SK720 *Flybarless System*

User Manual and Setup Guide

The SK-720 replaces the tail gyro, mechanical flybar, and receiver on your R/C Helicopter. Other features include flight logging with playback, optional-self leveling and more to come!

This unit is ideal for pilots from beginner to 3D expert. Go flybarless!

Table of Contents

1 Introduction

The SK720 Digital Flybar is a high performance yet compact and lightweight pitch, roll, and yaw stabilizer for radio controlled (R/C) helicopters. It replaces the traditional flybar (stabilizer bar) mechanism and tail gyro while saving power, increasing flight times and reducing repair costs. Features include:

- Fybarless stabilization with piro-compensation
- Works as up to a 9-channel receiver core when used with Spektrum/JR or Futaba SBUS satellite receivers
- Supports radios with either 1024 or 2048 servo steps and 22ms or 11ms frame rates
- Two dedicated Sat-RX ports allow connection of up to 2 Spektrum/JR satellite receivers.
- Can also be used with PPM and traditional R/C receivers
- Works with Digital or Analog swash servos
- Internal swash mixing for accurate control
- Suitable for 120, 135/140, and 90 degree eCCPM, as well as mCCPM swashplates
- Works with 2,3,4 or 5 blade rotor heads because phase is adjustable
- Swash Ring anti-binding algorithm
- Expansion port for future accessories such as GPS
- Optional 20 amp external power bus for over 50-size and nitro helis
- 3-axis accelerometer + 3 gyros, allowing self-levelling
- High-power 32 bit processor (for future upgradeability)
- Up to 10 servos (one tail servo, 4 digital or analog swash servos and 5 other analog servos)
- Port for a remote LED which can be mounted outside of the canopy
- Built in 2 GB USB mass storage device - Connect the unit to your computer without having to install drivers
- Flight data logs can be played back on your PC. Enables tuning of helicopter health
- Compatible with the Skookum SK-LCD terminal
- Supports most tail servos by name in the setup software
- Tutorial “Wizards” show how to use the setup software and help first time users set up their new SK720
- Existing SK360 setup files can be easily converted for the new unit

2 Package Contents

Your gyro package includes:

- SK720 Gyro unit
- Three vibration-damping mounting pads
- One USB cable
- Warranty & Quick-Start Card

3 Getting Started

The SK720 has a standard mini USB port located on the back of the unit. Connect your new SK720 to your PC using the included USB cable.

The PC setup software for the SK720 can be found on the unit's built-in flash drive. The SK720 will automatically be recognized as a new mass storage device when you connect it to your PC; the files on it will be accessible a few seconds after you first plug it in to your computer. Access files that are stored on the SK720 just like you would any other file on your computer.

Look for a file on the SK720 drive labeled "SK720_setup.exe". There is also a pdf copy of this user manual ("SK720_manual.pdf") and a configuration file ("SK720.CFG") file stored on the SK720. The manual can be viewed with Adobe Reader, and the configuration file should be ignored.

Install the setup software onto your computer by running the installation program "SK720_Setup.exe", which can be found on the SK720's built-in flash drive.

- See Section 7 of this user's manual for detailed instructions on how to install the SK720's Windows setup software.
- Use the PC based setup software's built-in tutorial wizards to guide you through setting up your new SK720 on your helicopter.
- See Section 11 of this user's manual if you have questions about any of the tutorial wizard steps.

4 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 SK720) between the radio receiver and the servos that position the helicopter's controls. Loss of control of the helicopter may result if the SK720 is mistuned or set up incorrectly. See Appendix C for warranty information.

WARNING: Stand clear! Always test fly in an area away from spectators and **keep yourself at a safe distance** when flying the helicopter, especially after any change in the gyro's setup or tuning. DO NOT stand closer than 10m (30 feet) from the helicopter during test hovers or any other flying. Keep bystanders clear of the flight area at all times.

WARNING: Always "safe" the motor before you use the PC setup software or SK-LCD terminal to set up or tune your SK-720. Basic safety practice is to kill the engine on a nitro RC helicopter or disconnect the motor or main battery on an electric RC helicopter whenever the heli is behind the flight line or is being adjusted in any way.

5 Modes, LED Indicator, and Power-Up

The two primary modes are Setup mode and Flight mode. The SK720 will automatically switch to setup mode whenever it is connected to a PC by a USB cable or connected to an SK-LCD Terminal.

While the SK720 is in setup mode, it will do the control mixing for the helicopter but it will not provide any stabilizing action. This enables mechanical setup and servo trimming. While in this mode, the indicator LED will slowly flash green.

In Flight mode, the LED Indicator will show solid red while the SK720 initializes and it will turn solid green once the SK720 is ready to fly. The SK720 will also pump the swashplate once after it initializes properly.

The gyro will not finish initializing until it is allowed to stand completely still for several seconds. An uninitialized SK720 will be able to fly but the helicopter might not be in trim. Always verify that the LED indicator is showing solid green before taking off to avoid flying in an out-of-trim condition.

LED State	Meaning
Slow Green	Setup Mode
Fast Green	USB File Transfer
Solid Red	Flight Mode – Initializing
Solid Green	Flight Mode – Ready to Fly
Green, with Red Flicker	Flight Mode – High Vibration Warning
Flashing Red	Error State
Alternating Red / Green	Firmware Updating – Do Not Disturb

A rapidly flashing red LED light indicates an error or warning. The most common causes are:

1) The cyclic stick wasn't centred during gyro initialization in flight mode
2) Your helicopter has onboard electrical system voltage problems.
3) It is too hot or too cold
4) The Micro SD card failed to initialize

Simply restarting the unit will clear these faults most times. If the faults do not clear after resetting the unit, please contact technical support.

NOTE: The setup software will display the error state that caused the LED to flash red. Errors are shown in magenta in the *Live Data* area. Warnings are shown in yellow in the *Live Data* area. Connect the gyro to the setup software using the USB cable to find the specific type of error. Error states are also recorded in the log file and will be displayed by the playback software. Resetting the gyro will clear the error message.

6 Setup Overview

NOTE: For clarity, *italics* will be used throughout this manual whenever fields and regions of the setup software are referred to by name.

You will need to complete the following steps before you can fly your SK720 equipped helicopter.

1) Connect the SK 720 to your computer[1] using the included USB Cable and install the setup software. See Chapter 7 for more details.
2) Start the setup software and familiarize yourself with the steps in the *Initial Configuration Wizard* tutorial. The tutorial wizard will start the first time that you start the setup software.
3) Set your gyro for your servos with the help of the *Initial Configuration Wizard*. Alternatively, see Steps 2 and 3 in Chapter 11 of this manual.
4) Set up a new helicopter model on your transmitter.
    a. Swash Type: 1 servo ("Normal" or "H-1", depending on your radio)
    b. Set all servos to normal direction (i.e. not reversed)
    c. Servo travel adjust: 100% to start
    d. Travel adjust: 100% to start
    e. Subtrims: 0
    f. Expo: linear for now
5) Mount the gyro in your helicopter. See Chapters 8 through 10 in this manual.
6) Check for correct sensor readings with the help of the setup software's *Initial Configuration Wizard*. Alternatively, see Chapter 11 Step 4 in this manual.
7) Adjust swash servos for correct movement and trim them square. See the *Swash/Cyclic Setup wizard* in the Setup software or Chapter 11, Step 5 in this manual.

[1] When the gyro is connected via the USB cable, the LED light will slowly blink green. See Chapter 5 for more information about the various LED states.

8) Set up the tail servo with the help of the *Tail Setup wizard* in the setup software. Alternatively, see Step 6 in Chapter 11 of this manual.
9) Set the Cyclic and Tail Gain Input Banks[1]. Reference Step 7 in Chapter 11 of this manual.
10) Fly and trim.

[1] Good starting points for the cyclic and tail gains can be found in the "Default", "Scale", or "Basic_3D" setups, all of which are included with the PC Setup software. Modify these default setups to suit your own helicopter. See Section 11 for Basic Setup instructions.

7 Installing the Windows Setup Software and Utilities

NOTE: For clarity, *italics* will be used throughout this manual whenever fields and regions of the setup software are referred to by name.

The PC setup software for the SK720 can be found on the unit's built-in flash drive. Connect your new SK720 to your PC using the included USB cable.

The SK720 will automatically be recognized as a new mass storage device (Flash drive). The files stored on it will be accessible a few seconds after you first plug it in to your computer. Access files that are stored on the SK720 just like you would any other file on your computer. Look for a file on the SK720 drive labeled "SK720_setup". (See Figure 7.1, below.)

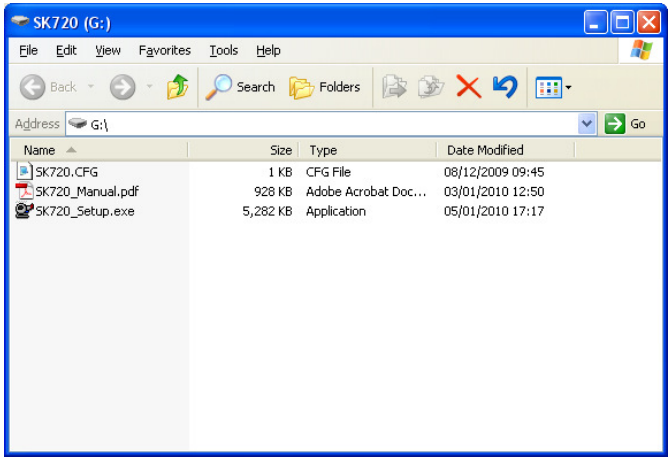

Figure 7.1 – SK720 Built-in Flash Drive

Install the SK720 setup software onto your computer by double-clicking on the installation program name. You will then be presented with a window similar to the one shown in Figure 7.2, below.

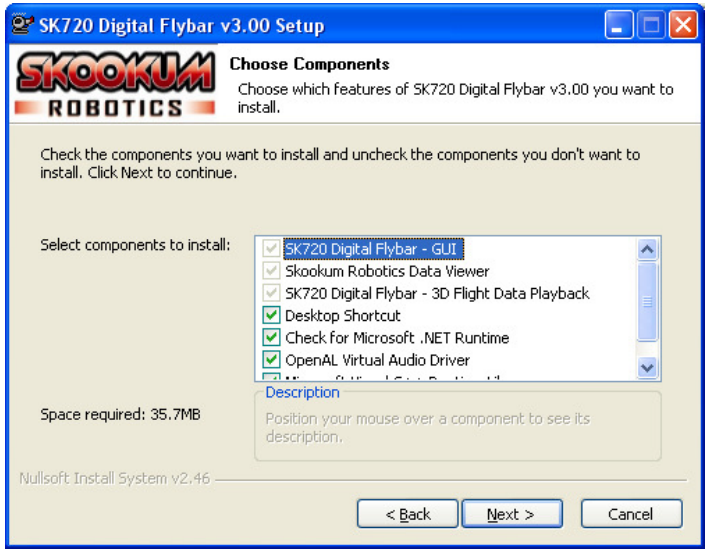

Figure 7.2 – SK720 Configuration Program Installation Options Screen

There are seven check boxes available and all but the "SK720 Digital Flybar – GUI" checkbox can be selected on or off. It is recommended that you install all of the available options unless you are sure that you won't need them[1]. Click the *Next* button to proceed to the screen shown in Figure 7.3. Select a directory in which you want to install the SK720 setup software (use the default directory if you are unsure) and then click *Install*.

[1] **For reference only**:

The latest version of Microsoft's .NET runtime library must be installed on your computer for the SK720 configuration software to work. Leaving the "Check for Microsoft .NET Runtime" option enabled will allow the installation program to test whether you have the required runtime library installed on your computer. If the required libraries are not already installed on your computer, then the setup software will direct you to a Microsoft website where you can download the required files.

The OpenAL virtual audio driver is used by the 3D Flight Data Playback utility to generate sound effects. It is not required if you have a Creative Labs sound card installed on your computer but we recommend that you install it anyway.

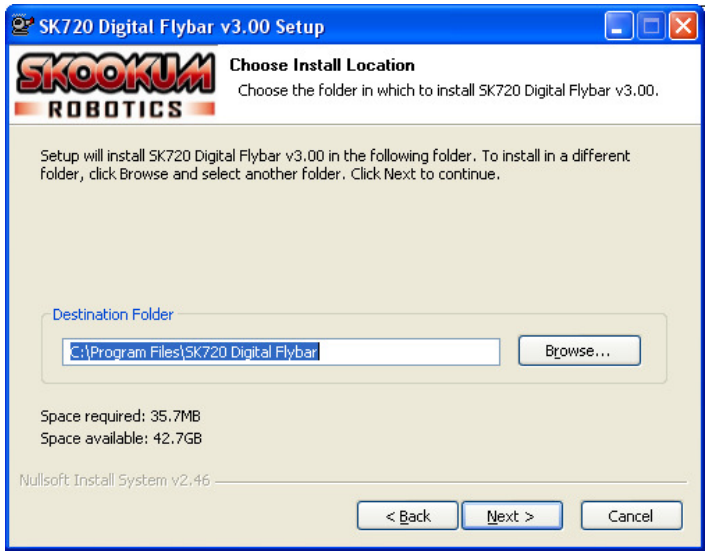

Figure 7.3 – SK720 Configuration Program Installation Folder Screen

After installing and starting the SK720 setup software on your computer, plug your SK720 into any available USB port using the supplied USB cable. The setup software will automatically detect the gyro. The *Connected* indicator in the top left corner of the setup software should turn green and the gyro's serial number and firmware revision should also be displayed. (See Figure 7.4, on the next page.)

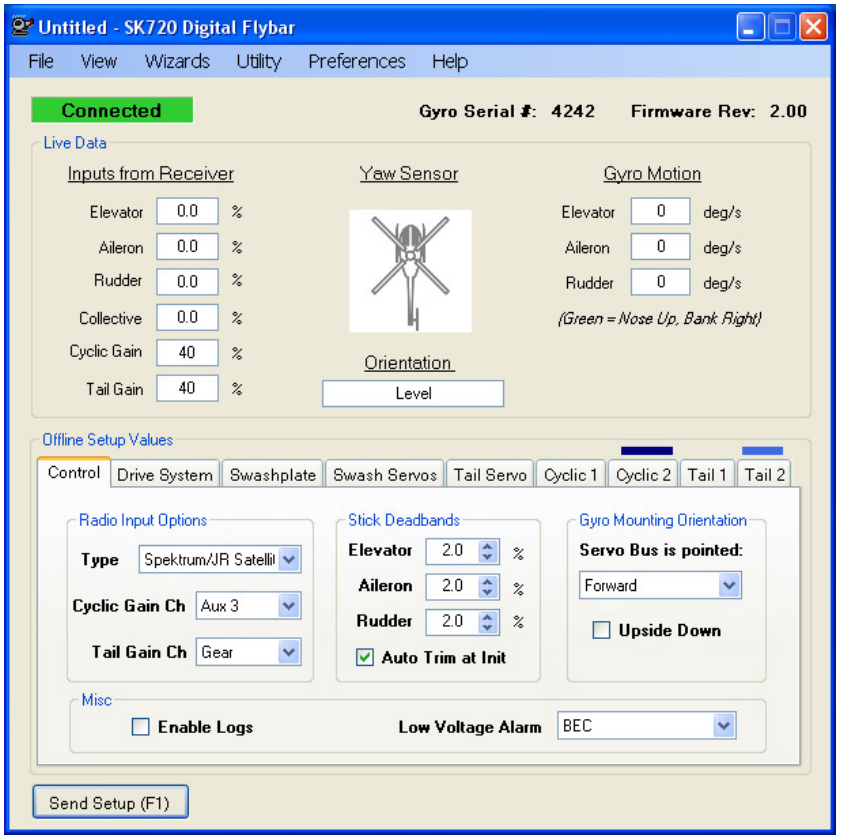

Figure 7.4 – SK720 Setup Software Main Window

If the software will not run on your computer, make sure that you have the latest version of "Windows .NET Runtime" installed. Check the Microsoft website for the most recent edition.

