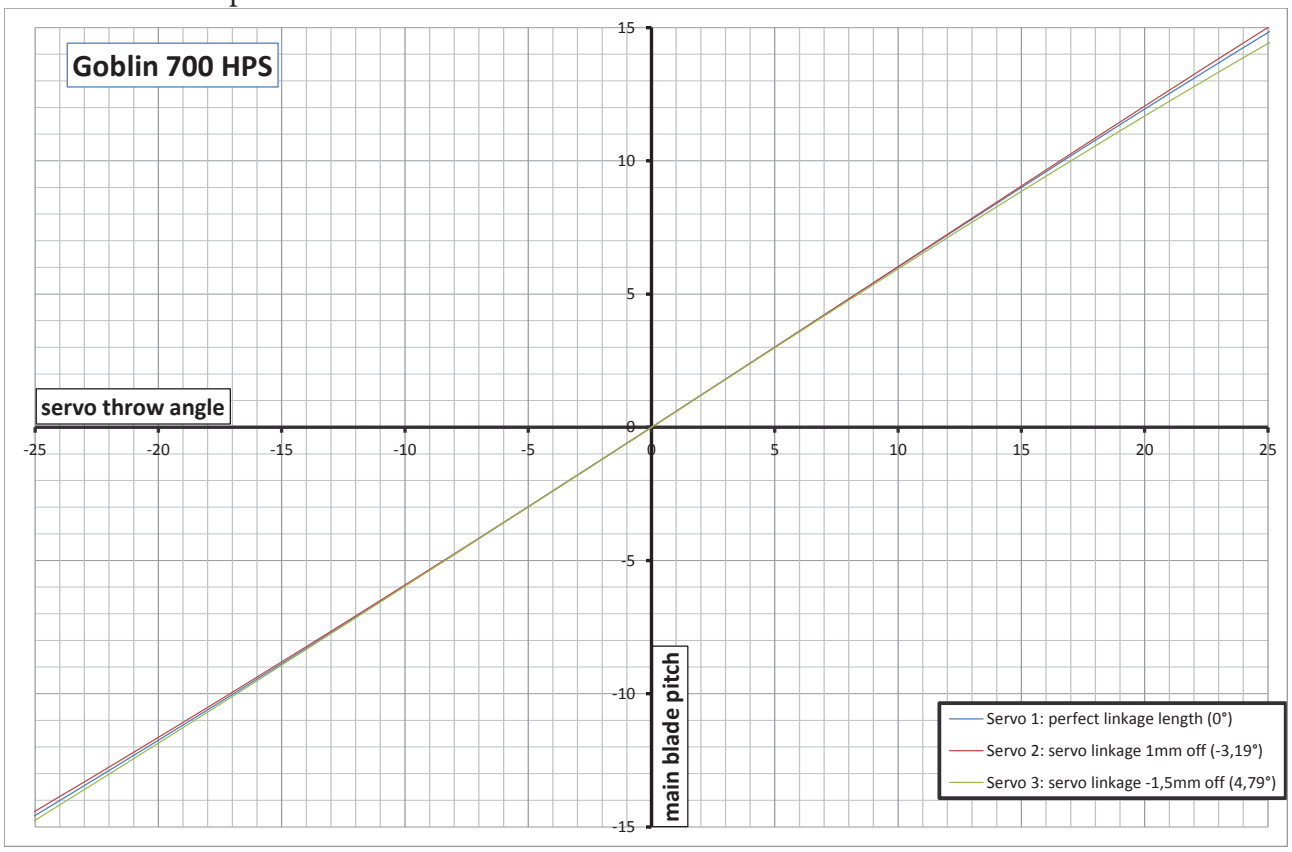
Adjusted servo mid-points

When adjusting the servo mid-points the green curve shifts to the left and the red shifts to the right so all three curves pass through the origin of the graph:

The legend of each curve states the exact angle the servo horn is off its optimum mid-point to compensate for the wrong linkage length. Servo 1 is 0° off, servo 2 is -3.19° and servo 3 +4.79° due to the change of the mid-points of servo 2 and 3.

