SK-360 *Digital Flybar*

User Manual and Setup Guide

Throw out your 1940's-technology mechanical flybar, and replace it with a Digital Flybar. Rock solid hovering with a less complex, lighter rotorhead for more power or longer flight times!

For 3D flying, you can dial up cyclic rates to the limit of blade stall, without losing any stability. Lightning-quick 3D, with great performance in wind and a solid hover!

Table of Contents

1 Intro

The SK-360 Digital Flybar is a high performance, compact, and lightweight pitch and roll stabilizer for model helicopters. Its function is to replace the traditional flybar (stabilizer bar) and its association linkages, while saving power, increasing flight times, and reducing repair costs. Features include:

Control Options:

- Control over the Bell and Hiller ratio (direct vs. stabilized control)
- Control over roll and pitch rates in-software
- Control feel is adjustable in software or on the gyro case

Swashplate Options:

- Suitable for 120, 135/140, and 90 degree eCCPM, as well as mCCPM swashplates
- Mixing In-Gyro, but able to accept pre-mixed 120° swash input
- Swash Ring anti-binding algorithm
- Phase Trim adjustable to +-90°

Servo Options:

- Works with digital or analog servos
- Synchronous with receiver's PWM frames for minimal lag
- Groups swash servo PWM pulses for low swash motion error
- Swash servo rate-equalizing prevents uncommanded pitch during aggressive maneuvers

2 Package Contents

Your gyro package should include:

- SK-360 Gyro unit
- Four strips of 3M-4408[tm] mounting tape
- USB Interface with jumper
- USB Extension Cable
- CD with Interface Software

Note: If your computer can't read mini-CDs, visit our website at:
`www.skookumrobotics.com/support.html`
to download the latest version of the setup software (you will not need to update the firmware).

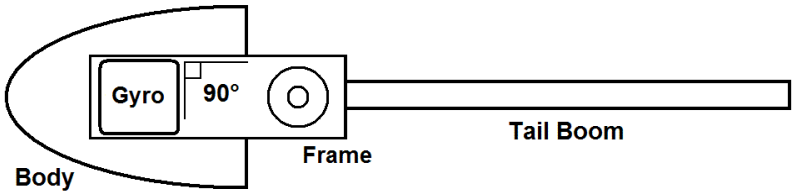
3 Safety

An R/C Helicopter is not a toy, and can cause serious injury to people or damage to property. Use of this gyro places a flight control computer (the gyro unit) between the radio receiver and the servos that drive the swash plate. If the gyro unit is mistuned or set up incorrectly, loss of control of the helicopter may result. See Appendix C for warranty information.

Please keep bystanders clear of the flight area at all times. Be sure to test fly away from spectators, especially when flying the helicopter after any change in the gyro's setup or tuning, and keep yourself at a safe distance.

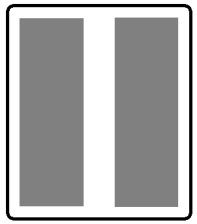
4 Mounting the Gyro

The front side of the gyro is marked on its case. The gyro unit can be mounted upside down, backwards, or sideways, but it must be level, and have its sides aligned as accurately as possible with the fore-aft axis of the helicopter. Misalignments of even a few degrees (2mm or 1/16" difference between the front and back edges of the case) may cause problems with tuning the gyro. The gyro should also be as far as possible from any heat sources, and at least 10cm away from Xtremelink[tm] receivers.



For vibration resistance, mounting tape with good damping must be used, such as the 3M-4408[tm] tape included. The gyro's case should not directly contact any hard surfaces of the helicopter's frame, and if a safety strap is used across the top of the gyro, it should be padded slightly. Cables connected to the gyro should have some slack near the gyro's case.

Before mounting the gyro clean its base and the mounting site with isopropyl alcohol. Then use two pieces of the supplied 3M mounting tape on the base of the gyro, as shown. If you use a pad/metal plate/pad mounting for a nitro heli, be careful that the stack is not too thick, as this might result in resonance.



5 Helicopter Airframe Setup

Good mechanical setup is critical to the gyro performing correctly. Please read this section fully.

The gyro should not be used in addition to a flybar, as the results could be unpredictable. It is intended for use where the swashplate alone drives blade pitch.

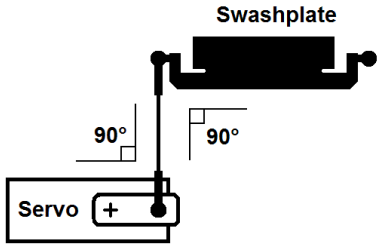
Blades:

Flat bottomed rotor blades are not recommended. They have a pitch-down moment about their axis of rotation that could put heavy loads on the swashplate servos. The ideal rotor blades will have a symmetrical airfoil, be torsionally stiff but a bit flexible spanwise, and balanced both spanwise and chordwise.

Servos:

The best performance will be achieved if the swashplate servo's full normal range of movement is used. For good "3D" performance, you will need servos that are fast, and if possible digital. For analog servos, check their specification, and drive them at 6v (if they are rated for it). Stronger, faster servos will let you use higher damping gains (see Section 15), which is important for maneuvers such as piro-flips.

Try to have 90-degree angles between servo and blade grip arms and linkage rods, for even movement. The gyro's USB setup interface will allow fine-tuning of servo centers to achieve this.