The *Initial Configuration Wizard* will start automatically the first time you start the software. Follow the tutorial wizard's steps to easily set up your SK720.

If the *Initial Configuration Wizard* does not start automatically, you can also start it by selecting *Initial Configuration Wizard* from the *Wizards* menu.

8 Mounting the Gyro

The gyro unit can be mounted upside down, backwards or rotated 90 degrees but it must be level and have its sides aligned as accurately as possible with the fore-aft axis of the helicopter as shown in Figure 8.1.

By default, the servo-port end of the unit is the front end. It can be installed in other orientations but **the SK720 label must always face up or down.** Note that 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 10 cm from Xtremelink[tm] receivers.

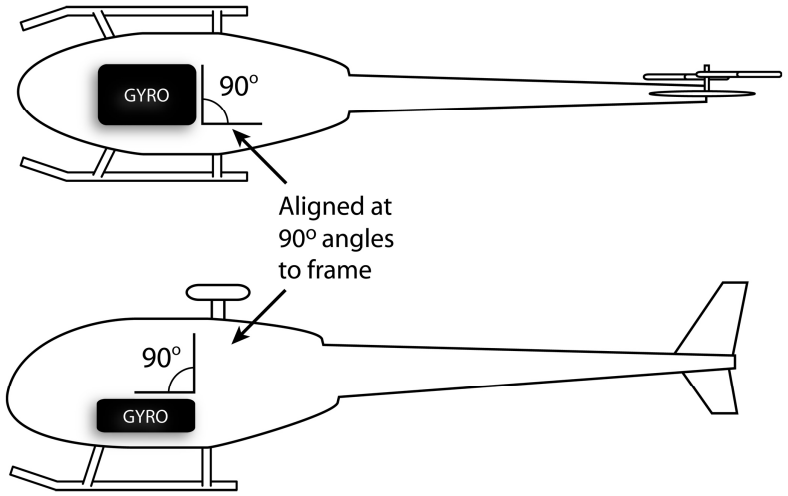

Figure 8.1 – SK720 Mounting Alignment

8.1 Mounting the SK720 in Small Electric Helicopters:

Mounting tape with good damping must be used to isolate the SK720 from vibration. Use the tape supplied with the SK720 to hold your SK720 in place in your helicopter.

Be sure to clean the SK720's base and the mounting site on the helicopter with isopropyl alcohol or another solvent before mounting the gyro. A loose-fitting padded safety strap may be used to ensure the gyro is secure in flight.

The gyro's case should not directly contact any hard surfaces on the helicopter's frame. If a safety strap is used across the top of the gyro, it should be padded slightly. Cables connected to the gyro should be flexible and should have some slack near the unit (i.e. do not strap the cables together or to the airframe within 5 cm of the SK720. Ideally, use a cable sleeve because this maintains a neat appearance while allowing the cables to move relative to one another.)

If you plan to use the SK720's self-levelling / bailout feature, it is better to mount the unit close to your helicopter's centre of gravity. Also, the lower the vibration levels on your helicopter, the better self-levelling / bailout will work. Subtle things like a canopy that rattles against hard mount points or a broken gear tooth can cause problems with self-levelling and flight logs. Note that some molded-plastic main gears can cause large amounts of noise and vibration; machined plastic gears may be better.

Note: If you are getting frequent vibration warnings from your SK-720, it indicates that the vibration level is over 10 G's!

8.2 Mounting the SK720 in Nitro and Large Electric Helicopters:

We strongly recommend that you use the Skookum Robotics SK-PW7 power bus accessory on electric helicopters with main rotor diameters larger than 1100mm (43 inches) and on nitro-powered helicopters.

The High power servos typically used on larger helicopters draw a lot of current. And while the SK720's servo rail is rated for a total of 10 amps, a set of four high powered servos will often be pulling 12 amps!

The SK-PW7 Power Bus was designed for up to 20 Amps of continuous current. It allows you to connect your high power 8.4 V servos directly to a 2S LiPo battery, without having to draw large currents through your helicopter's other on-board electronics. Also, six heavy servo cables will transfer a lot of vibration to the SK720's acceleration sensors. High vibration will degrade the quality of the self-levelling and flight log playback.

Mount the SK720 atop the metal damping plate that is included with the SK-PW7 Power Bus. Apply one vibration damping pad between the SK720 and the metal plate and a second pad between the metal plate and your helicopter (see Figure 8.2 below). For best results, cut the pad in half and put one half at each end of the plate with about 7mm (1/4") between the halves. Also check that everything on your helicopter is secure and that the engine runs smoothly if it is nitro-powered.

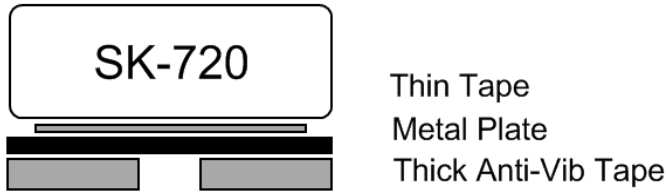

Figure 8.2 – SK720 Mounting Stack

If you plan to use the SK720's self-levelling / bailout feature, it is better to mount the unit close to your helicopter's centre of gravity. Also, the lower the vibration levels on your helicopter, the better self-levelling / bailout will work. Subtle things like a canopy that rattles against hard mount points or a broken gear tooth can cause problems with self-levelling and flight logs. Note that some molded-plastic main gears can cause large amounts of noise and vibration; machined plastic gears may be better.

Note: If you are getting frequent vibration warnings from your SK-720, it indicates that the vibration level is over 10 G's!

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9 Helicopter Airframe Setup

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

CAUTION: The gyro should not be used together with a mechanical flybar as the results could be unpredictable. It is intended for use where the swashplate alone drives blade pitch.

CAUTION: Do not connect the swashplate or tail servos to the gyro until after the SK720 has been set up for your servos. Your servos could be damaged by an incorrect configuration. See the *Initial Setup Wizard* in the PC Setup software or see Section 11 of this manual for information about how to set up the SK720 for your servos.

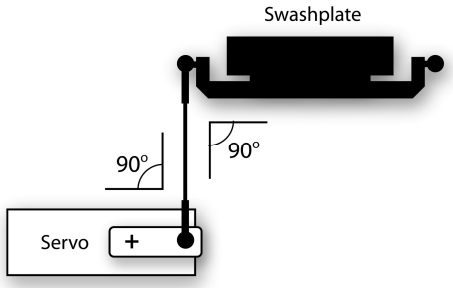
Main Rotor Blades:

Normal symmetrical rotor blades are recommended. Flat-bottomed rotor blades may be used but they have a nose-down moment about their pitch axis and so require powerful swash plate servos. The ideal rotor blades will be torsionally stiff but a bit flexible spanwise. Rotor blades must also be balanced both spanwise and chordwise. Heavier blades will make it easier to tune the helicopter.

Servos:

The best performance will be achieved if the servo's full normal range of movement is used. You will need fast (and ideally digital) servos for good "3D" performance. Stronger, faster servos will let you use higher damping gains (see Section 17) which is important for maneuvers such as piro-flips and tic-tocks. **Be aware that the current draw on your cyclic servos will be higher than with a flybar.**

Try to have 90-degree angles between the servo arms, linkages, swashplate and blade grip arms at zero degrees pitch ('mid stick') to ensure even movement. The gyro's USB setup interface will allow fine-tuning of servo centers to achieve this.



Flybarless Rotorhead:

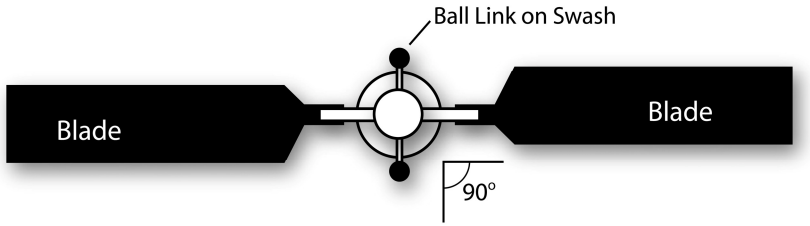
It is important that the linkages and swash have minimal backlash ("looseness") and the lowest friction possible. The stiffness of the rubber rotorhead dampers also affects flybarless tuning and flight performance. Performance will be better with the teeter damping stiffer than normal but excessive stiffness can cause vibration that is hard on the airframe, gyros and servos.

In general, phase trim does not need to be set on rotor heads that were specifically designed for use with flybarless systems.

Modified Traditional Rotorhead:

When setting up a rotorhead mechanism originally designed for helicopters with a flybar, removing the flybar while retaining normal servo arm length will likely give too much blade pitch action. Either the servo travel or servo arm length will need to be reduced to allow normal gains and good performance. (See Section 12 of this manual for a detailed description of how to check for correct cyclic and collective pitch setup.)

Some kind of anti-rotation or “follower” mechanism will also 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 adjusted. See the diagram below:



For initial flights, the phase angle should be adjusted so that when the blades are lined up with the helicopter’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 setup software.

It is important that the linkages and swash have minimal backlash (“looseness”) and the lowest friction possible. The stiffness of the rubber rotorhead dampers also affects flybarless tuning and flight performance. Performance will be better with the teeter damping stiffer than normal but excessive stiffness can cause vibration that is hard on the airframe, gyros and servos.

Tail:

It is important that you minimize tail rotor vibration. Tail rotor vibrations affect the helicopter’s elevator control because the axis of rotation of the tail rotor is aligned with the elevator axis. Also, if you have a belt-driven tail, be sure that your tail boom is electrically grounded to the helicopter’s frame or motor case to prevent static electricity buildup.

Helicopter Centre of Gravity:

The gyro will perform best when the helicopter’s centre of gravity (CG) is located directly under the main shaft or very slightly forward (i.e. very slightly nose heavy). This is especially important for maneuvers that use fast collective pitch changes combined with yaw (i.e. piros).

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10 Connections

The SK720 can be connected to a traditional receiver or directly to modern satellite receivers such as Spektrum, JR, Graupner, Futaba SBUS and PPM. The available options can be selected from the PC setup software. See Sections 10.1 through 10.4 for more on how to connect each type of receiver.

You will need to tell the SK720 which type of receiver you will be using. See the PC Setup Software's *Initial Setup Wizard* or Section 11 of this manual for instructions on how to set your SK720 for use with your type of receiver.

10.1 How to Connect Spektrum, JR Satellite or Gaupner Receivers:

One or two Spektrum/JR satellite receivers can be connected to the SK720. Two standard Spektrum/JR satellite receiver plugs are located on the side of the SK720 at the location labelled "SAT RX". Either plug can be used if you are using only one satellite receiver.

With the SK720's power off, connect your satellite receivers by plugging them in to the side of the unit.

The SK720 is set to Spektrum/JR Satellite Receiver mode by default at the factory. If you are using a Graupner satellite receiver, you will have to set your SK720 for that type of receiver. Follow the directions in the PC Setup Software's *Initial Setup Wizard* or in Section 11 of this manual to set your SK720 for use with your transmitter.

Connected Spektrum/JR satellite receivers can be set to bind with a transmitter using the PC setup software. Connect the SK720 to your computer using a USB cable and select *Bind Sat RX's on Power Cycle* from the *Utility* drop-down menu. All connected satellite receivers will then go into bind mode when the SK720 is unplugged from the USB and all other power sources, and then plugged back in to a battery or BEC.

In Spektrum/JR satellite receivers mode, the SK720 outputs the throttle channel on port "IO-A(T)". It also outputs up to four additional auxiliary outputs (IO-B, IO-C, IO-D and IO-E) for such things as a governor, landing gear or light control. The endpoints and trims of these auxiliary outputs must be adjusted in your transmitter.

NOTE: For safety, the throttle output is disabled while the SK720 is in setup mode. Be sure to set the fail-safe throttle level using the setup software (See Section 11, Step 3).

10.2 How to Connect Futaba SBUS Receivers:

CAUTION: The SK-SB1 cable will power the SBUS receiver but it will not power any servos or other hardware connected to your SBUS receiver. You could damage the SK720 and the SK-SB1 cable if you connect servos or other devices directly to your SBUS receiver as-is. The way around this is to remove the red wire from the SBUS end of the SK-SB1 adapter.

A Futaba SBUS receiver can be connected to the SK720 by plugging it in to either of the two plugs located on the side of the SK720 at the location labelled "SAT RX". Use an SK-SB1 dongle cable to connect the Futaba SBUS port on your receiver to the SK720's SAT RX plug.

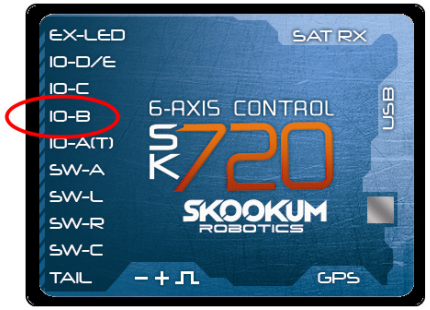
The SK720 is set to Spektrum/JR Satellite Receiver mode by default at the factory. You will have to set your SK720 for use with Futaba SBUS receivers. Follow the directions in the PC Setup Software's *Initial Setup Wizard* or in Section 11 of this manual to set your SK720 for use with your Futaba SBUS receiver.

In Futaba SBUS receiver mode, the SK720 outputs the throttle channel on port "IO-A(T)". It also outputs up to four additional auxiliary outputs (IO-B, IO-C, IO-D and IO-E) for such things as a governor, landing gear or light control. The endpoints and trims of these auxiliary outputs must be adjusted in your transmitter.

NOTE: For safety, the throttle output is disabled while the SK720 is in setup mode. Be sure to set the fail-safe throttle level using the setup software (See Section 11, Step 3).

10.3 How to Connect PPM Receivers:

A PPM receiver can be connected to the SK720 by plugging it in to port IO-B (circled) using a servo wire jumper cable. Connect the other end of the servo wire jumper to the PPM output on your PPM receiver. Be sure to set the SK720 for PPM receiver type before powering your receiver.



The SK720 is set to Spektrum/JR Satellite Receiver mode by default at the factory. You will have to set your SK720 for use with PPM receivers. Follow the directions in the PC Setup Software's *Initial Setup Wizard* or in Section 11 of this manual to set your SK720 for use with your PPM receiver.

In PPM receiver mode, the SK720 outputs the throttle channel on port "IO-A(T)". It also outputs up to three additional auxiliary outputs (IO-C, IO-D and IO-E) for such things as a governor, landing gear or light control. The endpoints and trims of these auxiliary outputs must be adjusted in your transmitter.

NOTE: For safety, the throttle output is disabled while the SK720 is in setup mode. Be sure to set the fail-safe throttle level using the setup software (See Section 11, Step 3).

10.4 *How to Connect Traditional Receivers:*

It is important to turn the SK720's satellite receiver option off using the PC setup software before connecting a traditional stand-alone receiver. Follow the directions in the PC Setup Software's *Initial Setup Wizard* or in Section 11 of this manual to set your SK720 for use with a traditional receiver.

Connect your traditional receiver to the SK720 using four servo jumper wires or using a SK-CBL receiver cable kit. (The SK-CBL receiver cable kit and/or servo jumper wires must be purchased separately). The connector mapping is:

Receiver Channel	SK720 Port
Aileron	IO-A
Elevator	IO-B
Rudder	IO-C
Collective Pitch	IO-D
Gain / Bank Select	EXT-LED

All power and ground pins on the SK720 servo ports are connected to one another internally. Only the signal pins (i.e. the row of pins closest to the SK720's label) and one ground pin need to be connected to the receiver.