Analysing the servo throw graph

What does this mean for our helicopter setup? Below is the same graph zoomed to just 15° main blade pitch:



At 0° servo throw, the main blade pitch on each of the 3 servos is 0° which gives a perfect perpendicular swash plate in relation to the main shaft.
When transmitter pitch ("equals" servo throw) is applied, the main blade pitch differs more and more between each servo the more transmitter pitch is applied.
This problem is addressed with the setup procedure in section 6.4 on page 28.

Adjusted servo end points

With the setup procedure in section 6.4 on page 28 the servo end points (equals servo throw) are adjusted in each direction of each servo to get the same blade pitch, and as a result a perpendicular swash plate (in relation to the main shaft) at full transmitter pitch.

The same procedure deals with the delta between full negative and full positive transmitter pitch. On the Warp 360 the setup servo throw for full negative transmitter pitch is more than for full positive transmitter pitch. This leads to the same absolute main blade pitch (i.e. -12° and +12°) despite the shown delta curve of the Warp 360.

8.3.3. After setup completion

With the Soko Kit and all its setup procedures the helicopter has:

- a perpendicular swash plate at 0° transmitter pitch,
- true 0° main blade pitch at mid throttle stick (equals 0° transmitter pitch),
- the same positive and negative full main blade pitch despite of deflections due to the head design/geometry,
- a perpendicular swash plate at full negative and positive transmitter pitch and everywhere between.

The most surprising point though is, that all this is true for servos which are nowhere near perfect 90° servo horns. Just servo 1 is still at this position. Servo 2 is -3.19° down and servo 3 is 4.79° up. That's a difference of 8° but the swash plate movement is perfect!

This fact is not an excuse to get lazy about the initial setup of the servo horns. It is still important. But the 90° servo horns are not as important anymore once the setup process is finished.

It is much more important to get the linkage lengths right!

But this is not the end. All the above deals just with an input of collective transmitter pitch, without taking cyclic pitch into account.
In addition there is one other minor flaw: A mechanical setup error (imperfect linkage lengths) is compensated with electronics (change of servo mid and end points).

Cyclic pitch

In all graphs so far the y-axis end points are +30° and -30° main blade pitch and the maximum values on the x-axis for the servo angle are +45° and -45°.
The reason for that is when full transmitter pitch and full aileron/roll and full elevator/nick are applied the servo horns rotate up to 45° - or even more.

Looking at the graph on page 50 the delta of main blade pitch between servo 2 and servo 3 at +45° is almost ~2.5°.

Of course the servo end points are adjusted to compensate for this deflection, but only for collective pitch. How the FBL system includes different servo end points in the cyclic pitch mixing is not exactly known and is probably different on each FBL system.

So the only way to avoid this problem completely is to get each servo on the same curve - ideally the blue curve of servo 1.

8.3.4. A mechanically perfect setup

Such a mechanically perfect setup looks surprisingly easy in the first place:

- Each servo horn has an angle of 90° (or 0°) in relation to its servo case
- Each servo-linkage has the exact same and perfect length
- Each blade-linkage has the exact same and perfect length (for correct blade tracking)

On such a setup each servo "uses" the same curve in the graph and therefore no deflection of the swash plate occurs on collective pitch, cyclic pitch and any other input combination. No adjustments of the servo mid-points are necessary.

The delta between full positive and full negative transmitter pitch still needs to be compensated electronically by changing the servo end points (servo throw). But the value is the same for all three servos and therefore all three still use the same curve.

Even the setup procedure for a mechanically perfect setup is simple:

- Setup the servo horns according to section 7.1 on page 35
- Follow the setup procedures in section 6 on page 18
- Instead of changing the servo mid-points adjust the servo-linkage lengths in the steps of setup procedure in section 6.2 on page 22

In theory this works perfectly, but in real life it doesn't.