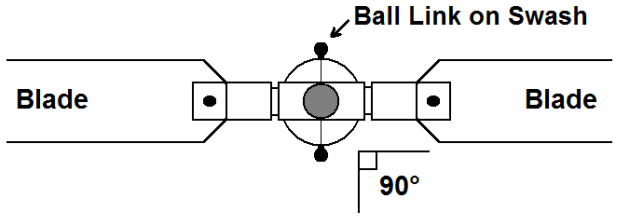


Rotorhead:

When setting up the mechanics originally designed for helis with a flybar, just removing the flybar but keeping normal servo arm length will likely give too much blade pitch action. Either servo travel or servo arm length will then need to be reduced. For example, on the Align[tm] TREX, you can adapt the flybar mixing arms as travel-reduction arms on the rotorhead, to reduce the effect of swashplate slop and reduce servo load. This will allow higher gains, and better performance.

Some kind of anti-rotation or "follower" mechanism will be needed, to keep the top of the swashplate from rotating relative to the blade grips.

If the swashplate is not held so the linkage to the blade grips is at 90 degrees to the blades (for 2-bladed rotors), the phase angle will need to be set to compensate. See the diagram below.



For initial flights, the phase angle should be adjusted so that when the blades are lined up with the heli's tail boom, they do not move with elevator input, but do move with aileron input (for 2-bladed rotors). This can be set either mechanically, or through the USB setup software.

It is important that the linkages and swash have little slop and the lowest friction possible.

How stiff the rubber rotor head dampers are will have an effect on tuning the gyro and flight performance. Performance will be better with the teeter damping a stiffer than normal, but too stiff can cause vibration, which is hard on the airframe, gyros, and servos.

Tail:

Because the axis of the tail rotor disk is lined up with the elevator axis of the heli, it's important that you minimize tail rotor vibration. Also, if you have a belt-driven tail, be sure that your tail boom is electrically grounded to the heli's frame or motor case, to prevent static electricity buildup.

Balance:

The gyro will perform best with the CG directly under the mainshaft, or very slightly nose heavy. This is especially important for maneuvers that use fast collective pitch changes combined with yaw, such as piros.

6 How to Check Cyclic Pitch & Phasing

The goal of mechanical and gyro swashplate setup is to get your normal collective blade pitch range, and a **cyclic range of about +-10 degrees,** which means a total range of 20 degrees. **This is important.** (Cyclic pitch is blade's pitch due to aileron or elevator input)

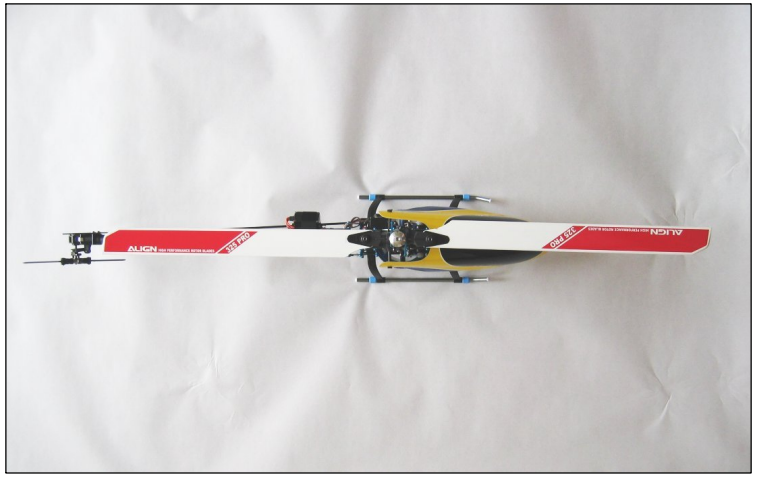
The rotor blades must also have the correct *phasing*. This means that aileron and elevator control input change each blade's pitch at the correct time. For most mechanical setups, the phase angle will not need adjusting.

While checking for good cyclic throws, phasing, and even swash motion, the gyro must be put in setup mode, by pushing the mode switch towards the gain dials (see Section 8).

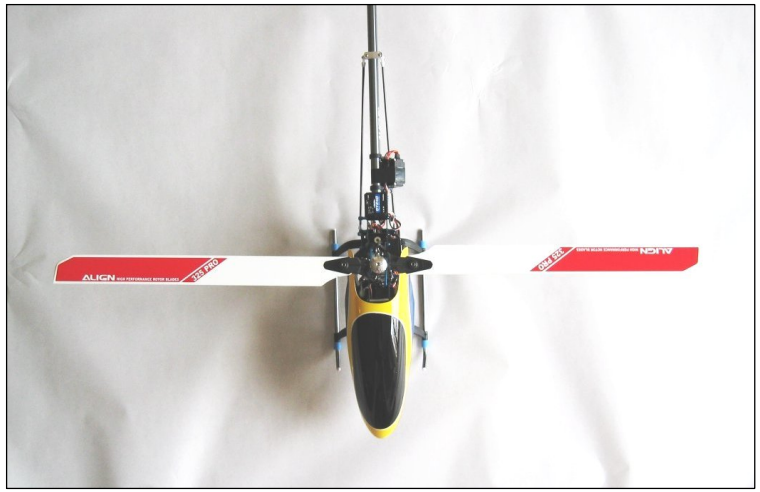
While in setup mode, all stick motions are sent directly to the swashplate as if stability gains were all zero (the gyro only does its mixing function). The gain dials and gain fields in the PC software will have no effect in this mode.