If you have purchased our SK-CBL receiver cable kit, hook up the Aileron and Elevator channels using normal male-male jumpers. Insert the single-plug end of the cable tree sideways across the signal (upper) pins of IO-C, IO-D and Ext-LED. The three-plug end of the cable tree should be connected as shown in Figure 10.1, on the next page.

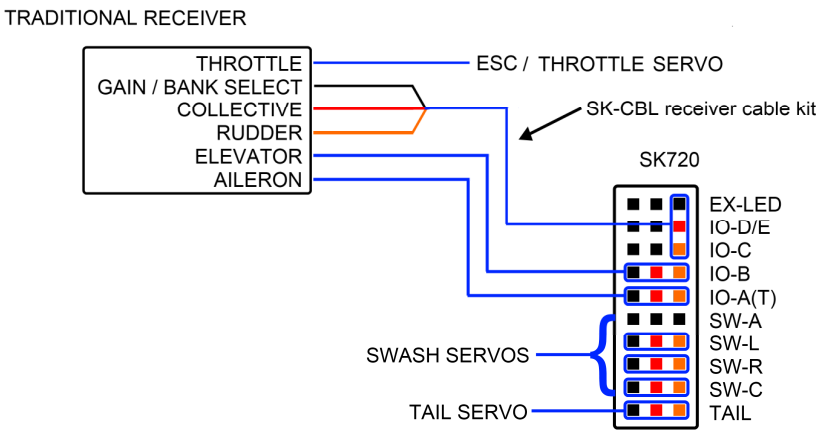


Figure 10.1 – How to Connect a Traditional Receiver to your SK720

Do you notice that that there is no throttle input to the SK720 from an external receiver? The throttle signal from an external receiver must bypass the SK720 and be connected directly to the throttle servo or BEC. Also, it is not possible to use an external LED when using a traditional receiver.

If you are using the SK-PWR bus along with your traditional receiver, please see the separate SK-PW7 Power Bus manual for details on how to connect it.

10.5 How to Connect Your Servos:

CAUTION: Do not connect the swashplate or tail servos to the gyro until after the SK720 has been set up for your servos. Your servos could be damaged by an incorrect configuration. See the *Initial Setup Wizard* in the PC Setup software or see Section 11 of this manual for information about how to set the SK720 for your servos.

NOTE: The SK720 needs to receive separate aileron, elevator and pitch inputs. Set the swash-type in your TRANSMITTER to "1-servo" for all receiver types and swash setups.

Plug your swash and tail servos into the servo plug ports located on the front edge of the SK720. The ports are labeled TAIL, SW-C, SW-R, SW-L and SW-A and are circled in the image below.

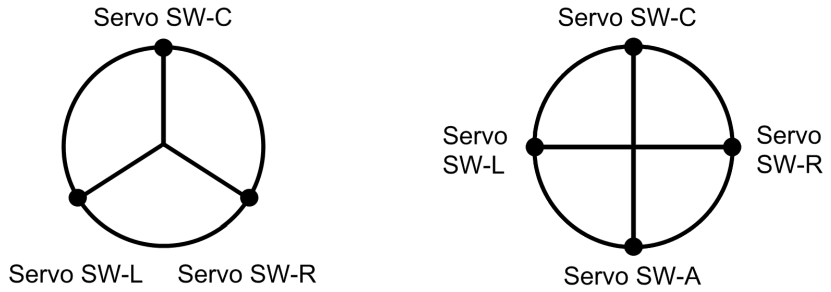
The tail servo should be plugged in to the TAIL port.

The swash servos should be connected per the following table and per the diagram on the next page:

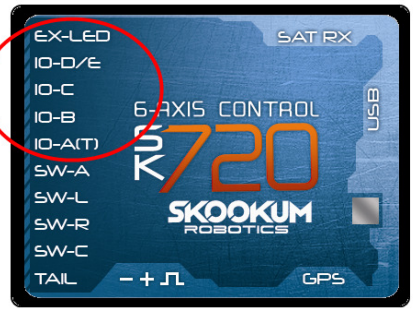
Swash Setup Type	SW-C	SW-R	SW-L	SW-A
120°, 135°/140° eCCPM	Centre	Right	Left	n/a
"1-servo" mCCPM	Elev	Ail	Pitch	n/a
90-deg eCCPM	Fwd	Right	Left	Aft

- ***Left/Right means the heli's left and right, when viewing the helicopter from its tail to its nose.***
- ***On 120°, 135° or 140° eCCPM swash plates, The SW-C servo can be located either at the front or back of the swash; both are equivalent.***

Servo Output Layouts:



Additional servo outputs are available if you are using Spektrum/JR, Futaba SBUS or PPM satellite receivers. The additional servo ports are circled in the image below. These outputs are not available if you are using a stand-alone traditional receiver.



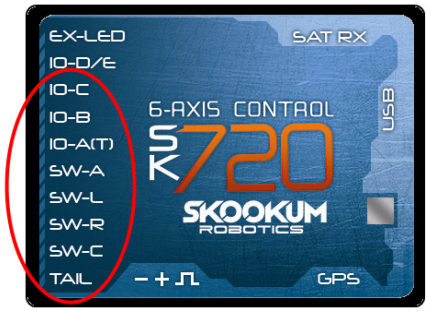
The electronic speed control (ESC) or throttle servo[1] should be connected to IO-A(T). Connect any auxiliary functions such as landing gear, lights or external governors to IO-B, IO-C, IO-D and IO-E. Connect your SK-LED or other external LED to the EX-LED port.

If your helicopter has blades 500 mm (20 inches) or larger, you should use the optional SK-PW7 Power Bus to isolate your SK720 from vibration and to supply your servos with sufficient electrical current to prevent brownouts. Please see the separate SK-PW7 Power Bus manual for more details on how to connect it.

[1] ESC and throttle servo control are only available via the SK720 when using satellite receivers. Otherwise, these devices must be connected directly to your traditional receiver.

10.6 How to Power the SK720:

The allowed voltage range for your SK720 is 5V to 10V. The SK720 can be connected to a battery or BEC by plugging it in to any open servo port except the IO-D/E or the EXT-LED ports. All other ports (circled in the image below) are connected to a joined power rail. Just one of these ports needs to be connected to a battery or BEC.



Use the SK-PW7 Power Bus if you intend to use high voltage (8.4V) servos together with any 5.0V equipment on your helicopter.

10.7 Optional Connections:

Power Bus:

We strongly recommend that you use the optional SK-PW7 Power Bus for helicopters with blades longer than 500mm (20 inches). This accessory isolates the SK720 from vibration carried by heavier servo cables and is capable of handling 20 amps of continuous current to eliminate brownouts. The SK-PW7 Power Bus also makes it possible to neatly install both 8.4V and 5.0V equipment on the same helicopter.

See the separate SK-PW7 Power Bus manual for details on how to connect your receiver, SK720 and servos using the SK-PW7 power bus.

RPM Sensors:

CAUTION: Be sure to activate the RPM sensor from the PC setup software before connecting your RPM sensor. Your RPM sensor could be damaged if you don't. See Section 11 of this manual for information about how to set the SK720 for use with an RPM sensor.

With an RPM sensor connected, your helicopter's flight logs will include RPM data. Once set, **the RPM sensor connects to port IO-C**. Most hall-effect base sensors will work but be careful with sensors from Eagle Tree. Wiring on Eagle Tree sensors is non-standard but they should work normally if you switch their red and black leads.

Miscellaneous Outputs:

If it is difficult to see the SK720's status LED when it is mounted on the helicopter, an external LED can be used. Just connect it to the port labelled "EX-LED" like a normal servo cable. For this port, the top pin is for Green, the middle pin is for Red, and the bottom pin is Ground. This option cannot be used in combination with a traditional radio receiver, however.

There are also two additional ports on the side and back of the SK720 gyro. One is for connecting the SK-LCD interface and the other is for connecting an optional GPS or other future expansion accessories.

11 Gyro Setup Using the USB Interface

Note: The PC Setup Software has built-in Wizards to guide you through these set up steps as a first-time user. We suggest that you set up your helicopter the first time by following the step-by-step instructions in the *Initial Configuration Wizard*, *Swash/Cyclic Setup Wizard* and *Tail Setup Wizard*. Using the Wizards will make initial setup of your SK720 much easier and will help you learn how to use the PC Setup Software.

CAUTION: Do not connect the swashplate or tail servos to the gyro until after the SK720 has been set up for your servos. Your servos could be damaged by an incorrect configuration.

Step 1: Connecting

- Start the SK720 setup software on your PC. See Section 7 of this manual for instructions on how to install the setup software on your PC.
- Set your radio's transmitter so Aileron, Elevator, and Pitch (Collective) are output each on a separate channel ("Normal" or "1-Servo" swashplate mode on Spektrum/JR transmitters or "H-1" mode on Futaba transmitters). Also centre all the trims and subtrims.
- The initial setup will be easier if you use a straight-line pitch curve and no expo or dual rates in your radio. These features can be set up later according to your usual preferences.
- Connect the SK720 to your PC using the included USB cable. The SK720 setup software will automatically detect that the gyro is connected to your computer. Check that the connection indicator in the upper left is green and says *Connected*.
- Good starting points for the cyclic and tail gains can be found in the "Default", "Scale" or "Basic3D" setups, all of which are included with the PC setup software. Look for these default setups under the SK720 setup software's *File* menu.

WARNING: Do not use any of the "Default", "Scale", or "Basic3D" setup files mentioned above without first modifying them to suit your helicopter per Section 11, Steps 2 through 5.

WARNING: All the control input and sense directions set up in Steps 2 through 5 below must be correct or your helicopter will instantly crash if you try to fly it. Follow these steps carefully and complete the pre-flight check outlined in Section 13 of this manual before flying your helicopter.

Step 2: Match the Gyro to Your Transmitter

- Click the *Control* tab in the *Offline Setup Values* area in the lower half of the setup software window (see Figure 11.1 below). Select the type of receiver that you will be using by choosing one of the options in the *Type* box.

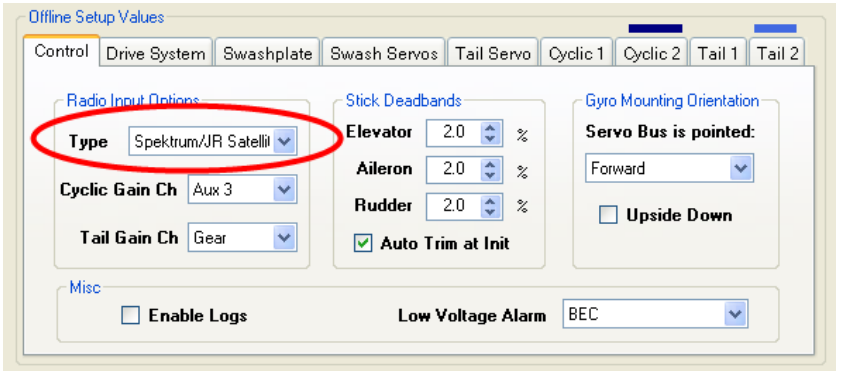


Figure 11.1 – Selecting Receiver Type

- 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.**
- The SK720 will automatically reset itself any time you change the receiver type and then press the send setup button.
- Try moving the elevator stick towards you (nose up) and look at the *Elevator* field under the *Inputs From Receiver* area (circled in Figure 11.2 on the next page). The number displayed should be close to 100% and should be shown on a **green** background when the transmitter's control stick reaches its stops. If it is negative and displayed on a **red** background, reverse that channel in your radio. If it's too low or reaches 100% much before the stick's limit, adjust the endpoints (ATV's) for that channel in your transmitter. Typical end point (ATV) values will be near 125% for JR/Spektrum radios.

- Repeat for Aileron and Rudder inputs but move the sticks right (**green**).
- Then check the collective pitch input, moving the stick up (**green**). Reverse and/or alter the end point values as necessary.
- If the values in the *Inputs From Receiver* (circled in Figure 11.2 below) do not change as you move the sticks on your transmitter, check to see if your receiver is bound.
- Spektrum/JR Satellite receivers can be bound using the SK720's bind mode. Enable the bind mode from the *Utility* menu on the setup software by selecting *Bind Sat RX's on Power Cycle*. Selecting this option will cause all connected Spektrum/JR satellite receivers to enter bind mode the next time that the SK720 is power cycled (i.e. turned off and then on again).

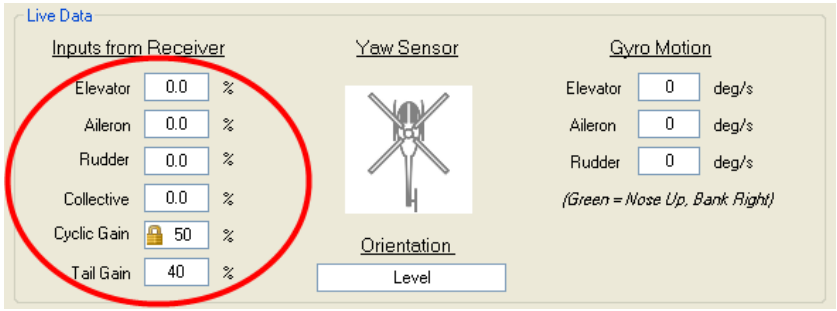


Figure 11.2 – Inputs From Receiver

Step 3: Set up the Throttle Servo or ESC

NOTE: You should skip to step 4 if you are using a traditional receiver. There is no throttle output from the SK720 when you use a traditional receiver.

- Disconnect the SK720 from the PC (for safety, the throttle output is disabled while connected to your PC).
- Connect your ESC or throttle servo to port IO-A(T) on the SK720 then use the endpoints, trims and reversing in your transmitter to setup the throttle servo to suit your helicopter.

WARNING: Your helicopter could spool up unexpectedly if you set the throttle failsafe value to anything other than idle.

- Now make sure the helicopter's motor is off and then reconnect the SK720 to your PC. On the *Drive System* tab (see Figure 11.3 below), click *Set Throttle Failsafe* and follow the instructions that appear.

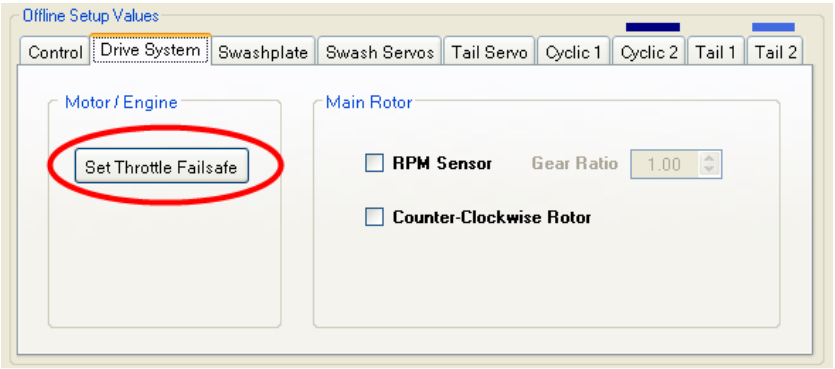


Figure 11.3 – Setting the Throttle Failsafe

The throttle failsafe setting is the throttle position that the SK720 will send to your throttle servo or BEC when the SK720 looses radio reception or if the transmitter is accidentally turned off before the helicopter.