Real life problems for a mechanically perfect setup

There are a couple of things which makes such a mechanically perfect setup time consuming:

- Each servo needs to be mounted in such a way that the root of each servo horn is at the exact same vertical position.
  The graphs above show how a difference of just 1mm in linkage length leads to different main blade pitches. A vertical mounting position difference of the servos of 1mm is the same as a linkage length error of 1mm.
- Each servo-linkage has to be the same length down to a fraction of a millimetre.
- Not all helicopters use the same mounting position for all 3 servos.
  On a lot of helicopters the back servo is mounted differently than the two front servos. This leads to different servo-linkage lengths and makes it very difficult to determine the perfect lengths for the servo-linkages.

All points above can be solved by enough time, try and error and a lot of patience. But there is one additional point which makes such a setup impossible:

- The current linkages do not allow minor changes of their length

The vast majority of the servo-linkages and blade-linkages on the market have two clockwise threads on the linkage rod.

This means a full turn of the ball-link is needed to change the length of the linkage and to be able to put it on the ball again. So the possible length changes are too coarse.

We just know of two helicopter kits (KDS Agile 5.5 and Kasama Srimok FBL) which come with all turnbuckle linkages. Upgrades to clockwise/counter-clockwise servo-linkages and blade-linkages (turnbuckle linkages) are available for a few helicopters.

A mechanically perfect setup is only possible on such a helicopter - but still a little bit more time consuming.

8.3.5. Conclusion

The main thing to take from this whole section is to make as many adjustments as possible mechanically (linkage-lengths) and as few as possible electronically (servo points adjustments).

Until all linkages shipped with the helicopter kits are turnbuckle style,we can't get rid of some servo point adjustments in the FBL system.

Till then it is better to spend more time to optimizing the linkage lengths than to getting your servo horns perfectly setup. Because you have to adjust the servo mid-points afterwards anyways - which alters the perfect 90° servo horn.

8.4. With head stopper disc option

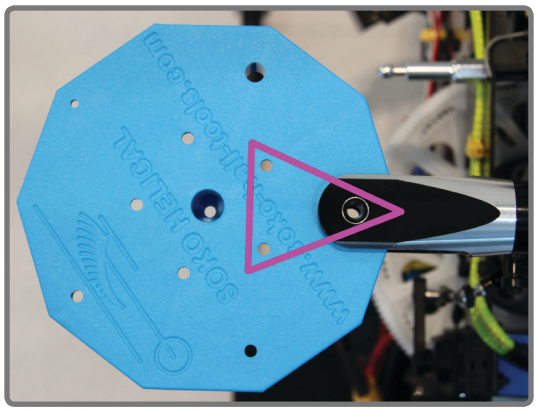
We recommend to use the “Without head stopper disc” versions of the setup procedure as the head stopper disc surface of the head is not perfectly perpenticular on most helis.

We keep the steps here in the appendix for your reference though.

8.4.1. Position 1

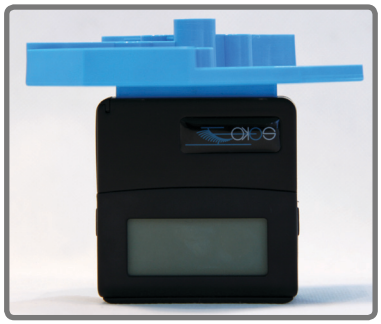
There is the option to screw the Soko Gauge tight on the Soko Helical before you mount it on the rotor head. See step 7 for more details. Another option is to use the special mounting velcro instead of the screws (see section 5.3 on page 17).

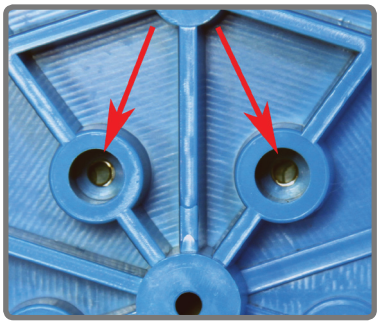
1. Remove both main blades.
2. Remove the head stopper disc.
3. Determine the corner of the Soko Helical which fits best in the main blade grips and remember which two holes are closest to the grip (for our 550 size helicopter the purple holes are the right one).