To check the cyclic range and phasing:

1) Set collective pitch to zero.
2) Align a blade along the fuselage, pointing over the nose of the helicopter as in the photo below:



3) Now try full nose-up elevator control, with aileron centered. Measure the pitch of the blade that points over the nose.
4) If the mechanical setup is ideal, the blade should not change pitch. If it does you will need to adjust the phase angle, either mechanically at the swashplate or using the gyro's USB interface. If the pitch becomes negative adjust the phasing clockwise (+), if positive then adjust it anti-clockwise (-). **Note:** this will give you normal phasing (90 degree lead); multi-bladed rotors may fly better with some positive phase trim.
5) Try full right aileron control, with elevator control centered. The blade's pitch should be about -8 degrees.
6) Try full left aileron control, with elevator control centered. The blade's pitch should be about +8 degrees.
7) Align a blade at 90 degrees to the fuselage, pointing over the right side of the helicopter as in the photo below:



8) Try full nose-up elevator control, with aileron control centered. Measure the pitch of the blade that points over the right side of the helicopter. It should be about -8 degrees.
9) Try full left nose-down elevator control, with aileron control centered. The blade's pitch should be about +8 degrees.

If the cyclic blade pitch range is changed, the gyro's stability gains will need to be changed as well. For example, increasing cyclic pitch range by 10% is the same as increasing the stability gains by 10%.

7 Connections

The gyro has 3 inputs, and 4 outputs, labeled on the top of its case. **Note that the USB interface does not supply power.** For the inputs from the radio receiver, the connector mapping is:

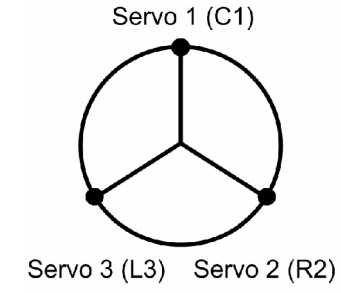
Swash Setup Type	Input 1	Input 2	Input 3
120 deg eCCPM, gyro-mixed	Elevator Ch	Aileron Ch	Pitch Ch
120 deg eCCPM, pre-mixed	Centre Ch	Right Ch	Left Ch
135/140 degree eCCPM	Elevator Ch	Aileron Ch	Pitch Ch
"1-servo" mCCPM	Elevator Ch	Aileron Ch	*n/a*
90-deg eCCPM	Elevator Ch	Aileron Ch	Pitch Ch

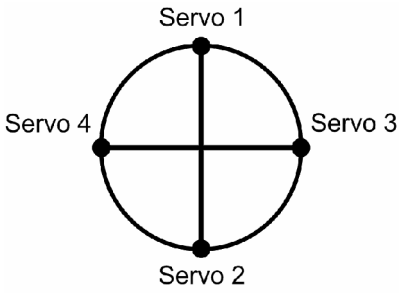
Left/Right means the heli's left and right, looking from its tail to its nose.

The preferred method is gyro-mixed mode (set "1-servo" in your radio). For the in-transmitter mixing option (see Section 10), the "Centre Output' is the radio receiver output that you'd otherwise plug the centre servo into, and so on for the left and right outputs.

For the outputs to the servos, the connector mapping is:

Swash Setup Type	Servo 1	Servo 2	Servo 3	Servo 4
120, 135/140 deg eCCPM	Centre	Right	Left	*n/a*
"1-servo" mCCPM	Elev	Aile	*n/a*	*n/a*
90-deg eCCPM	Fwd	Aft	Right	Left

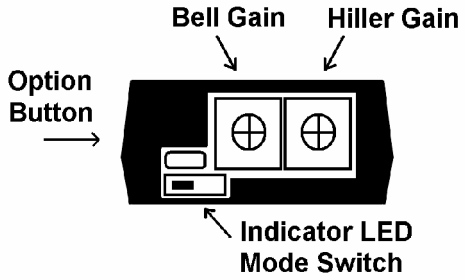




8 Modes, Indicators, and Power-Up

The two primary modes are Setup mode, and Flight mode, chosen by the position of the small switch on the gyro's side. Towards the gain dials is Setup mode, and away from the dials is Flight Mode.

Note: The gyro will change from Setup to Flight mode right away, but won't change from Flight to Setup until you also cycle its power.



Setup mode lets you use the USB connection, and also used for mechanical setup - control motions pass straight through, with no stabilizing action. While in this mode, the indicator LED will slowly flash green.

In Flight mode, the LED Indicator will show solid red while it's still initializing, and turn solid green when it's ready to fly. The gyro will not finish initializing unless it is completely still. It will also not read in new values from the gain dials until it is left still for a few seconds.

The option button is used to enter Self-Setup mode and Firmware Update modes (described in Section 10 and Appendix B).

WARNING: Always check before flight that the LED is **solid green**. If you take off in setup mode the flight will be "very exciting", short, and possibly also expensive.

The LED flashing red rapidly indicates an error. There are four possible causes:

1. The cyclic stick wasn't centered at initialization in flight mode
2. The supply voltage fell below 3.6v at some point
3. It is too hot or too cold
4. The gyro has a systems fault

If the first three causes can be ruled out, please contact technical support.