Step 4: Check the Gyro's Sense Directions

- On the *Control* tab of the GUI, select which way the SK720's servo bus is pointed in your helicopter (circled in Figure 11.4 on the next page). Also select whether the gyro is mounted upside down (label facing down) or right side up (label facing up).
- Now look at the *Gyro Motion* fields in the *Live Data* area (shown in Figure 11.2 on the previous page). Note that these fields sense movement, not angles.
- Pick up the helicopter and slowly tilt it nose-up. The Gyro Rate for Elevator should be positive and show **green**.
- Repeat for the Aileron (roll) axis but slowly tilt the helicopter to the right. The Gyro Rate for Aileron should be positive and show **green**.

- Repeat for the Rudder (yaw) axis but slowly rotate the helicopter nose-right (clockwise). The Gyro Rate for Rudder should be positive and show **green**.

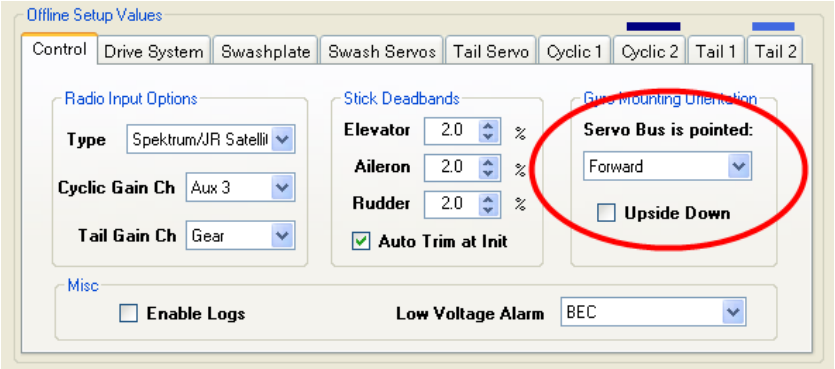


Figure 11.4 – Setting Gyro Mounting Orientation

Step 5: Swash Mixing / Servo Setup

NOTE: The SK720 will not provide any stabilizing action while in set up mode. This enables mechanical set up and servo trimming.

- Click the *Swashplate* tab in the *Offline Setup Values* area in the lower half of the setup software window (see Figure 11.5 below). Set the *Swash Type* just as you normally would in your transmitter.

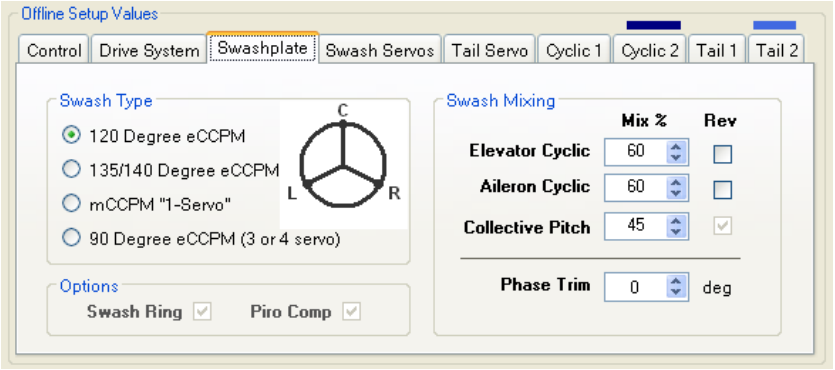


Figure 11.5 – Offline Setup Values *Swashplate* Tab

- Go to the *Swash Servos* tab in the *Offline Setup Values* area in the lower half of the setup software window (see Figure 11.6 below). Select the servo type and speed according to the specifications of your servos. Use the default servo speed if you don't know what setting to use for your servos.

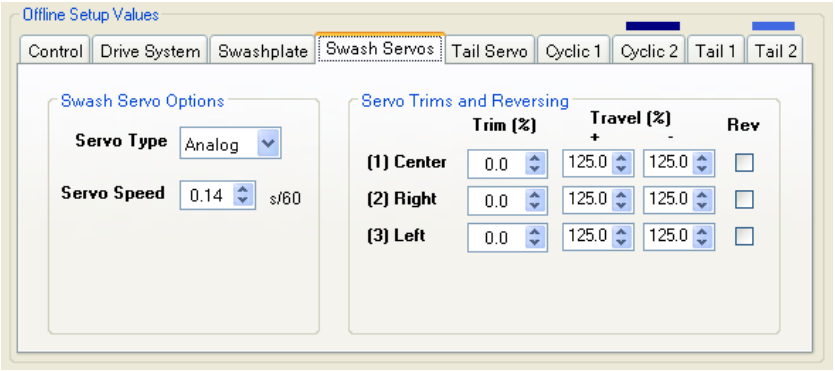


Figure 11.6 – Offline Setup Values *Swash Servos* Tab

- Make sure the control sticks are centered and then plug the servos into the gyro. Check for good motion and no binding.
- Fit your servo arms so they are as close to 90 degrees to the linkage as can be achieved. Next, adjust the servo trims in the setup software until their arms are at exactly 90 degrees to their linkages, and then use the linkages to level the swashplate.

NOTE: Trims and sub-trims on the transmitter should be set to neutral for best results. Do not try to change cyclic throw or servo trims using your radio.

- Use the collective stick to check that all swashplate servos are correctly synchronized. (i.e. all swashplate servos move up and down together in response to collective stick motion.) If the swash plate servos are not correctly synchronized, then you can reverse the individual servo directions by clicking on the associated *Rev* checkbox in the *Servo Trims and Reversing* area of the *Swash Servos* tab. (See Figure 11.6 above.)
- Check aileron and elevator swash motion for correct direction of travel. If it isn't right, you can reverse the elevator and aileron channels by clicking on the appropriate checkbox in the *Swash Mixing* area on the *Swashplate* tab. (See Figure 11.5 on the previous page.)

- Now check the blade pitch range in response to full maximum and full minimum collective, elevator and aileron. Plus or minus 12 degrees of collective pitch and plus or minus 10 degrees of cyclic pitch are good starting points for most sport fliers. These can be adjusted using the *swash mixing* values on the *Swashplate* tab. (See Figure 11.5 on the previous page.)

  Try to keep swash mixes to 60% or less. This prevents unwanted interaction at max and min collective. Increase the servo travels instead if you need more motion.

NOTE: The *Elevator Cyclic* and *Aileron Cyclic mixing* change together in default setup software interface. Select the *3D Tuning* or *Advanced* interface from the *Preferences* menu if you want to adjust either value separately.

Step 6: Tail Setup

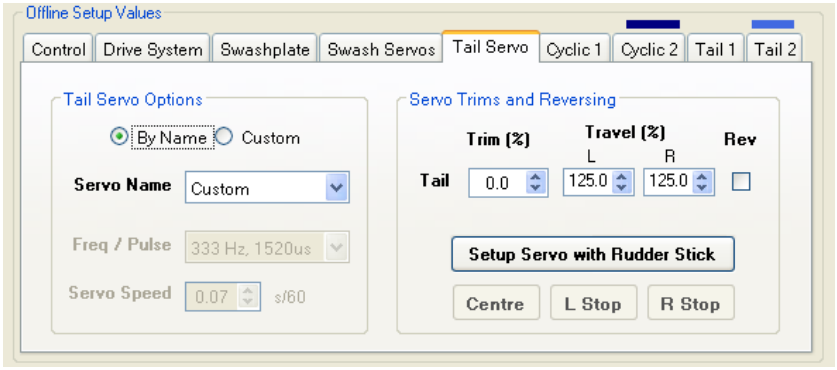


Figure 11.7 – Offline Setup Values *Tail Servo* Tab

- Click the *Tail Servo* tab in the Offline Setup Values area of the Windows SK720 setup software. Select "By Name" and find the model of tail servo on your heli in the *Servo Name* drop-down list.
- If you can't find your model of servo in the list, then select Custom and look up the pulse type, max frame rate and speed for your tail servo. (Most servos will work at 333 Hz but the pulse type is important.)
- Now, connect the tail servo to the gyro. First check that the direction of the servo is correct by moving the rudder stick on your radio as shown in Figure 11.8 on the next page.

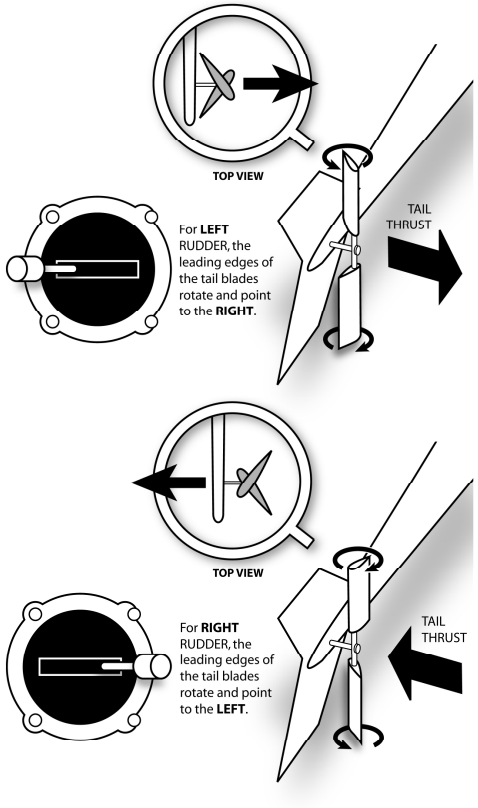


Figure 11.8 – Check for Correct Tail Rotor Blade Movement

- If the tail blade pitch response is not correct, reverse it by clicking on the *Rev* checkbox in the *Servo Trims and Reversing* area (see Figure 11.7).
- Set the servo centering and endpoints by clicking "Setup Servo with Rudder Stick" and follow the instructions in the popup window.

NOTE: The Tail servo will not move normally when the system is in the *Setup Servo With Rudder Stick* mode. It will only "trim" in the direction of the transmitter stick position.

- The tail linkage should be set up so that, at center, the servo arm is at 90 degrees to its pushrod and the tail blades have 0 degrees of blade pitch.

Step 7A: Cyclic and Tail Gain Input Banks (Satellite Receivers)

- If you are using satellite receivers (i.e. Specktrum, JR, Futaba SBUS or PPM), you should have separate control over the Cyclic Gain and Tail Gain inputs. By default, the gear channel will control the overall cyclic gain and an Aux channel will control the overall tail gain. This can be modified on the *Control* tab if needed (see Figure 11.9, below).

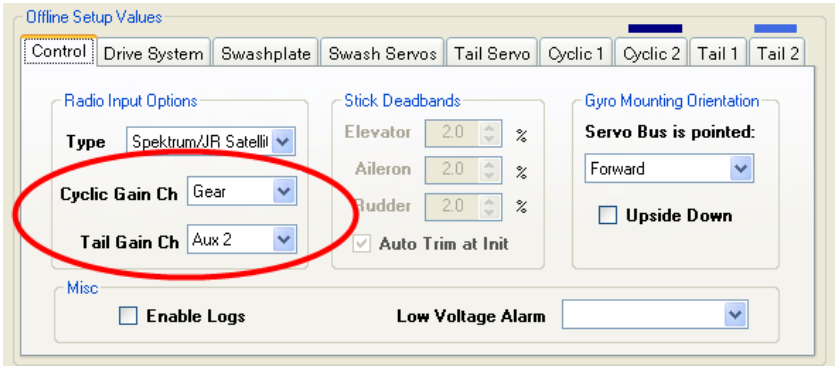
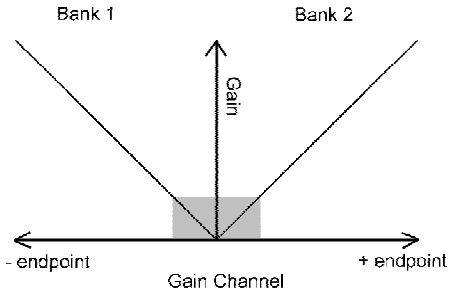


Figure 11.9 – Selecting Which Channels Control Cyclic/Tail Gains

- The gain channel's endpoint setting in your transmitter will set the amount of gain for that function. For example, setting your gear channel's end points to +40% and –50% will give you 40% gain on one bank and 50% gain on the other. This is illustrated below:



- The direction of a gain channel's output will set which cyclic or tail bank is active. You can tell which bank is active by looking at the position of the blue bar over the Cyclic and Tail tabs. The blue bar will be located over the currently active tab. In Figure 11.9 above, the Cyclic 2 and Tail 2 tabs are the active tabs (i.e. the settings on those tabs will be the active settings on the SK720).

- You can see the effect of changes in your transmitter's endpoints on your gain settings by looking at the *Cyclic Gain* and *Tail Gain* fields in the Live Data area of the PC setup software (see Figure 11.2 on Page 31). Set your tail and cyclic gains using your radio's endpoints. 50% is a safe starting point for both the tail and cyclic gains[1].

Figure 11.10 – Cyclic Tab (Basic User Interface setting)

- You can also "lock" a gain to a fixed value by selecting *Lock Cyclic/Tail Gain to* on the Cyclic/Tail tabs. The Cyclic tab is shown in Figure 11.10 above but the Tail gains can be locked on a Tail tab using an identical slider and check box. Click the checkbox to enable the slider and then drag the slider with your mouse to set your locked gain values.
- Locking a gain will cause the SK720 to use the fixed value, regardless of the gain channel's end point setting. A small lock icon in the Cyclic Gain or Tail Gain fields in the live data area indicates that locked gains are being used (see the *Cyclic Gain* field in Figure 11.2 on Page 31).

[1] For users of JR / Spektrum radios that have a gyro gain menu, tail gains of 50% equal 0, 100% equal +100 and 0% equal –100. Use values greater than 50% for one bank and less than 50% for the other. Alternatively, disable the gyro gain menu and set the gain channel end points per the method described above.

- If you only have one channel available for selecting between gain banks, you can control one or both of the cyclic and tail gain functions with that channel. In that case, you should set the lock values per one of the options in Table 11.1, below.
- Alternatively, you can choose not to use two cyclic or two tail banks by selecting "None" in the *Cyclic Gain Channel* and/or *Tail Gain Channel* fields (see Figure 11.9). Choosing this option will result in the gains being locked on the associated tab.
- See Section 16 of this user manual for detailed description of how to use the features in the *Cyclic* and *Tail* gain banks to tune your helicopter.

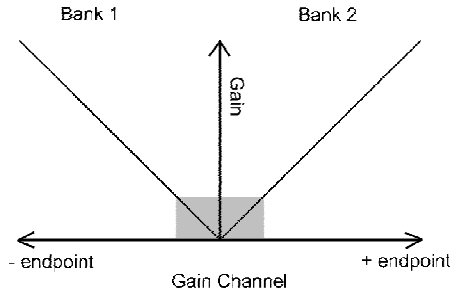
Step 7B: Cyclic and Tail Gain Input Banks (Traditional Receivers)

- Only one gain channel is available when using a traditional radio receiver. That single gain channel can be set to control both the cyclic and tail gain functions. To avoid both the cyclic and tail banks having the same overall gain, you can lock the gain percentage for any bank (see Figure 11.10). The gain channel will then select which bank is active but won't affect the gains. For example:

Cyclic Banks	Tail Banks	With Only One Gain/Bank Channel
Locked	Locked	Selects banks. Endpoints do not set either gain.
Locked	Not Locked	Selects banks. Endpoints set the Tail Gain
Not Locked	Locked	Selects banks. Endpoints set the Cyclic Gain
Not Locked	Not Locked	Not recommended - Both scaled together

Table 11.1 – Using Locked Gain Values With a Single Gain Channel

- The gain channel's endpoint setting in your transmitter will set the amount of gain for that function. For example, setting your gear channel's end points to +40% and –50% will give you 40% gain on one bank and 50% gain on the other. This is illustrated below:



- Check that your radio can select which tail and/or cyclic bank is active, as indicated by a small blue bar over each setup tab. The small blue bar shows which switch position corresponds with which cyclic and tail gain tab.
- Alternatively, you can choose to use only one cyclic and/or tail bank by selecting "None" in the *Cyclic Gain Channel* and/or *Tail Gain Channel* fields (see Figure 11.9). Choosing this option will result in the gains being locked on the associated tab.
- See Section 16 of this user manual for detailed description of how to use the features in the *Cyclic* and *Tail* gain banks to tune your helicopter.