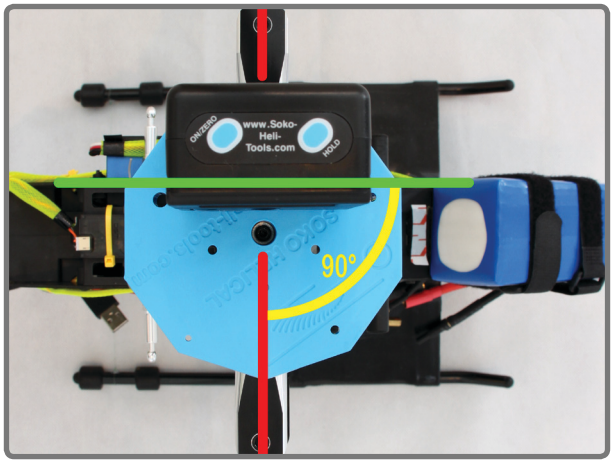
4. Place the Soko Gauge upside down on the table.

5. Place the Soko Helical upside down on the Soko Gauge so you can see the nuts in the Soko Gauge through the memorized holes of the Soko Helical. Loosely screw both together using two of the three M3 screws supplied.
   Hint: If you use the velcro instead of the screws be sure to put the boss at the bottom of the Soko Helical through the velcro before you screw the Soko Helical onto the rotor head in the next step.

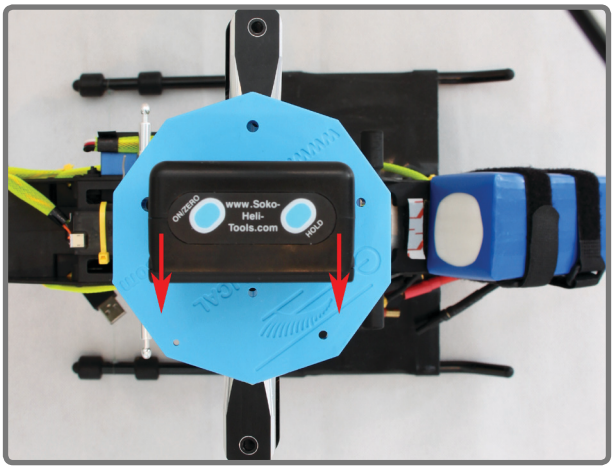




6. Depending on your helicopter's size and brand, choose the fitting screw (M1.6, M2 or M3 supplied with the Soko Kit) for your head stopper disc thread in the rotor head. Use at least one washer and put it in the centre hole of the Soko Helical.
   To gain access to the centre hole, move the Soko Gauge as far out as possible. Next screw the Soko Helical tight onto the rotor head where the head stopper disc was placed.
   The measuring axis of the Soko Gauge (green) needs to be perpendicular (yellow) to the line of the main blades (red). The Soko Helical should sit firmly and turn with the rotor head.



7. Move the Soko Gauge as close to the centre as possible (red arrows) and screw it tight from underneath.
   Depending on your helicopter size and brand, as well as your tools, it may be hard to reach the two screws. If this is too difficult, screw tight the Soko Gauge in Step 5. But be sure to leave enough space around the centre hole to screw the Soko Helical onto the rotor head.
   Another option is to use the velcro instead of the screws.



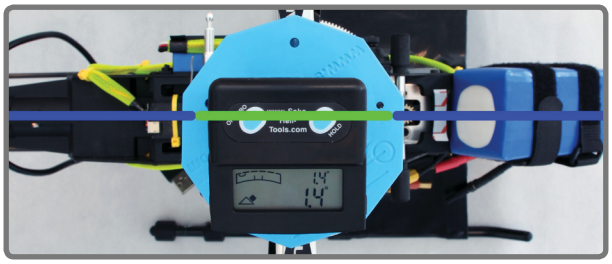
8. The Soko Kit is now mounted as the head stopper disc.