9 Gyro Setup Using the USB Interface

Step 1: Connecting

- First install the USB Interface software for your SK-360 gyro. Unplug the swashplate servos the gyro for now.
- Set your radio's transmitter so Aileron, Elevator, and Pitch (Collective) are output each on a separate channel ("Normal" or "1 Servo" swashplate mode).
- The initial setup will be easier if you use a straight-line pitch curve, and no expo or dual rates. Later those features can be set in the transmitter as you normally would.
- Connect the gyro to the USB interface, and **set the mode switch on the gyro toward the gain dials** to put it in setup mode. Turn on the heli's power, and start the setup software.
- Check that the connection indicator in the upper left is green and says *Connected*.

Step 2: Match the Gyro to Your Transmitter

- In the *Offline Setup Values* area in the lower half of the window, click the *Swashplate* tab. Then select the *Swash Type* that matches your heli's swashplate, and make sure *Mixing Location* is set to *In Gyro*.
- Now click the *Control* tab. Center all the trims on your transmitter, and be sure the cyclic stick is centered.
- Click the *Send Setup* button, or press the F1 key to set the changes on the gyro. **You must SEND the setup whenever you want to test changes.**
- After a few seconds, check *Inputs from Receiver* again. The % values for Elevator, Aileron, and Pitch should be close to zero. You can trim the collective pitch centering on the *Controls* tab.
- Try moving the elevator stick towards you (nose up), and look at the Pilot Control field under Elevator. The number displayed should be close to 100% and show **green**. If it is negative, go to the *Control* tab, and click the *Reverse* field for elevator. If it's too low or reaches 100% much before the stick's limit, adjust *Travel* on the control tab.
- Repeat for Aileron Pilot Control, but move the stick right (**green**). Then repeat for the Pitch input, but move the stick up (**green**).

Step 3: Check the Gyro's Sense Directions

- Now look at the *Gyro Rates* fields in the *Live Data* area. **Note: the Rate fields only sense movement, not angle.**
- Pick up the heli and slowly tilt it nose-up. The Gyro Rate for Elevator should be positive and show **green**. If not, click *Flip Elevator Axis* on the Control tab. If the gyro rate for *Aileron* is high instead, click *Rotate 90 Degrees* on the Control tab.

- Repeat for the Aileron (roll) axis, but slowly tilt the heli to the right. The Gyro Rate for Aileron should be positive and show **green**.

WARNING: All the control input and sense directions in steps 2 and 3 must be correct, otherwise your heli will instantly crash if you try to fly it.

Step 4: Swash Mixing / Servo Setup

- Go to the *Swashplate* setup tab again, and set the *Swash Mixing* values ("CCPM and Travel") just as you would in your transmitter.
- Go to the Servos tab, select the frame rate according to servo type, and enter the speed of your servos from their specifications.
- Make sure the control sticks are centered, and then plug the servos into the gyro. Check for good motion and no binding.
- **NOTE:** While in setup mode, the gyro will give 100% swash control to the transmitter sticks (zero stability gains), to allow for mixing, servo travel, and mechanical setup.
- Check that the swashplate motion is correct. **Note:** the correct blade pitch range for elevator or aileron input is about +-10 degrees.
- If the servos don't move in the correct directions, reverse them on the *Servos* tab. If the Aileron or Elevator motion is reversed, change the sign of their swash mixing value (ex, + to -). Try to keep swash mixing values below 60%. If you need more motion increase the servo travels instead, for ex. to all to 125%. This prevents unwanted interaction at max and min collective.
- *Do not* try to change cyclic throw using the *Control* tab.
- Adjust the servos for a level swashplate on the *Servo* tab.

Step 5: Ready for Flight

- **Save your setup to disk**, then go to Section 11 of this manual.

Final Setup Note: The expo, dual-rate, and pitch-curve features of your radio can be used normally, as long as they do not exceed 100% travel.

10 Alternate Setup Method, Using the Transmitter

Self-setup is provided to allow use of the gyro when a PC is not available to help set it up.

For 90-degree mCPPM (mechanical mixing), this method will give you a basic setup no different than if you used the USB interface.

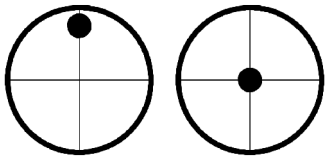
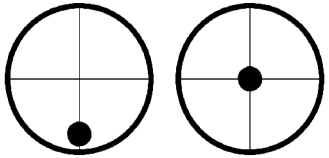
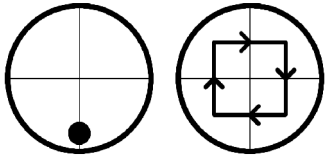
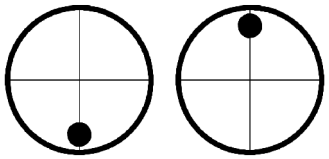
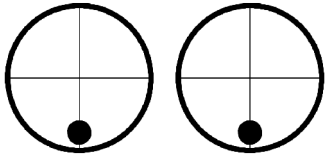
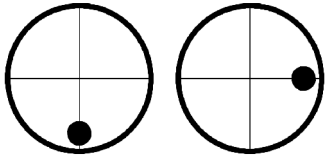
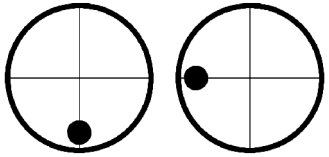
For 120-degree eCPPM, this method will teach the gyro the swash mixing in your radio, so in flight it can de-mix those signals, do its stability work, and then re-mix outputs for the servos. **Note:** for 120-degree eCCPM separated control inputs are preferred, and will provide more precise control of your helicopter. For that option, see Section 9.