Step 8: Ready for Flight

- Save your setup to your computer's hard drive by selecting *Save Setup* from the *File* menu, then go to Section 12 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.

12 How to Check Cyclic Pitch & Phasing

NOTE: The gyro must be put into setup mode before the cyclic throws, phasing and swash motion can be checked for correctness. Place the gyro into setup mode by connecting it to an SK-LCD Terminal or to a computer using a USB cable. A slowly flashing green LED on the SK720 indicates that the gyro is in setup mode.

The goal of mechanical and gyro swashplate setup is to retain your normal collective blade pitch range while setting a **cyclic range of about ±10 degrees. This is important.** (Cyclic pitch is the blade's pitch due to aileron or elevator input.)

While in setup mode, control stick motions are sent directly to the swashplate and tail rotor as if stability gains were zero (i.e. the gyro only does its mixing function). The gyro's gains 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 and tail of the helicopter as in Figure 12.1 below:

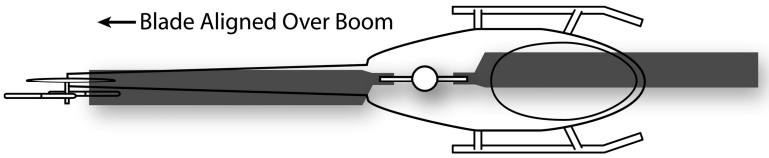


Figure 12.1 – Cyclic Aileron (Roll) Phasing

3) Now try full nose-up elevator control with the aileron centered. Measure the pitch of the blade that extends over the nose. If the mechanical setup is ideal, the blade should not change pitch as you move the elevator control.

NOTE: The aileron control, not the elevator control, changes the main rotor blade pitch when the main rotor is aligned as shown in Figure 12.1 above. This is normal and is true for both flybarless and non-flybarless helicopters.

4) If the main rotor blade pitch changed when you moved the elevator stick to full nose-up at step 3, then you will need to adjust the phase angle. You can do this either mechanically at the swashplate or using the Phase Trim option on the Swashplate tab (see Figure 12.2). If the pitch became negative then adjust the phasing clockwise (+), if it became positive then adjust it anti-clockwise (-). This will give you normal phasing (90 degree lead); multi-bladed rotors may fly better with some positive phase trim.

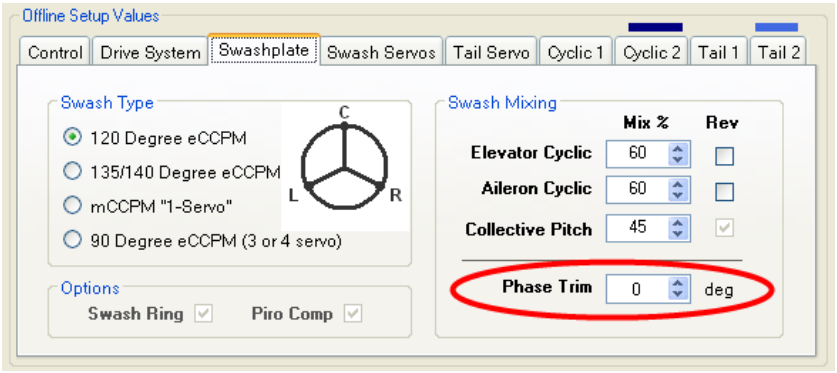


Figure 12.2 – Swashplate Phase Trim

5) Try full right aileron control with elevator control centered. The blade's pitch should be about -10 degrees.
6) Try full left aileron control with elevator control centered. The blade's pitch should be about +10 degrees.

7) Next align a blade at 90 degrees to the fuselage, pointing over the right side of the helicopter as in Figure 12.3 below:

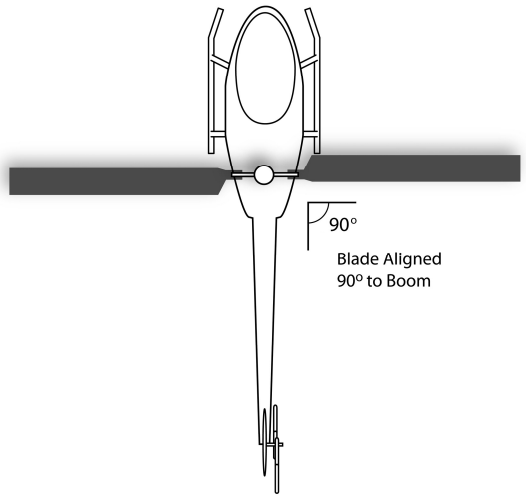


Figure 12.3 – Cyclic Elevator (Pitch) Phasing

8) Try full nose-up elevator control with aileron control centered. Measure the pitch of the blade that extends over the right side of the helicopter. It should be about -10 degrees.

9) Try full left nose-down elevator control with aileron control centered. The blade's pitch should be about +10 degrees.

NOTE: The SK720's cyclic gains will need to be changed any time that the cyclic blade pitch range changes. For example, increasing cyclic pitch range by 10% is the same as increasing the stability gains by 10%.

13 After Setup: Final Check!

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

1) Power up the helicopter with the servos connected and the swashplate mechanically set up. Leave it undisturbed and wait for the LED to turn green.
2) Input full right aileron on your transmitter. Check that the swashplate tilts to the right.
3) Input full up elevator (nose up). Check that the swashplate tilts back.
4) Input full right rudder on your transmitter. Check that the tail pitch changes for right yaw.
5) Select throttle hold mode and then set zero collective pitch. Check that the swashplate moves to give zero blade pitch.
6) Set full up collective pitch. Check that the swashplate moves to give maximum blade pitch.
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.
8) Rotate the heli's nose to the right 90 degrees. The tail blades should move to counter-act the motion.

WARNING: Remember to return your throttle stick to the idle position before releasing throttle hold.

NOTE: In flight mode, the swashplate will tilt slightly forward at full positive collective to compensate for tail-drag. Likewise, it will tilt slightly back at full negative collective.

14 Flight with the SK720 Gyro

In flight mode, the swashplate will not respond to the controls directly. Its action will be similar to a heading-hold tail gyro. 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 helicopter, always wait at least 5 seconds after the rotor stops before spooling up again. This enables the gyro to detect that the helicopter is spooling up. Don't move the cyclic stick until the heli is light on its skids to prevent confusing the gyro before the helicopter can respond to the gyro's control inputs. If the *Auto trim at Init* feature is on, avoid using the transmitter trims for elevator, aileron or rudder. If you do use trims (i.e. *Auto trim at Init* feature is off), you'll have to zero them before every flight.

Note: When you use the *Self Tune Bell Gains* option, the SK720 has to be sure that the helicopter is on the ground before it will save the auto tuned gains to its memory. To ensure that it saves its memory, do not turn off the power to the SK720 until after the helicopter has been still for 5 seconds after the blades have stopped turning and the engine is off.

WARNING: Observe these precautions before every flight:

1) Check to ensure that the Indicator LED is solid green (not flashing).
2) Check that positive collective increases blade pitch.
3) Check that right aileron stick tilts the swash for a right roll.
4) Check that nose-up elevator stick tilts the swash for nose-up.
5) Always takeoff, land and fly at a safe distance from yourself and bystanders.

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15 Using the Self-Leveling / Bailout option

WARNING: Vibration levels must be low for this feature to work. View several flight logs in the playback software before enabling self-leveling to check that the red vibration error message does not appear.

If you use the SK720's self-leveling / bailout option, there are a few things to be aware of:

- Self-leveling works better on helicopters with low vibration levels. Tune your helicopter to eliminate high vibration and mount your SK720 as shown in Section 8 of this manual.
- Watch for vibration warnings where the LED is green but flickers red. Self-leveling will be automatically turned off whenever the SK720 displays this LED warning.
- The maximum speed of recovery to level will only be as high as the maximum control rate for cyclic.
- The self-leveling system is not an auto-hover feature. It doesn't know about wind or location so the helicopter will still drift if left on its own.
- The self-leveling feature will work from any orientation including upside down. The SK720 will **not** automatically adjust the collective, however. You will need to manually adjust the collective during a recovery and the helicopter may loose significant altitude in the process.
- If you fly extended periods of 3D stunts, the unit's sense of "which way is up" may not be perfect. It may help to reduce the use of high collective pitch due to the high vibration it causes (i.e. if you hear the blades barking). Be prepared to switch back to normal mode after the helicopter has mostly recovered.
- If you manually fly the helicopter in one of the two "Always On" self-leveling modes, it will feel like you are flying a coaxial helicopter. You will have to continuously hold elevator and aileron controls to overcome the SK720's desire to self-level the helicopter. Flipping the helicopter upside down may be difficult or impossible, depending on how strong the self-leveling setting is.
- If you manually fly the helicopter in one of the two "Always On" self-leveling modes, avoid high yaw rates (piros) combined with large aileron or elevator control inputs. Doing so may tumble the helicopter due to interaction between pilot control and self-leveling - but if you center the sticks it will recover.

The SK720's self-levelling feature is enabled by choosing a self-levelling mode on the setup software's Cyclic tabs and then moving the adjacent slider to set the self-levelling percentage. (see Figure 15.1, below). This value sets how strongly the helicopter tends to pull itself towards level in elevator and aileron. A higher self-levelling percentage will make your helicopter return to level quicker when the controls are released.

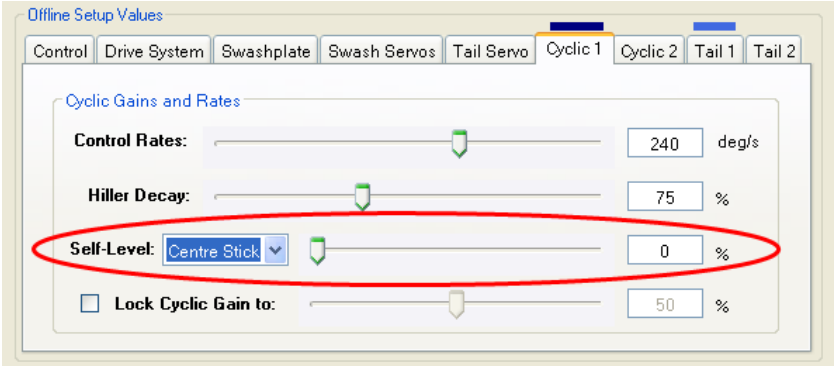

Figure 15.1 – SK720 Setup Software *Cyclic* Tabs (Basic User Interface setting)

The *Centre Stick* self-levelling mode illustrated in Figure 15.1 above is the recommended self-levelling mode for new users of the SK720. The helicopter will fly normally with self-levelling set this way but it will automatically return to level when the cyclic stick is released.

The *Always On* self-levelling mode is the original SK720 self-levelling mode. The helicopter will always try to level itself in this mode, making it feel like a coaxial helicopter. This mode will also make some aerobatics impossible (i.e. stunts involving inverted flight) because the helicopter will "fight" the pilot's control inputs more strongly the further the helicopter is from level.

In the *CS+Inverted* self-levelling mode, the helicopter will level itself to inverted if the cyclic is centred when the helicopter is within 60° of inverted. Your helicopter will return to upright and level if the cyclic is centred while the helicopter is within 120° of right-side-up.

The *On+Inverted* mode will level the helicopter to inverted when within 60° of upside-down. Unlike the *CS+Inverted* mode, the *On+Inverted* mode will not switch off when you move the cyclic stick.

CAUTION: Do not use inverted self-levelling unless you already have some experience with inverted hovering. Also, The On+Inverted mode will make your helicopter seem to "stick" upside-down. You will have to switch to another cyclic bank to recover.

Using Self-Levelling as a Bailout Mode:

If you want to use the SK720's self-levelling feature as a "bail out" mode, choose the *Centre Stick* mode together with a high percentage of self-levelling (i.e. 80%). The helicopter will fly normally with self-leveling set this way but it will automatically return to level when the cyclic stick is released.

You can also use the *Always On* self-levelling mode for bail-out. To do this, set up one Cyclic tab as your primary tab and set up the second cyclic tab as your bailout mode. You will then be able to switch between active Cyclic banks to enable/disable self-levelling.

If you use this method, it is best to copy all of your settings from your primary Cyclic tab to your bail-out Cyclic tab if you intend to set up a bail-out mode. Do this by right-clicking the mouse on your primary cyclic tab to bring up a popup menu. Choose *Copy Cyclic 1 to Cyclic 2* as shown in Figure 15.2 below.

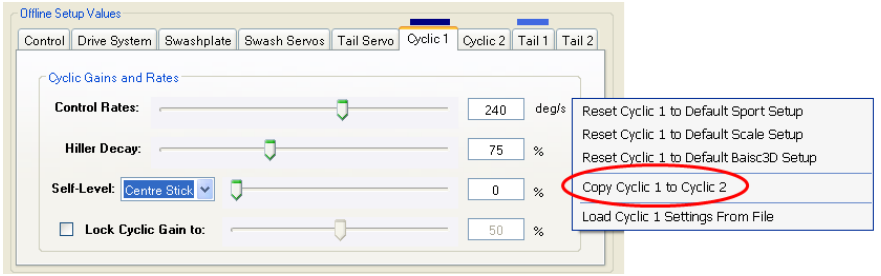

Figure 15.2 – SK720 Setup Software *Cyclic* Tabs with Popup Menu

CAUTION: Ensure that your trims are set the same in both gain banks on your transmitter if one bank is to be used as a bailout mode.

16 Basic Tuning

Definitions:

- **Tail gain** adjusts the holding ability of the gyro in yaw (rudder).
- **Cyclic gain** adjusts the stability and holding ability of the gyro for aileron (roll) / elevator (pitch).

Follow these steps:

1) As a starting point for most helicopters, adjust the gains to about **50% for the Cyclic and 50% for the tail.**

   Note: For very small helicopters, start with 40% for the Cyclic gain, and 30% for the tail 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 Skookum Robotics technical support for help before flying again.**

3) Incrementally adjust the tail gain to the maximum value possible without seeing any oscillation during hover or after sharp stick motions.

4) If the helicopter doesn't hold well in pitch or roll or "slides" to the side, turn the Cyclic gain up a small amount. If the helicopter oscillates while hovering, turn the Cyclic gain down slightly. Repeat until you get the best gain.

5) Try some forward flight. If the helicopter oscillates in roll at high speed, turn the Cyclic gain down a small amount. If it doesn't hold well, turn the Cyclic gain up.

6) Turn on the *Self Tune Bell Gains* option on one or both Cyclic tuning banks[1]. For each of those banks, fly the helicopter as you normally would for at least four flights. Use the SK720 setup software to disable self tuning once the gains stop changing significantly.

[1] *Self-Tune Bell Gains* is always turned on when using the setup software's Basic user interface. Select the *3D Tuning* or *Advanced* interface from the *Preferences* menu if you would like to turn off self-tuning bell gains.

7) After tuning your SK720, use the PC setup software to save a copy of your setup to your computer's hard drive. Save your setup using the *Save Setup* option in the *File* menu.

No further tuning should be required for most users. If the maximum aileron and elevator motion of the helicopter is not fast enough for you however, or for other advanced tuning, see Sections 17 and 19 of this manual.

17 Advanced Tuning for 3D Pilots

Once you have flown a few flights and are familiar with using the setup software, you can do some more advanced tuning to further improve your helicopter's performance during piros and fast collective changes.