Troubleshooting	
Problem	**Solution**
The supplied screw to mount the Soko Helical on the rotor head is too short or too long	Add or remove shims to adjust the length or use the original screw which came with the helicopter and mounts the head stopper disc.
The Soko Kit wobbles on the rotor head, is tilted or doesn't sit flat	Use the "Without head stopper disc" version (section 5.1 on page 13).

8.4.2. Absolute vertical alignment of main rotor shaft

In order to bring the main rotor shaft into an absolute vertical position (spirit level), the Soko Kit must be mounted as head stopper disc.

1. Place your heli on a stable and even surface.
2. Be sure that you can read the display of the Soko Gauge at every position of the rotor head during a full turn. Use a workbench in the middle of the room or place the heli on the floor. For the latter method, flip-up the display so you can read it from the top.
3. Turn the head so that the Soko Gauge (green) is aligned with the longitudinal axis (blue) and measures the nick angle. The target angle is an absolute angle of 0.0°.



One way to achieve small changes of the angle is to put sheets of paper (red hatched area) under one side of the skids or chassis until you read 0.0° (we had to put it under the front of the helicopter to achieve 0.0°).

4. Turn the rotor head 90° and repeat the procedure for the roll axis. Use sheets of paper under one side of the skids (green hatched area) or chassis until you read 0.0° (we had to put it under the left side of the helicopter).

5. Finally, turn the rotor head slowly (yellow arrow) one full turn. The display should read 0.0° at any position you stop the rotation.

6. The main rotor shaft is now in vertical spirit level.

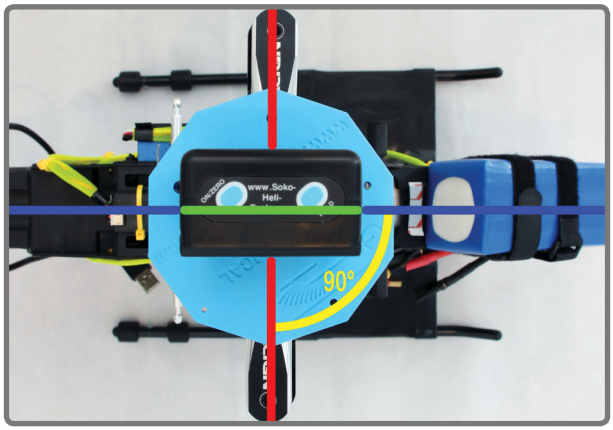
If your FBL system has a self-level feature, it's a good idea to recalibrate the sensors.

Finally, if you remove the Soko Kit from its position at the head stopper disc, be careful to not alter the alignment of the heli on the surface.

8.4.3. Check the CoG

To setup the centre of gravity the Soko Kit must be mounted as head stopper disc.

1. Turn the rotor head so that the Soko Gauge (green) measures the nick angle of the helicopter and the main blade axis (red) is at right angles to the longitudinal axis of the helicopter (blue).



2. Now prevent the rotor head from rotating. This is highly dependent on your brand and size of heli. For example, use a tape or cord to tie the tail gear to the main gear.
3. Assemble everything (batteries, canopy, etc.) ready-to-fly.
4. Lift the helicopter by the two main blade grips. Be sure the heli can nick as freely as possible. Another and more accurate way to do this is to build a handle out of strings which attaches on the blade grips or hang it from the ceiling.
5. Read the absolute angle on the Soko Gauge. The target is an angle of 0.0°.
6. Place the helicopter back on the surface and adjust the centre of gravity according to the angle. The common way to do that is to slightly change the position of the main battery.
7. Repeat the step 4 to 6 until the desired angle is achieved (as close to 0.0° as possible). Don't forget to mark the final position of the battery.
8. The centre of gravity is now adjusted.