The first step is to set your radio's swash mixing to get the correct amount of cyclic and collective pitch motion, which for cyclic pitch is about +-10 degrees (see Section 6).

Then put your radio into idle-up mode, with dual rates set to high.

Then to enter self-setup mode, put the gyro's mode switch towards the gain dials and hold down the option button (**gently**) while powering up the gyro. The LED will flash red and green, and then stay green for a few seconds before the setup cycle starts. It will then blink green to count out the step number at the start of each step. After each step-count, hold the control sticks as shown in the following table until the next step count is blinked.

(Note the table shows the stick positions for "Mode 2" transmitters, where the left stick is Collective Pitch and yaw, and the right stick is Elevator and Aileron cyclic control)

	Step 1: Collective up, Cyclic stick centered
	Step 2: Collective down, Cyclic stick centered
	Step 3: Collective down, Cyclic pushed around each of the four corners
	Step 4: Collective down, Cyclic stick up
	Step 5: Collective down, Cyclic stick down
	Step 6: Collective down, Cyclic stick right
	Step 7: Collective down, Cyclic stick left

After all steps are complete, the LED should blink red and green to signal success. If the setup failed, it will blink red rapidly, and will **not** change or store the gyro's settings.

If the self-setup procedure is successful, you can put the gyro into PC-interface mode, get the setup file from it, and modify it further (to apply phase trim, you must set it with the USB-interface **after** each self-setup).

Note: If this option is used, you must carry out the setup procedure above after every change of throws, servo centers, or swash mixing on your radio.

Note: Self-setup will use the last setup file that was stored in the gyro as a starting point, and only change swash mix, servo centre/revs, and control centre/rev settings.

11 After Setup: Final Check!

Any time you change the gyro's setup, always do these checks:

1) Put the gyro into setup mode, with the servos connected and the swashplate mechanically set up.
2) Try full right aileron. Check that the swashplate tilts to the right.
3) Try full up elevator (nose up). Check that the swashplate tilts back.
4) Command full up collective pitch. Check that the swashplate moves to give maximum blade pitch.
5) Try zero collective pitch, with throttle hold active. Check that the swashplate moves to give zero blade pitch.
6) Put the gyro into Flight mode, leave it undisturbed and wait for the LED to turn green.
7) Pick up the helicopter, wait a few seconds, and then tilt it nose down and to the right. The swashplate should tilt back and left.

Note: In flight mode, the swash will tilt forward slightly at full positive collective pitch, and backward slightly at full negative pitch, to compensate for tail-drag during fast climbs and descents.

12 Flight with the SK-360 Gyro

In flight mode, the swashplate will not respond to the controls directly. Its action will be similar to a heading-hold tail gyro. Also, after it has been static for a few seconds, it will level the swash during spool up to ensure a stable take off.

When you land your heli, always wait at least 5 seconds after the rotor spools down before spooling up again, so the gyro knows the helicopter is spooling up. Don't move the cyclic stick until the heli is light on its skids to prevent confusing the gyro when it can't fly. If the *Auto trim at Initialization* feature is on, avoid using the transmitter trims for elevator or aileron. If you do use trims, you'll have to zero them before every flight.

ALWAYS do these pre-flight checks:

1) **The Indicator LED should be solid green (not flashing).**
2) **Positive collective should increase blade pitch.**
3) **Right aileron stick should tilt the swash for a right roll.**
4) **Nose-up elevator stick should tilt the swash for nose-up.**

13 Basic Tuning

If you have set up your helicopter's mechanics properly, and the cyclic throws are correct, then tuning should be easy. **Note:** always let the gyro be still for a few seconds after adjusting the gain dials, so the gyro knows to read the new settings. If your heli is nitro-powered, you'll need to stop the motor.

Definitions:

- **Bell gain** adjusts how much aileron and elevator control will directly tilt the swashplate.
- **Hiller gain** adjusts the stability and holding ability of the gyro.

Follow these steps:

1) As a starting point, adjust the dials on the gyro to about **30% for the Bell elevator gain, and 50% for Hiller gain.**
2) Lift the helicopter off into a hover, and try some small elevator and aileron motions. **If it oscillates or does anything violent as you spool up, email tech support for help.**
3) If the helicopter doesn't hold well in pitch or roll, or "slides" to the side, turn the Hiller gain up a small amount. If the helicopter oscillates while hovering, turn the Hiller gain dial down slightly. Repeat until you get the best gain.
4) Try some forward flight. If the helicopter oscillates in roll at high speed, turn the Hiller gain down a small amount. If it doesn't hold well in pitch, turn the Hiller gain up.
5) While in a hover, pitch the helicopter sharply nose down, centre the cyclic stick, then do the same nose-up. If the helicopter is slow to start, turn the Bell gain dial up a small amount. If the helicopter snaps back a bit and oscillates after it stops, turn the Bell gain dial down a small amount. Repeat until you get the best balance. For sport flyers, the Bell gain needs to be only roughly correct.