1) If you haven't already done so, change your setup software interface to *Advanced* or *3D Tuning*. Do this by selecting one of these two options from the *Preferences* menu.
2) The helicopter's centre of gravity should be directly under the main shaft. Check by putting the blades at right angles to the fuselage and pick the helicopter up with your fingers under the blade-grips. The helicopter should hang with the main shaft straight up and down.
3) Ensure that the swash motion is even throughout its range.
    - Put the SK720 into setup mode and set collective pitch to zero. The swash should be level. Adjust the individual servo centers or the linkages as required.
    - Set the collective pitch to maximum positive. The swash should still be level. If not, adjust the servo travels for one or two of the swash servos on the *Swash Servos* tab in the SK720's setup software. (See Figure 17.1 below)
    - Do the same for max negative pitch, using servo travels for the other direction.

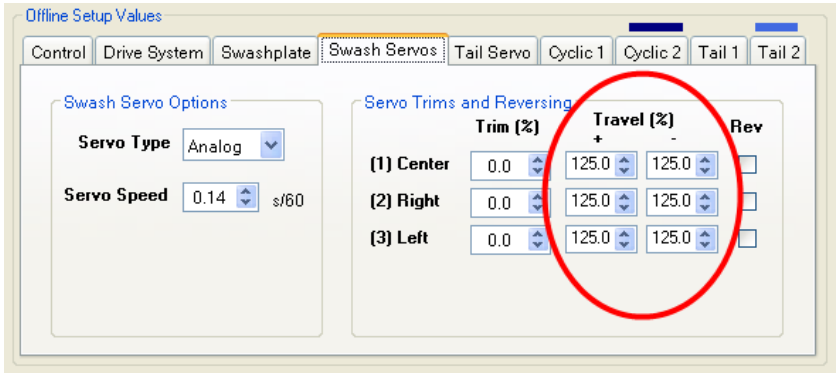

Figure 17.1 – Swash Servo Travel Adjustment Settings

4) Trim the swash for level hover. On a day with light wind, temporarily set the Hiller Decay to 200%, and hover the helicopter hands-off, both nose-out and nose-in. If it consistently drifts to its right, left, forward or back, adjust the mechanical linkages to the swashplate to eliminate the drift. Note that the swash will not be perfectly level as some sideways tilt is necessary to counteract the sideways thrust of the tail rotor.
5) Adjust the *Tail Drag Compensation* on the *Cyclic* gain banks in the PC setup software. There are fields for setting drag compensation in the elevator and aileron axes (see Figure 17.2 below). On a day with light wind, start from a hover and then apply maximum positive collective. If the helicopter's nose goes up, lower the *Tail Drag Comp* number for *Elevator* by 1 or 2 steps. If the nose goes down, increase the *Elevator* value by 1 or 2 steps. If the helicopter banked the right or left, you may also have to adjust tail drag compensation for Aileron. If it banked right, decrease the value.

NOTE 1: Tail Drag Compensation is only a coarse setting; it doe not need to be set precisely.

NOTE 2: The *Tail Gain* and *Cyclic Gain* values are overall gains. The gain settings on the Tail and Cyclic tabs are multiplied by these overall values.

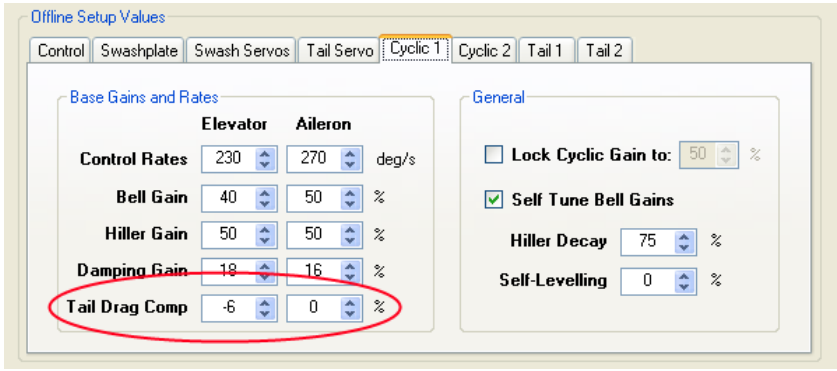

Figure 17.2 – Tail Drag Compensation setting

6) Adjust the collective-torque compensation for the tail. (See Figure 17.3 below.) Start from a hover and then apply maximum positive collective. If the tail goes right, increase the collective to tail mixing for on the *Tail* tab by adjusting the *Collec Mix* field. If it goes left, decrease that value.

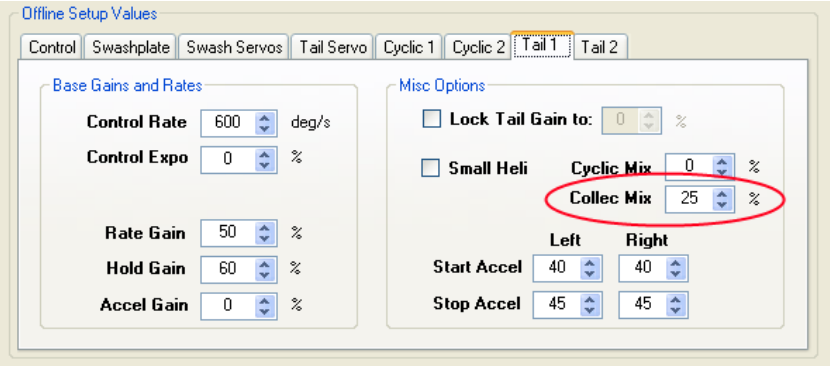

Figure 17.3 – Collective-Torque Compensation setting

7) Turn on the *Self Tune Bell Gains* option on one or both *Cyclic* tuning banks (see Figure 17.2). For each of those banks, fly the helicopter as you normally would for at least four flights. Use the SK720 setup software to disable self-tuning once the gains stop changing very much.

NOTE: Changes to the self-tuned bell gains are stored by the SK720 only after it has been standing still for at least 5 seconds. Let your helicopter stand for at least 5 seconds after the rotor stops turning and the engine has been shut down to allow the SK720 to save any changes to its internal memory.

18 Replaying Flight Recorder Data Logs

The SK720 is unique among flybarless systems in its ability to log large amounts of data about your helicopter in-flight. That in-flight data can be replayed in a 3D viewer or analyzed in a vibration analysis utility. Data logs are created by the SK720 whenever logging is turned on in the setup software. The two available log formats are *Playback* logs and *Vibration* logs.

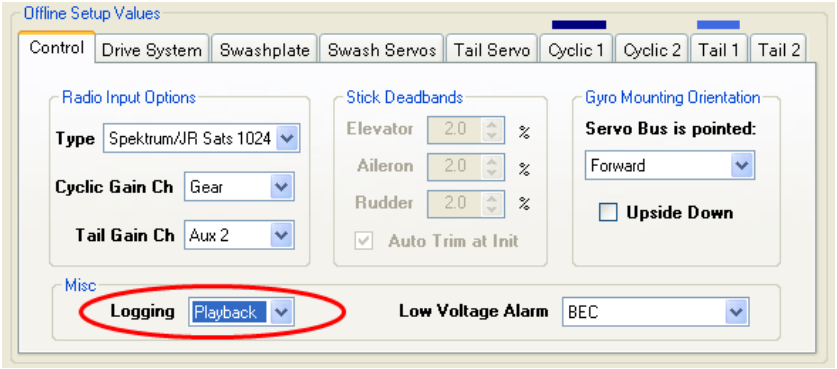

Figure 18.1 – Enabling Logging in the SK720 Setup Software

The 3D viewer mathematically reconstructs your flights from the data in *Playback* logs, allowing you to improve your maneuvers or just show your friends. Flight logs for the 3D viewer are created by the SK720 when the *Playback* option is turned on in the setup software (see Figure 18.1, above). Starting at SK720 firmware version 2.00, playback logs have a .SKL extension. Earlier playback logs have a .BIN extension.

The vibration analysis utility gives you a tool to detect sources of high vibration on your helicopter. Flight logs for the vibration analyser are created by the SK720 when the *Vibration* option is turned on in the setup software. Vibration logs have an .SKV extension

Note: *Vibration* logs cannot be played back in the 3D viewer, and *Playback* logs cannot be analysed in the vibration analyser.

3D Viewer

Start the 3D viewer by selecting *Replay Flight Log* in the *File* menu of the SK720 setup software. You will be shown a dialog box similar to that shown in Figure 18.2 below.

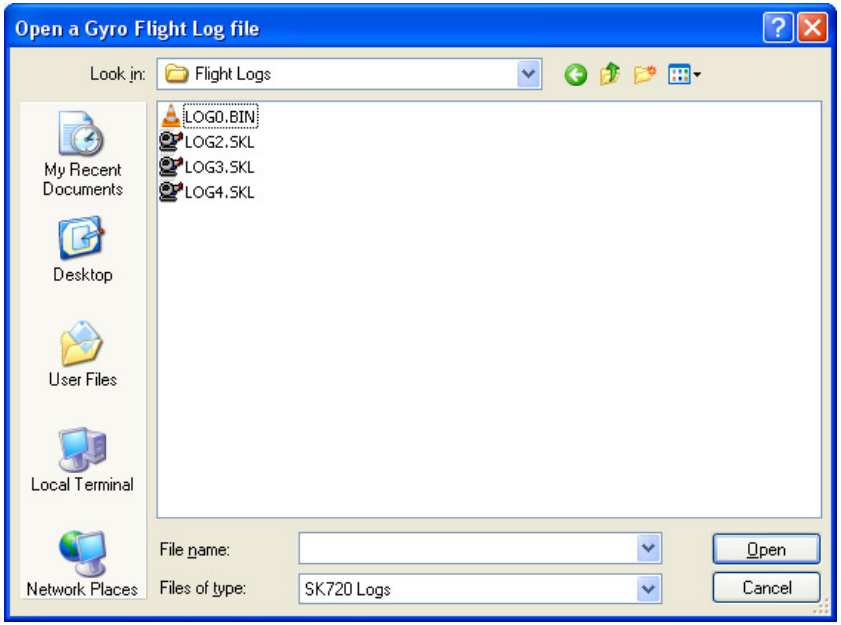

Figure 18.2 – Replay a Flight Log

Navigate to the directory where your flight logs are located and click the Open button. (We recommend that flight logs be copied off your gyro and onto your hard drive before replaying them.) The 3D-viewer window will then open and begin playing back your flight.

Starting with Revision 2.00 of the setup software, you can also play back logs by double clicking directly on the .SKL file name in any Windows Explorer window.

NOTE: Only logs containing actual flight time will be played back.

When the 3D-viewer starts, you will see a window similar to the one shown in Figure 18.3 below. There are four buttons at the bottom of the 3D-viewer window that are used to control playback. In order, they are *Stop*, *Play/Pause, Fast Forward* and *Mute*. The Play button changes into a pause button while playback is in progress. The white and gray progress bar may also be used to control playback. You can jump forward or backwards in the playback sequence by clicking on the progress bar with your mouse.

Figure 18.3 – 3D-Viewer Window

As with the self-leveling feature, accurate playback is dependent on good mechanical setup of your helicopter. High vibration will negatively affect the accuracy of the helicopter's calculated motion, particularly the way in which it is shown to maneuver around the 3D viewer's virtual sky.

In cases of high and extreme vibration, the helicopter will not be shown to fly around the sky at all. Instead, it will be displayed at a fixed location in front of the viewer. Only the rotations (pitch, roll, and yaw) will be modeled in that event.

If your helicopter is experiencing high vibrations in flight, a warning will be displayed on the playback screen in order to assist you in correcting those vibration problems. High vibrations are identified with a yellow warning

message. Extreme vibrations are identified with a red error message. Extreme vibrations also result in the "green with red flicker" LED state on your SK720. (See Section 5 of this manual for more information about indicators and errors on your SK720.)

You can use the Vibration Analyser to trouble-shoot high vibration on your helicopter (see below).

Data Viewer

The Skookum Robotics Data Viewer was installed on your computer by default when you installed Version 2.51 (or later) of the SK720 setup software. If you cannot find the Data Viewer on your computer, download the latest version of the setup software from the Skookum Robotics website and install it.

Start the Skookum Robotics Data Viewer from the Windows Start menu and choose *Open* from the Data Viewer's *File* menu. *Vibration* log files have a .SKV extension as shown in Figure 18.4 below.

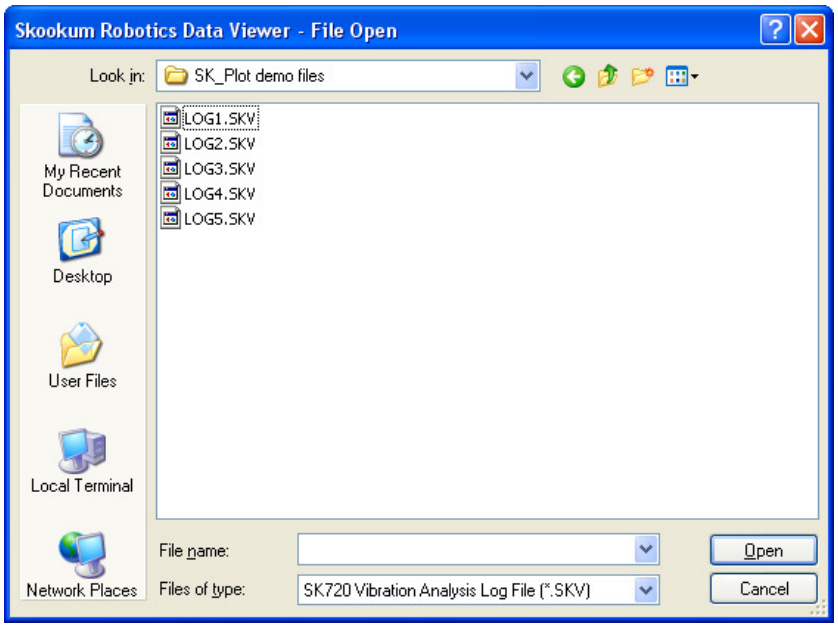

Figure 18.4 – Open a Vibration Log

Alternatively, you can open vibration logs from any Windows Explorer window by double-clicking on the vibration log file name.

The Data Viewer can display accelerometer vibration frequencies in any of three axes: lateral (left-right), up-down and fore-aft. It can also display the overall vibration. The available options can be chosen from the Data Viewer's *Show* menu.

When data logging is set to *Vibration* mode, vibration data is recorded by the SK720 in frames at approximately 1-second intervals throughout your flight. You can select which data frame is displayed in the Data Viewer by using the slider at the bottom of the window. Information about the vibration frequencies and time that the current data frame was recorded is displayed at the bottom of the window.

Hover your mouse cursor over any vibration peaks to see the corresponding frequency and RPM for that peak. In the example below, the highest peak occurs at approximately 16000 rpm. This corresponds to the tail rotor frequency on the test helicopter and suggests that the tail rotor is the source of the highest vibrations.

Please see the Data Viewer's online help webpage (available from the *Help* menu) for more information about how to use this tool to tune your helicopter.