For most users, no further tuning should be required. But if the maximum aileron and elevator motion of the heli is not fast enough for you, or for other advanced tuning, see Sections 15 and 16.

Good starting points for the gains can be found in the "Default", "Scale", or "Basic_3D" setup files, all of which are included with the USB interface software.

14 USB Interface Software Reference

To use the SK-360 interface software, first install the software on your PC, and plug in the USB interface. Then attach the jumper to the gyro, set its mode switch for setup mode, and power it up (with the motor disabled, if you have an electric heli). On your PC, the "Connected" indicator should turn green, and the gyro's serial number and firmware revision should be displayed (Note: the servos may be slightly jittery while connected to the USB port, due to noise from your computer).

If the software will not run at all, make sure your "Windows .NET Runtime" is up to date. Check the Microsoft website for the latest version.

On the menu bar, the *File* menu allows you to save or load gyro configurations (setups), or go back to the default setup. The *Connect* menu allows you to send a setup to the gyro (burning it into its memory), or fetch a setup from the gyro. Any setup sent to the gyro will be labeled with the first 8 letters of its filename.

Live Data

This area displays constantly updated telemetry from the gyro, including the control **inputs from the receiver, and position outputs to the servos**. Remember that while in setup mode, all elevator or aileron stick motions are sent directly to the swashplate (as if stability gains were all zero, and bell gain is 100%), to allow for easy mechanical setup.

For Inputs and Outputs, the units displayed can be percent of full throw from the current setup, or PWM pulse-width (microseconds). ***Note that the collective Pitch display should turn green for positive (climb) pitch if the gyro is set up correctly.***

Under "Gyro Internals", the **Pilot Elevator and Aileron** command percentage is given as a guide for setup. ***It is important that cyclic stick input for nose-up, and for right-roll, should give positive values here. Nose-up stick and right aileron should both show green backgrounds.*** These readings can also be used to test the dead-band settings.

The elevator and aileron **Gyro Rates** values are in degrees per second, and show the currently sensed motion of the gyro.

The **Bell Gain and Hiller Gain dial** settings are displayed here for ease of recording values arrived at by field-testing. For each type of gain, the first percentage is the gain for elevator, the second is the gain for aileron (they're linked by the ratio of elevator vs. aileron for each gain on the *Advanced* tab of the gyro's setup).

Swash Tab

Swashplate Type: Select your swashplate and mechanical mixing type. Options are 120 eCCPM, 135/140 degree eCCPM, 90 degree mechanically mixed (separate servos for each of elevator, aileron and pitch control), and 90 degree 3 or 4 servo eCCPM, where servos are directly connected to the swash but 90 degrees apart.

Mixing: Options are in-gyro, and in-transmitter. In gyro is preferred; here the inputs to the gyro are separate channels for elevator, aileron, and pitch (collective) control. With in-transmitter mixing, inputs are expected to be pre-mixed for 120-degree CCPM swashplates. Initial setup for in-transmitter mixing should be carried out using the "self setup" feature in Section 10.

Elevator Cyclic: Percent of full swashplate motion at full stick deflection for elevator cyclic. **This Can be a negative number, but cannot be zero.**

Aileron Cyclic: Percent of full swashplate servo motion at full stick deflection for aileron cyclic. Can be a negative number, but cannot be zero.

Collective Pitch: Percent of full swashplate servo motion at full stick deflection for collective. This can be a negative number.

Phase Trim: Rotates the plane of cyclic action about the mainshaft, to allow correction for gyroscopic and aerodynamic effects, and the use of 3 or 4 blade rotor heads. For example, setting phase trim to 90 degrees would make full stick deflection for aileron tilt the swashplate down. Note that the phase angle depends on the rotor rpm and load.

Swash Ring: Limits motion of the swashplate to prevent binding when large amounts of both elevator and aileron cyclic are used (i.e. assume the swashplate is round, not square).

Servo Tab

Frame Rate: The *Sync* synchronizes pulses to the servos with your receiver's output for minimum latency. *Digital* uses higher frame rates than analog servos can handle and has little latency. For digital servos, 125 Hz is best, 100 Hz is rarely used. **Do not use digital frame rates for analog servos.**

Equalize Servo Speeds: Accounts for the different radius of motion for the servos in an eCCPM swashplate arrangement. For example, for a 120-degree swash, an aggressive pitch motion will demand higher speed from the centre servo than the left or right servos, so it may lag behind causing uncommanded collective input. This feature would slow all the servos evenly to the maximum rate of the centre servo.

Servo Speed: Take this from your servo manufacturer's specifications. Units are in seconds per 60 degrees of motion. This helps the gyro move the swash evenly. This field only matters if *Equalize Servo Speeds* is on.

Servo Travel: Amount of servo motion on either side of centre. Servo motion outside of its mechanical limits can cause binding and overheating. The servo travels can be set individually to trim the swash to be level at max, zero, and min collective pitch.

Servo Trims and Reversing: Here each servo's center point can be set, and each can be reversed if needed. This is the same idea as sub-trim on your transmitter. Be careful that the servo doesn't bind.

Control Tab

Receiver/Control Setup: Similar to the settings for the servos, but here the centers and reversing for the inputs from the radio receiver are set. **Note**: Features of your radio such as exponential or pitch curves will work normally.