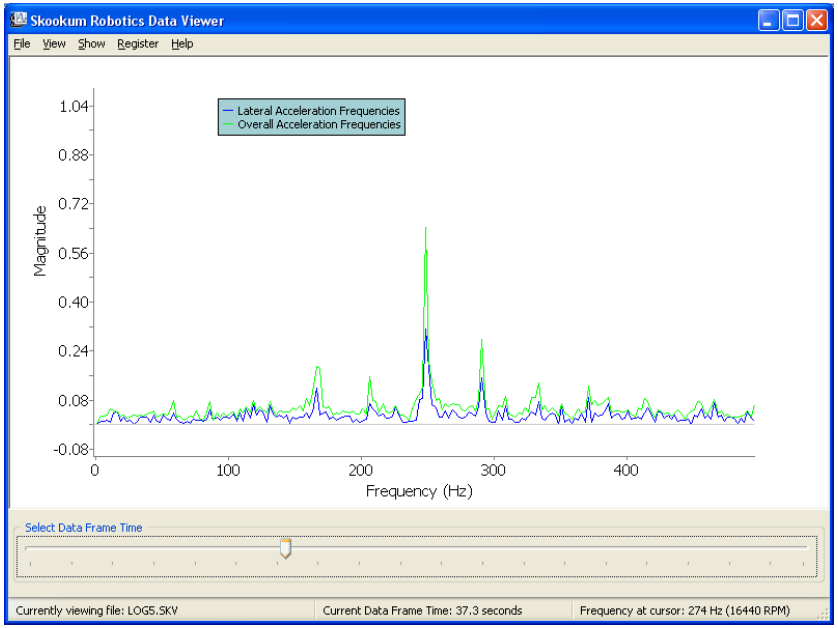

Figure 18.5 – View a Vibration Log

19 Setup Software & Advanced Features Guide

The main window of the setup software is broken down into three areas:

- The menu bar provides access to the program's features and functions.
- *The Live Data* region is updated in real time whenever the gyro is connected to your computer with a USB cable.
- The *Offline Setup Values* tabs display the values for your gyro's current helicopter setup file settings.

NOTE: This section is for reference only. You do not need to read or understand everything that is in it to use your SK720.

Menu Bar

Items in the *File* menu include:

Load Setup: Click this menu item to load a setup from your computer's hard drive. The *Offline Setup Values* tabs will be updated with newly loaded setup. Any setup sent to the gyro will be labeled with the first 16 letters of the configuration file's Windows filename.

Save Setup: Use this menu option to save a setup to your computer's hard disk. This feature is useful if you want to experiment with different settings or backup your current settings to disk.

Reset to Sport Setup: Use this menu item to reset the SK720 settings to the default sport setup.

Reset to Scale Setup: Use this menu item to reset the SK720 settings to the default scale setup.

Reset to Basic 3D Setup: Use this menu item to reset the SK720 settings to the default basic 3D setup.

Upgrade From SK360: Use this menu item to import a stored SK360 configuration file into the SK720 configuration program. The imported SK360 configuration can then be tweaked and loaded onto your new SK720.

Replay Flight Log: Select this item from the File menu to replay your flight logs in the 3D viewer. See Section 16 of this manual for detailed description of how to use the 3D viewer.

Items on the *Utility* menu include:

Bind Sat RX on Power Cycle: use this option to bind any Spektrum/JR satellite receivers that are connected to your SK720. Connect the SK720 to your computer using a USB cable and then select this option. All connected satellite receivers will go into bind mode the next time that the SK720 is power cycled (i.e. turned off and then on again).

Reset Log Counter: When flight logging is enabled (see the Control Tab section below), selecting this option causes the log index number to be reset to zero. Thereafter, log file names will be "LOG0.BIN", "LOG1.BIN", etc.

Reset Gyro: Selecting this item on the *Utility* menu causes the gyro to reset immediately. The unit will disconnect and then reconnect to Windows in the process. Ensure that all open files on the SK720 flash drive are saved and closed before selecting this option. This option is useful when binding satellite receivers because it allows the unit to be reset without having to disconnect it from your computer.

Format MicroSD Card: This option will permanently erase the contents of your SK720 mass storage device. Be sure to back up any important files (such as the SK720 setup software directory) before selecting this option. Note that the format is done by the SK720 itself. Use this option periodically to improve the speed of writes to the SK720's flash drive. The gyro will disconnect and then reconnect to Windows in the process and it may take 30 seconds or more to complete.

Update SK-720 Firmware – SK720 program (firmware) updates will be provided from time to time by Skookum Robotics. Select this option and follow the on screen instructions to update your SK720 with the latest software improvements.

Update SK-LCD Firmware – Choose this option to load the latest software revision (firmware) onto your SK-LCD accessory. The SK-LCD must be connected to your SK720 before starting the update.

Live Data

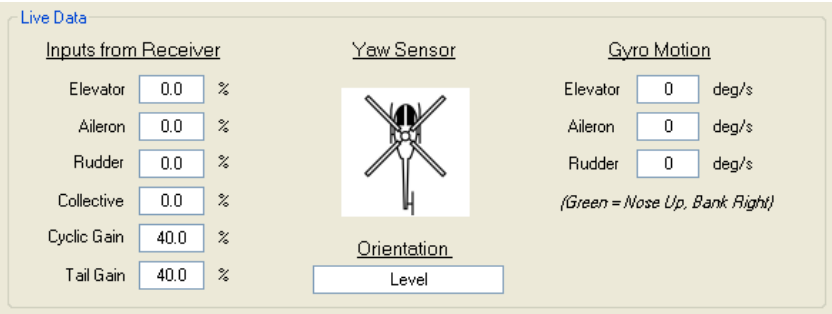

Figure 19.1 – SK720 Setup Software *Live Data* Region

This area displays live telemetry from the gyro, including your radio *Inputs from Receiver* and *Gyro Motion*. Remember that while in setup mode, all elevator, aileron and rudder stick motions are sent directly to the helicopter's servos to allow for easy mechanical setup. See Figure 19.1.

Under *Inputs From Receiver*, the **Pilot Elevator, Aileron, Rudder and Collective command percentage** is given as a guide for setting up your radio. See Section 10, Step 3 for details about how this data is used to help setup your SK720.

Control Tab

The *Control* tab is found in the *Offline Setup Values* region of the main SK720 setup software window, as shown in Figure 19.2 below.

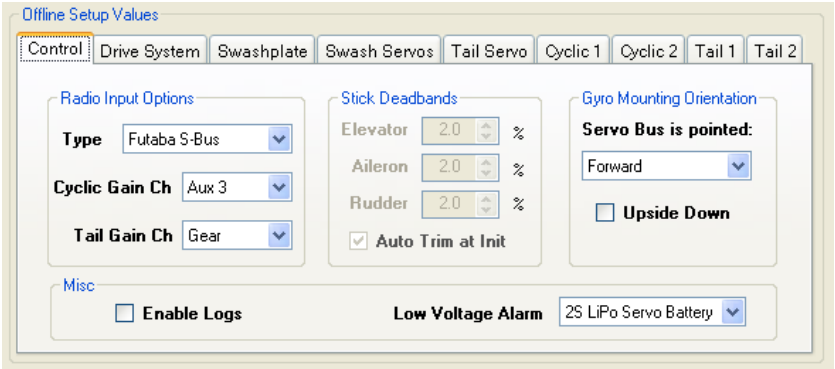

Figure 19.2 – SK720 Setup Software *Control* Tab

Type: When the *Satellite Receivers* option is selected in this field, the SK720 will look for control inputs from the "SAT RX" ports and servo ports IO-A to IO-C will become outputs. Otherwise, ports IO-A to IO-E will be set to receive signals from a traditional radio receiver's outputs.

Auto Trim at Init: With this feature enabled, the gyro will use the aileron, elevator, and rudder stick centers it receives at initialization as neutral cyclic and rudder (as applicable). If disabled, the gyro's inputs will need to be trimmed at the radio for each flight due to drift in the stick's sensors.

Stick Dead Bands: To avoid drift due to small errors in stick centering, a dead-band can be set for the cyclic (elevator and aileron) functions as well as the tail (rudder). 1 to 2 percent is a good value for most radios (note your radio's centering may change with temperature). For scale models, larger dead band can give a solid control feel while in stationary hover. Note that all helicopters should have some dead band on rudder.

Mounting Orientation: These settings can be changed to allow the gyro to be mounted in a variety of orientations in your helicopter. See Section 11, Step 4 for details on how to use these options.

Low Voltage Alarm: Use this box to set the low voltage alarm level. Options are BEC or 2S LiPo servo battery. Low voltage will trigger a "Voltage" error to be recorded and will cause the SK720's LED to blink red.

Drive System Tab

The *Drive System* tab is found in the *Offline Setup Values* region of the main SK720 setup software window, as shown in Figure 19.3 below.

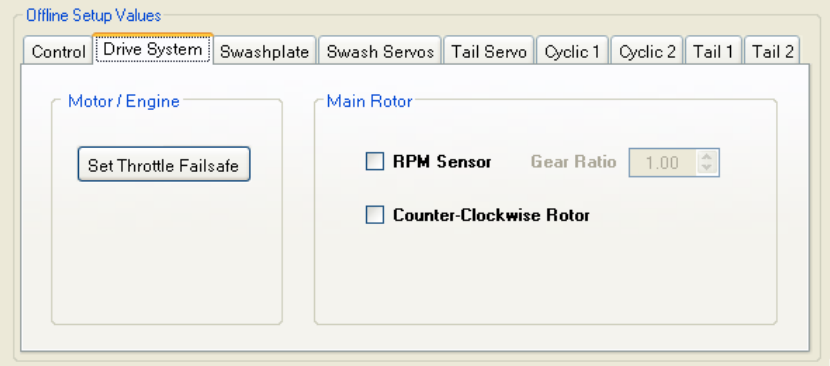

Figure 19.3 – SK720 Setup Software *Drive System* Tab

Set Throttle Failsafe: After setting up your ESC or throttle servo, use this button to tell the SK720 what your throttle channel idle setting is. This sets the fail-safe if you lose the radio link, and helps improve auto-rotations.

RPM Sensor: Click this checkbox to tell your SK720 that an RPM sensor is connected to port IO-C. If selected, the SK720 will record RPM data in the flight logs. The *Gear Ratio* box will be enabled when the RPM sensor is selected on. Enter a value in the *Gear Ratio* box to calibrate your sensor to your main rotor RPM.

Counter-Clockwise Rotor: Click this checkbox to tell your SK720 that your helicopter's main rotor rotates counter-clockwise.

Swashplate Tab

The *Swashplate* tab is found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.4 below.

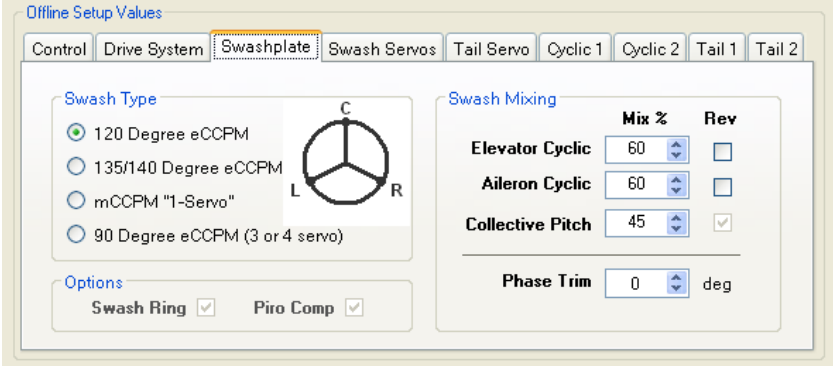

Figure 19.4 – SK720 Setup Software *Swashplate* Tab

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.

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).

Piro Comp: Compensates for the effects of rapid yaw rates on cyclic stability. This is important for 3D stunts and when flying in wind.

Mixing: The inputs to the gyro must be separate channels for elevator, aileron and pitch (collective) control because the SK720 does its own swashplate mixing. This gives the full precision of your radio set rather than losing half of its precision with in-transmitter mixing. It also allows for extra mixing features normally only available on high-end radios such as Swash Ring and Servo Equalizing.

Elevator Cyclic: Percentage of full swashplate motion at full stick deflection for elevator cyclic. You can reverse the elevator servo using the Rev checkbox.

Aileron Cyclic: Percentage of full swashplate motion at full stick deflection for aileron cyclic. You can reverse the aileron servo using the Rev checkbox.

Collective Pitch: Percentage of full swashplate motion at full stick deflection for collective. You can reverse the collective servo using the Rev checkbox.

Phase Trim: Rotates the plane of cyclic action about the main shaft, to allow correction for gyroscopic and aerodynamic effects. It also allows the use of 3 or 4 blade rotor heads. For example, setting phase trim to 90 degrees would make full left aileron stick deflection tilt the swashplate fully forward. Note that the phase angle will vary with rotor rpm and load so a "happy medium" value must be sought when setting this value. See Section 12 of this user's manual for a step-by-step description of how to check the cyclic phasing.

Swash Servos Tab

The *Swash Servos* tab is found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.5 below.

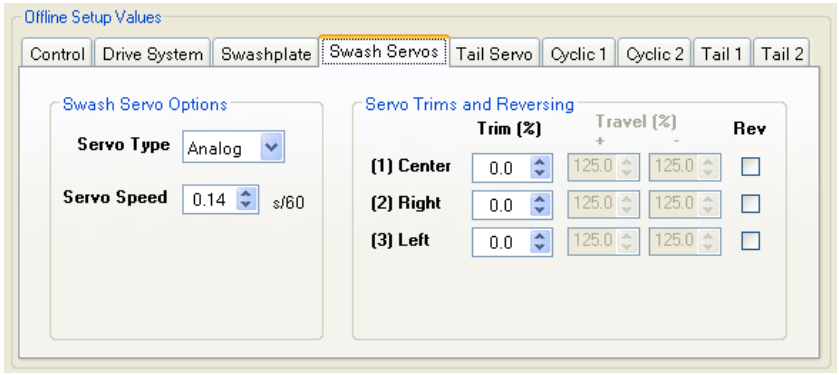

Figure 19.5 – SK720 Setup Software *Swash Servos* Tab

Servo Type: *Digital* uses higher frame rates than analog servos can handle which, along with their better holding power, improves performance. **Do not use digital frame rates for analog servos.**

Servo Speed: Take this value 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: Scales the amount of motion each servo has on either side of centre (endpoints). 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.

Tail Servo Tab

The *Tail Servo* tab is found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.6 below.

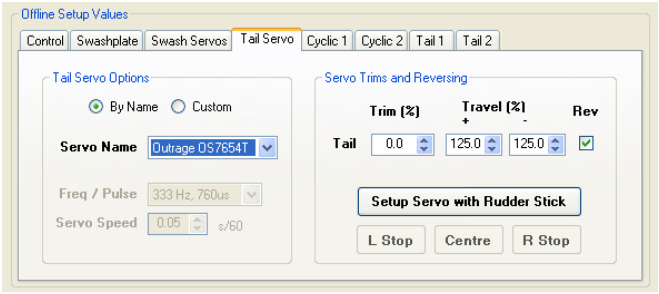

Figure 19.6 – SK720 Setup Software *Tail Servo* Tab

By Name / Custom: The tail servo type can be selected by either model number and manufacturer, or if your servo type is not in the list, by its specifications.

Freq / Pulse: If you have chosen to specify custom servo options, then you can use this field to select the pulse-type and update rate (frequency). Note that the wrong setting could cause the servo to bind and overheat! This field will be greyed out if the *By Name* option is chosen.

Servo Travel: Amount of servo motion on either side of centre (endpoints).

Servo Trims and Reversing: Sets the tail servo's centre point and direction.

Setup Servo with Rudder Stick: This button starts a wizard that allows you to easily set up the tail servo's centre point and travel. Just press the button and follow the prompts.

Cyclic Tab

NOTE: This section explains the Basic User Interface's Cyclic tab. See the Advanced Tuning Options section (Section 19.1) for details on the Advanced Cyclic tab.

The *Cyclic* tab is found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.7 below.

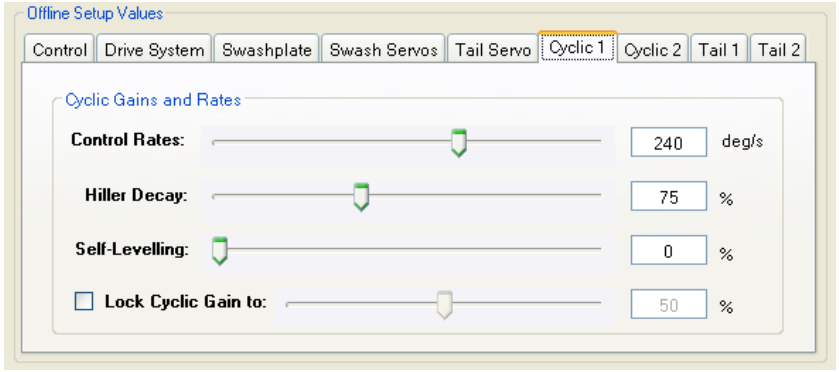

Figure 19.7 – SK720 Setup Software *Cyclic* Tab (Basic User Interface)

Control Rates: The roll or pitch rate of the helicopter at maximum cyclic stick deflection. This setting has a similar effect to changing the area of a flybar's paddles.

Hiller Decay: A value of 100% here can help smooth out rapid tic-tocks, piros or other 3D manoeuvres, 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 helicopter precisely in hover.

A noticeable effect of higher Hiller Decay values is the need for more forward cyclic (down elevator) to keep the helicopter moving in forward flight.

Self-Leveling: Sets how strongly the helicopter tends to pull itself towards level in elevator and aileron. Set the Self-Leveling value to a higher value (i.e. 80%) in one of the two Cyclic tabs to enable a "bail-out" switch. Activate the bailout mode by switching to that bank.

Lock Cyclic Gain: This allows you to lock in the value for overall cyclic gain. The SK720 will then ignore the end point setting in your transmitter and use the value you set here instead.

Tail Tab

NOTE: This section explains the Basic User Interface's Cyclic tab. See the Advanced Tuning Options section (Section 19.1) for details on the Advanced Tail tab.

The *Tail* tab is found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.8 below.

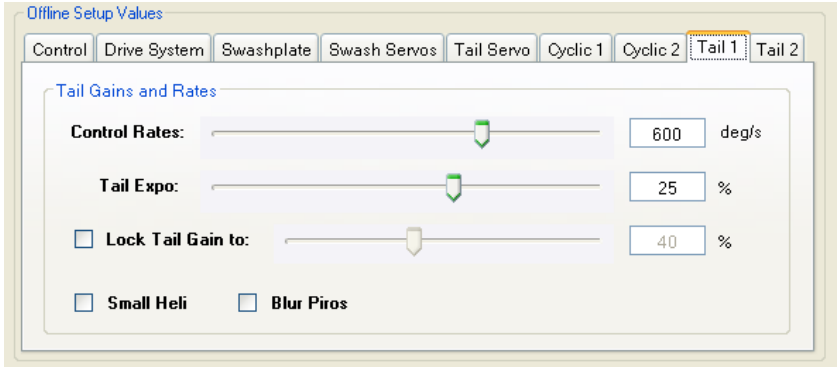

Figure 19.8 – SK720 Setup Software *Tail Servo* Tab

Control Rate: Sets the maximum allowable yaw rate of the helicopter at maximum rudder stick deflection. One rotation per second is 360 degrees per second.

Tail Expo: Positive values make the rudder stick less sensitive near center-stick, negative values make it more sensitive near center.

Lock Tail Gain: This allows you to lock in a value for overall tail gain. The SK720 will then ignore the end point setting in your transmitter and use the value you set here instead.

Small Heli: This option increases the response delay that the system expects the tail servo to have. It is useful for helicopters 450 size and smaller.

Blur Piros: Select this option to make your helicopter jump to a piro rate of 900 degrees per second (very fast) when you hold the rudder stick at full travel (100%).

19.1 Advanced Tuning Options

The helicopter can be tuned in a more detailed way using the advanced user settings of the SK720 setup software. To enable the advanced settings, select the *Advanced* interface from the *Preferences* menu.

Cyclic Tuning Tabs

The two *Cyclic* tabs are found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.9 below. The tab that is currently active is denoted by the blue bar. Switch the active tab using your transmitter's gain/bank channel.

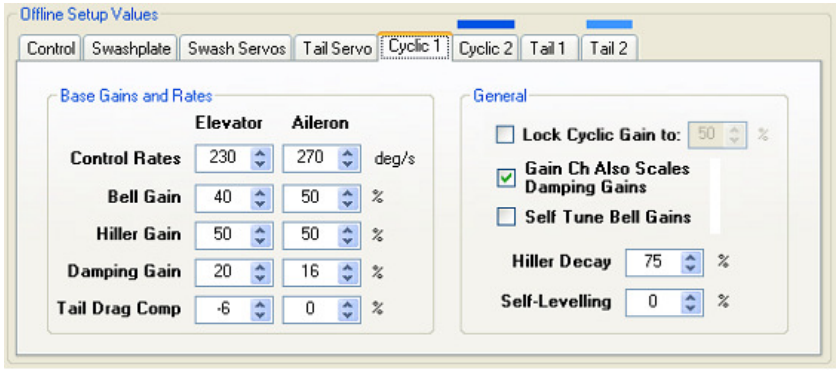

Figure 19.9 – SK720 Setup Software *Cyclic* Tabs

Control Rates: The roll or pitch rate of the helicopter at maximum cyclic stick deflection. This setting has a similar effect to changing the area of a flybar's paddles.

Bell Gain: Amount of motion of the swashplate in response to cyclic stick deflection, normally auto-tuned by the SK720.

To manually adjust the Bell gains: While in a hover, pitch the helicopter sharply nose down, centre the cyclic stick and then do the same nose-up. If the helicopter is slow to respond, turn the Bell gain up a small amount. If the helicopter snaps back a bit and oscillates after it stops, turn the Bell gain down a small amount. Repeat until you get the best balance. For sport flyers, the Bell gain needs to be only roughly correct.

Hiller Gains: This gain's effect is 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 rotor head mechanics, stronger servos and stiff blades allow higher gains here. When hiller gain is too high, the heli will oscillate at 1-2 cycles per second.

Damping Gains: Roll and pitch rate motion damping. Higher gain helps with stability and is equivalent to having heavier rotor blades or a higher head speed. Fast digital servos allow higher gains here. The default gains are best for analog servos but can be set to 20/16 for digital servos. When damping gain is too high, the heli will oscillate quickly.

Tail Drag Compensation: All helicopters have uneven drag on their airframes, especially the tail., use this setting to trim out the effect of tail boom drag for better piros and tick-tocks.

Lock Cyclic Gain: This allows you to lock in the value for overall cyclic gain, which the gyro uses to scale the Hiller and Damping gains. The gyro will then only pay attention to the gain channel for selecting this bank, but it will ignore the % value the channel has.

Cyclic Gain Channel Also Scales Damping Gain: If enabled, then the Cyclic gain channel will also adjust the damping gains by the ratio of the Cyclic Gain input vs. the elevator Hiller gain in the setup.

For example, if Elevator Hiller gain is 50% on a Cyclic gains tab, the Cyclic Gain channel is set to 100% and Damping is set to 20% for elevator on the Cyclic gains tab, then the resulting damping gain would be 100/50*20 = 40%.

This option 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.

Self Tune Bell Gains: If enabled, the SK720 will auto-tune the Bell Gains in flight and save the new values in the setup a few seconds after it lands. To lock in the values once auto tuning is complete, disable this checkbox.

Note: If you have auto-bell tuning on and it sets the bell gain above 85%, then the control rates are higher than your helicopter is capable of.

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

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 helicopter precisely in hover.

Self-Leveling: Sets how strongly the helicopter tends to pull itself towards level in elevator and aileron. Set the Self-Leveling value to a higher value (i.e. 75%) in one of the two Cyclic tabs to enable a "bail-out" switch. Activate the bailout mode by switching to that bank.

Intentionally Left Blank

Tail Tuning Tabs

The two *Tail* tabs are found in the *Offline Setup Values* region of the main SK720 setup software window as shown in Figure 19.10 below. The blue bar marks the tab that is currently active. Switch the active tab using your transmitter.

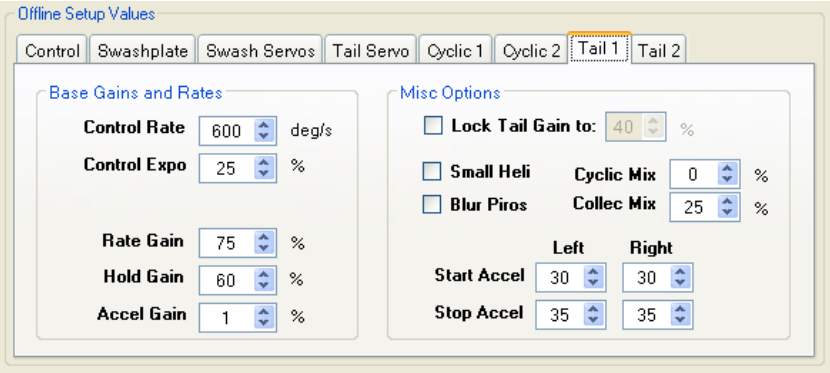

Figure 19.10 – SK720 Setup Software *Tail* Tabs

Control Rate: Sets the maximum allowable yaw rate of the helicopter at maximum rudder stick deflection.

Expo: Positive values make the rudder stick less sensitive near center-stick, negative values make it more sensitive near center.

Rate Gain: The response of the tail blades to the error in rate of motion. This is the tail's primary gain.

Hold Gain: The response of the tail blades to accumulated tail position error. This allows the gyro to trim the tail and compensate for wind. Set this value to 0% for rate mode. Set this value to about 60% for heading hold.

Accel Gain: Response to acceleration error of the tail. Gives a sharper response but is normally set low or to zero. Sometimes helpful on smaller helis that feel "loose" near center. This gain can be hard on the tail servo, especially if there is a lot of vibration.

Small Heli: This option increases the response delay that the system expects the tail servo to have. It is useful for helicopters 450 size and smaller.

Blur Piros: This option makes it so a 100% input on the rudder stick will make the heli jump to a piro rate of 900 degrees per second (very fast).

Start Accel: The maximum rate of starting acceleration of the tail, left or right. If the value is too low, the helicopter will seem sluggish in yaw. If it's too high, it will tend to bounce even at low gains.

Stop Accel: The maximum rate of stopping acceleration of the tail. Normally a little bit higher than the start acceleration.

Cyclic to Tail: Feeds in tail pitch to directly compensate for torque changes due to changes in blade pitch due to cyclic (aileron and elevator). Normally 0% to 15%. Increase this value if the helicopter's tail twitches to the right during flips.

Collec to Tail: Feeds in tail pitch to directly compensate for torque changes due to changes in collective pitch. Normally 15% to 30%. Increase this value if the helicopter's tail twitches to the right during climb outs.

Tail "Rate Mode" and "Heading Hold": Set the hold gain to 0% for rate mode. Set the hold gain to about 60% for heading hold mode.

20 Trouble Shooting Guide

Symptom	Problem & Solution
The SK720 stays in initialization mode (LED stays red, won't go green).	The heli must be stationary and not vibrating for the unit to initialize. This symptom can also be caused by large amounts of electrical noise.
Helicopter tends to drift (feel loose) in elevator and/or aileron.	Hiller gain is too low.
Hiller gain isn't high enough, even at 100%.	Increase cyclic blade-pitch range
After a sharp elevator or aileron command is released, the helicopter oscillates slowly.	Hiller gain is too high.
While in high-speed forward flight, the helicopter pitches up or down momentarily.	Elevator damping gain is too low.
Helicopter 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 aileron.	Aileron damping gain is too low (Warning: too-high damping gain is hard on servos), or Hiller is too high.
Helicopter hesitates in elevator and aileron, 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 an elevator or aileron change the rotor disk springs-back after the stick is released.	Bell gain is too high relative to Control Rates.
Responds too sharply to aileron or elevator.	Bell gain is too high.

Symptom	Problem & Solution
Random jitter or jumps in roll and pitch, or tilts at one particular rpm.	Vibration effects on the gyro. Make sure it is mounted on good damping tape and doesn't contact the frame. Also check for tail rotor vibration.
Can not set Hiller very high without causing oscillation, especially with high head speeds.	Lack of servo speed and/or precision. 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 by a proportional amount.
Aileron or Elevator give roll and pitch rates that are too fast.	Decrease Control Rate gains, and then decrease the Bell gains.
Cyclic feels mushy in the centre.	Reduce control dead-band.
Not perfectly locked in hover.	Try higher control dead-band.
Helicopter 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.
Helicopter 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.
Helicopter "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, equalize swash servo throws, and check tail drag compensation.
During piros with collective pitch changes, or piros during forward flight, the helicopter wanders.	Servos are not fast enough, or heli needs to be better tuned for 3D. See section 17.

Symptom	Problem & Solution
Helicopter 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 SK720 gyro is mounted correctly. Also check rotor head phasing.
SK720 initializes properly but there are violent twitches in hover, in aileron/elevator or rudder (yaw).	Electrostatic buildup on the tail belt drive. Ground the tail boom to the frame, and use a silicon-based lube on the tail belt.
In self-leveling mode, the heli tends to wander.	The vibration level of your heli may be too high. Improve the main and tail rotor's balance, and/or move the SK720 closer to the heli's C of G.
Heli yaws wildly in one direction.	Check that the sense direction for the rudder (yaw) is correct, and that the tail servo moves in the right direction.
Tail oscillates even when the gain is low.	Friction and/or slop in the tail linkage.
Tail twitches a bit in hover and/or gain can't be set very high without wag.	Too much vibration is getting into the unit. Make sure its case isn't contacting the heli's frame, and the wires leading to it are a bit loose. For larger helicopters, you may want to use a separate power bus to allow lighter wires leading to the unit.
Tail gain can't be set high enough without oscillation (wag)	Check if the tail boom is stiffly braced, and that the full range of tail blade pitch uses most of the servo's motion. Faster/stronger servos may help.
Tail doesn't hold very well in wind or backwards flight.	Set the tail Hold gain higher.
Helicopter slowly yaws in hover.	Make sure that "auto trim at init" is turned on, and/or increase the deadband value for rudder.
Piro starts/stops in one direction are good, but the other direction bounces.	Set the start/stop acceleration values for the tail to be lower for the direction that bounces.

Appendix A: Specifications

Dimensions	39x30x14mm
Weight (without cables)	17 grams
Operating Temperature Range	-10c to +45c
Operating Voltage	3.6 to 10 VDC
Power Consumption	75 mA
PWM Input Signals	6 Channels (900-2100 us)
Servo Output Signals	8 Channels (760, 960 or 1520 signals)
Servo Options	Analog or Digital
Setup	USB interface, or SK-LCD Terminal
Field Gain Setting	Gain channel inputs

Appendix B: Firmware Upgrades

1) Make sure you have the most up to date version of the setup software installed. You can find it on our website, at: **www.skookumrobotics.com**
2) Connect your unit to the setup software, and save up your current setup file to your computer as a precaution.
3) Disconnect any external power supply from the SK-720.
4) Check that you have a good connection to the internet.
5) Go to the menu bar in the setup software and select Utility->Update SK-720 Firmware. The setup software will then download the new firmware directly to your unit, and begin updating it.

WARNING: Do not disturb the SK720 while the firmware is updating. The firmware update process may fail if you do, thereby making the unit into a paperweight. Your SK720 would then need to be returned to Skookum Robotics for servicing.

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 SK720 OR OTHER PRODUCTS.

Skookum Robotics will provide customers with technical assistance by email free of charge. If a gyro's serviceability is in question following 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.

Manufactured in Canada by Skookum Robotics, Ltd

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