Auto Trim at Initialization: With this feature enabled, the gyro will use the cyclic-stick centre it receives at initialization as neutral cyclic. If left off, the gyro will use the exact values entered in the Control tab.

Dead Band: A dead-band can be set for the cyclic (elevator and aileron) functions, so the heli doesn't drift with small errors in stick centering. One percent is a good value for most radios (note your radio's centering may change with temperature). For scale models, deadband can give a solid control feel while in stationary hover.

Mounting Orientation: The motion sensing directions can be flipped or rotated 90 deg, to allow the gyro to be mounted in any orientation. After mounting, always send the setup to the gyro, and then move the heli slowly and watch *Gyro Rates* on the *Live Data* display to **be sure nose down is negative elevator rate, and right tilt is positive aileron rate.**

15 Advanced Tuning Options

The helicopter can be tuned in a more detailed way using the settings on the *Advanced* tab of the USB interface program:

Maximum Rate: The desired roll or pitch rate of the heli at maximum cyclic stick deflection. Equivalent to the area of a flybar's paddles. If increased, Bell gain will also need to be increased slightly.

Bell Gain: Amount of motion of the swashplate in response to cyclic stick deflection. Normally set by a gain dial on the gyro's case, that dial can be disabled to lock the bell gain to a specific value.

When the gain dial is used, it will set the elevator bell gain, but the aileron bell gain will be a fraction of that, by the ratio set here. Example: The Advanced Tab shows Bell gains of 20% elevator and 10% aileron, and the gain dial is not disabled. Then if the gain dial is set to 50%, the elevator bell gain will be 50% and the aileron bell gain will be 25%.

Hiller Gains: Similar to "heading hold" on a yaw gyro. Higher Hiller Gain is equivalent to increasing the weight of a flybar's paddles, and adds stability and resistance to wind gusts. This feature gives the heli a "locked-in" feel. Slop-free linkages, rigid rotorhead mechanics, stronger servos, and stiff blades allow higher gains here.

The Hiller gain dial is used to set the elevator and aileron hiller gains in the same manner as described above for the Bell gain dial.

Damping Gains: Roll and pitch rate motion damping. Higher gain is equivalent to having heavier rotor blades or a higher head speed, and helps with stability during forward flight and pyros. Fast digital servos allow higher gain here. The default gains are best for analog servos, but can be set to 20/16 for digital servos. Appropriate Damping gains are normally about 1/3 as large as the Hiller gains.

Tail Drag Compensation: All helis have uneven drag on their airframes, especially the tail. This feature lets you trim out the effects that has during hard collective pitch use, for better pyros and tick-tocks. To use this feature, follow these three steps:

1) Make sure your heli's balance point is under the main shaft, or slightly nose-heavy.
2) Check that your swash is level at min, zero, and max collective pitch while in Setup mode. On the servo tab, first adjust the swash to be level at zero pitch using the trims, then use the servo travels to make sure the swash is level at min and max collective. This is needed because servos are not all identical; the pots that measure their position can vary by 10% or more.
3) If the heli tends to nose-up when max collective is applied quickly from a hover, subtract one from elevator tail comp. If the heli goes right, subtract

one from aileron tail comp. Add one to the fields if it noses down, or goes left.

Vibration Filter: Where high-frequency vibration is present, especially on a nitro heli, this option will filter the outputs to the servos to reduce servo jitter and wear. However filters also introduce response lag, so its use should be minimized. This feature is meant to protect servos; it will not resolve control problems caused by vibration.

Hiller Decay: Causes accumulated Hiller response to decay back to neutral, to make the gyro more forgiving of insults. If you watch a heli with a flybar in hover, after a sharp control input you'll see the flybar's disk offset for a moment, then drift back to level. This provides the same effect.

A value of 100% here can help smooth out rapid tic-tocks, piros, or other 3D maneuvers, especially repeated ones. However, high values for Hiller Decay will also limit the gyro's ability to hold steady in gusty wind, or trim the heli perfectly in hover.

Disable Gain Dials: If enabled, the gain dials on the gyro itself will have no effect. The gains will be taken straight from those entered in the gains setup tab.

Hiller Dial Also Scales Damping Gain: If enabled, then the Hiller gain dial will also adjust the damping gains, by the ratio of the Hiller Dial setting vs. the elevator Hiller gain in the setup.

For example, if Elevator Hiller gain is 50% on the Advanced tab, the Hiller Dial is set to 100%, and Damping is set to 20% for elevator on the Advanced tab, the resulting damping gain would be 100/50*20 = 40%.

This can make it easier to re-tune the gyro when mechanical changes are made that will affect the gains, such as to cyclic pitch or head speed.

Show Actual Gains: Brings up a table of the actual gains the SK360 will use in flight. These gains are based on the settings on the Advanced tab, modified by the Bell and Hiller dial's settings. This feature can help you understand how the gain dials and base-gains work together.

Default Gains: Resets all of the settings on the Advanced tab to those in the Default setup file. Does not effect any settings on the other tabs.

16 Tuning Troubleshooting Guide

Symptom	Problem & Solution
Heli tends to drift (feel loose) in pitch and/or roll.	Hiller gain is too low.
Hiller gain isn't high enough, even at 100%.	Increase cyclic blade-pitch range using the Swash Mixing setup values, or increase servo travel.
After a sharp pitch or roll command is released, the heli oscillates slowly.	Hiller gain is too high.
While in high-speed forward flight, the heli pitches up or down momentarily.	Pitch damping gain is too low.
Heli tends to oscillate rapidly. (Test by giving a sharp elevator or aileron command, and then release of the stick)	Damping gain is too high.
While in high-speed forward flight, the heli sometimes oscillates in roll.	Roll damping gain too low (Warning: too-high roll damping gain is hard on servos), or Hiller gain is too high.
Heli hesitates in pitch and roll, and continues to move for a bit when the stick is released.	Bell gain is too low relative to Control Rates. Increase Bell gain slightly, or decrease Control Rates.
After a pitch or roll change the rotor disk springs-back after the stick is released.	Bell gain is too high relative to Control Rates. Decrease it slightly, or increase Control Rates.
Responds too sharply to aileron or elevator.	Bell gain is too high.
Heli precesses in hover (a motion like a child's spinning top as it slows down). Gets worse with higher Hiller gains.	Interaction between the Elevator, Aileron, and Yaw axes. Check that the SK-360 gyro and the yaw gyro are both mounted correctly. Also check phase angle.

Symptom	Problem & Solution
Random jitter or jumps in roll and pitch.	Vibration effects on the gyro. Make sure it is mounted on good damping tape, and doesn't contact the frame. Also check for tail vibration.
Can't set Hiller high enough without causing oscillation, especially with high head speeds.	Lack of servo speed, precision, or the frame rate is too slow. Rotor head mechanics should use full servo throw for desired cyclic pitch range.
Aileron or Elevator don't give fast enough roll and pitch rates.	Increase Control Rate gains. You will then likely have to increase the Bell gains slightly.
Aileron or Elevator give roll and pitch rates that are too fast.	Decrease Control Rate gains, and then decrease the Bell gains slightly.
Cyclic feels mushy in the centre.	Reduce dead-band.
Not perfectly locked in hover.	Try higher dead-band.
Heli drifts slowly in elevator or aileron with cyclic stick centered soon after take off.	Radio receiver centering drift. Many receivers' center points drift with temperature, up to 3 ticks of trim. Use transmitter trims to correct.
Heli drifts slowly in elevator or aileron with cyclic stick centered after several minutes of flight.	Gyro temperature changing too quickly, or receiver drift. Make sure the gyro and receiver aren't mounted near heat sources, and let it acclimatize to field temperature.
Heli "jumps" in pitch or roll after hard changes between positive and negative collective.	Check that the heli's centre of gravity (CG) is directly under the main shaft, and tune swash servo throws and tail drag compensation.
During yaw piros with collective pitch changes, or piros during forward flight, the heli wanders.	Damping gains are too low, servos are not fast enough, swash moves unevenly, or **tail drag compensation needs tuning (see page 19)**.

Appendix A: Specifications

Dimensions	41x31x15mm
Weight (without cables)	16 grams
Operating Temperature Range	-5c to +45c
Operating Voltage	3.6 to 8.5 VDC
Power Consumption	28 mA
Wiring Gauge	22
Input Signals	3 Channels (PWM 700-2300 us)
Output Signals	4 Channels (PWM 700-2300 us)
Servo Options	Analog or Digital
Setup	USB interface, or by Transmitter Sticks
Field Gain Setting	Bell and Hiller Gain Dials, 0 – 100%

Appendix B: Firmware Upgrades

1) Obtain the latest firmware update from **www.skookumrobotics.com**
2) Unzip the hex file from the compressed archive file using WinZip (or a similar program), to a convenient directory on your PC.
3) Power it down the gyro, and connect its USB interface.
4) Load the Digital Flybar USB interface software on your PC.
5) Set the mode switch away from the gain dials (Flight mode), hold down the option button (**gently**), and then power up the gyro. The LED should stay off, and *Connect* on the setup screen will stay red.
6) Click the menu item Firmware, and then Update Firmware.
7) Select the hex file from step 2, and wait for the firmware upgrade to complete.
8) When finished, the connection indicator on the PC should turn red, and the gyro will be in Flight mode.
9) Move the mode switch towards the gain dials, and cycle the power. The new firmware revision number should show up on the top right of the USB interface display.

Appendix C: Warranty and Technical Support

Warranty and Repair:

Skookum Robotics Ltd warrants this product against any defects in materials or workmanship for a period of 90 days from the purchase date. This warranty is limited to the original purchaser. In the event of a malfunction, Skookum Robotics will repair or replace the product to meet its standard operating condition. This warranty does not apply in cases where the product has been overheated, electrically shorted, subject to crash damage, otherwise abused, or had unauthorized repair attempts.

UNDER NO CIRCUMSTANCES DOES SKOOKUM ROBOTICS ACCEPT LIABILITY FOR INCIDENTAL DAMAGE OR INJURIES RESULTING FROM THE OPERATION OF THE SK-360 OR OTHER PRODUCTS.

Skookum Robotics will provide customers with technical assistance by email free of charge. If a gyro is suspect due to a crash, we will check it over for only the cost of postage. If the unit has malfunctioned and the 90-day warranty period has expired, we will attempt repair, and discuss the cost of possible repairs with the owner, again for only the cost of postage.

If you wish to return the gyro unit or related product, please write “WARRANTY RETURN” clearly on the shipping box, and mail it to the address given below.

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