



# **SK-GPS**

## **Instruction Manual**

Rev. 1.10 – August 1, 2014



# SK-GPS Connection and Setup Guide



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## 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 the *Warranty and Technical Support* section 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.



## Box Contents

The SK-GPS includes:

- The SK-GPS unit
- Anti-vibration kit for the SK-720
- Tri-color super-bright External LED
- Two 4-pin connecting cables
- Mounting tape for the SK-GPS

Figure 1 - The SK-GPS Module, LED and connecting cables





## Getting Started

The SK-GPS uses the same setup software as the SK-720. However, you will need to upgrade the setup software and SK-720 firmware to the latest versions (3.30 software, 3.30 firmware as of Feb, 2013) in order to set up and use the GPS module.

### ***SK-GPS Internal Blue LED States***

There are five (5) LED indicator states for the SK-GPS. These states are shown in the table below:

Figure 2 - SK-GPS LED Patterns

LED State	Mode
Solid	Good satellite lock
Slow Flash	Searching for satellite lock
Fast Flash	Error
Short Single Blinks	Compass swing mode, Yaw
Short Double Blinks	Compass swing mode, Nose Up

A demonstration of the different LED states can be found on our Youtube channel (<http://www.youtube.com/user/SkookumRobotics>)

### ***Swash Bump at Init***

Normally, when the SK-720 finishes initializing it will “bump” the swashplate up and down to show it’s ready to fly. If the SK-GPS is connected, the swash bump will not happen until the SK-GPS also has a satellite lock.

If your heli is a multicopter, the SK-720 will instead give two very short pulses of all the motors.



## Mounting the SK-GPS

The SK-GPS can be mounted in four different configurations. In all configurations the module's antenna (the black dome) must point upwards in order to receive a good signal. It should also have a clear view of as much of the sky as possible, without carbon fibre or metal covering it or directly beside it. Plastic or thin fibreglass canopies are normally ok.

The GPS module must also be mounted 90° to the helicopter's frame, - aligned with the main shaft, with its back parallel to the tail boom. As a result, the SK-GPS can be mounted *label-left*, *label-right*, *label-front*, and *label-aft*. The diagram below displays an example of each mounting position on both a single rotor helicopter.

If you mount your GPS module on your heli's tail boom, make sure to position it no more than half way to the tail assembly. If you mount the GPS module away from the helicopter's centre of gravity, be sure to change the *Offset* setting in the software. An explanation of the *Offset* setting can be found in the *Configuring the SK-GPS* section.

Figure 3 - SK-GPS Mounting Positions

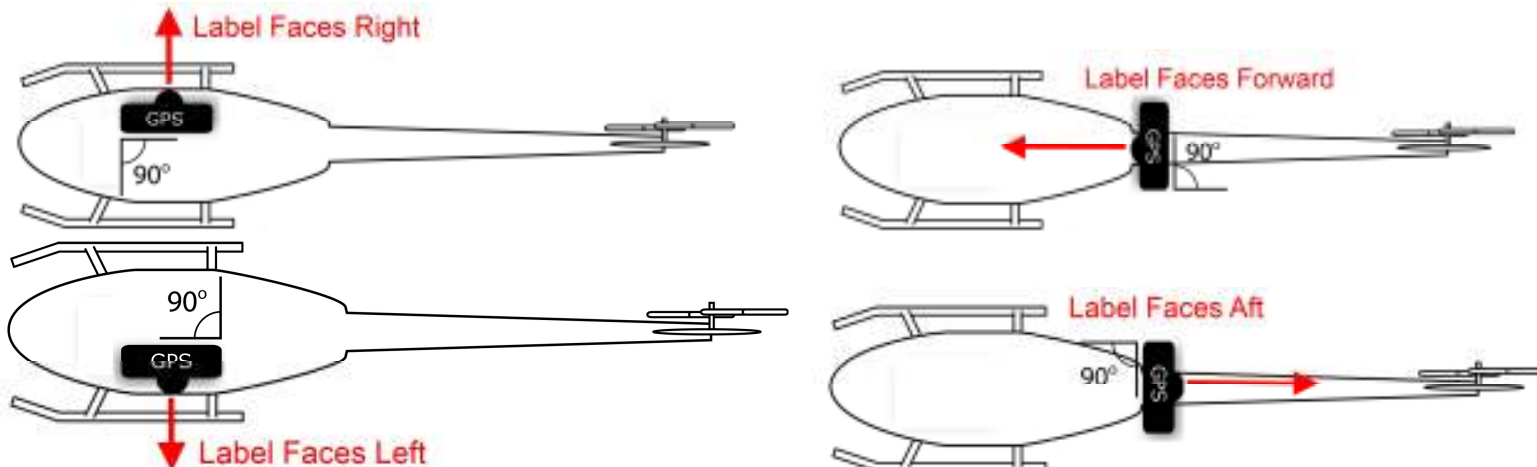
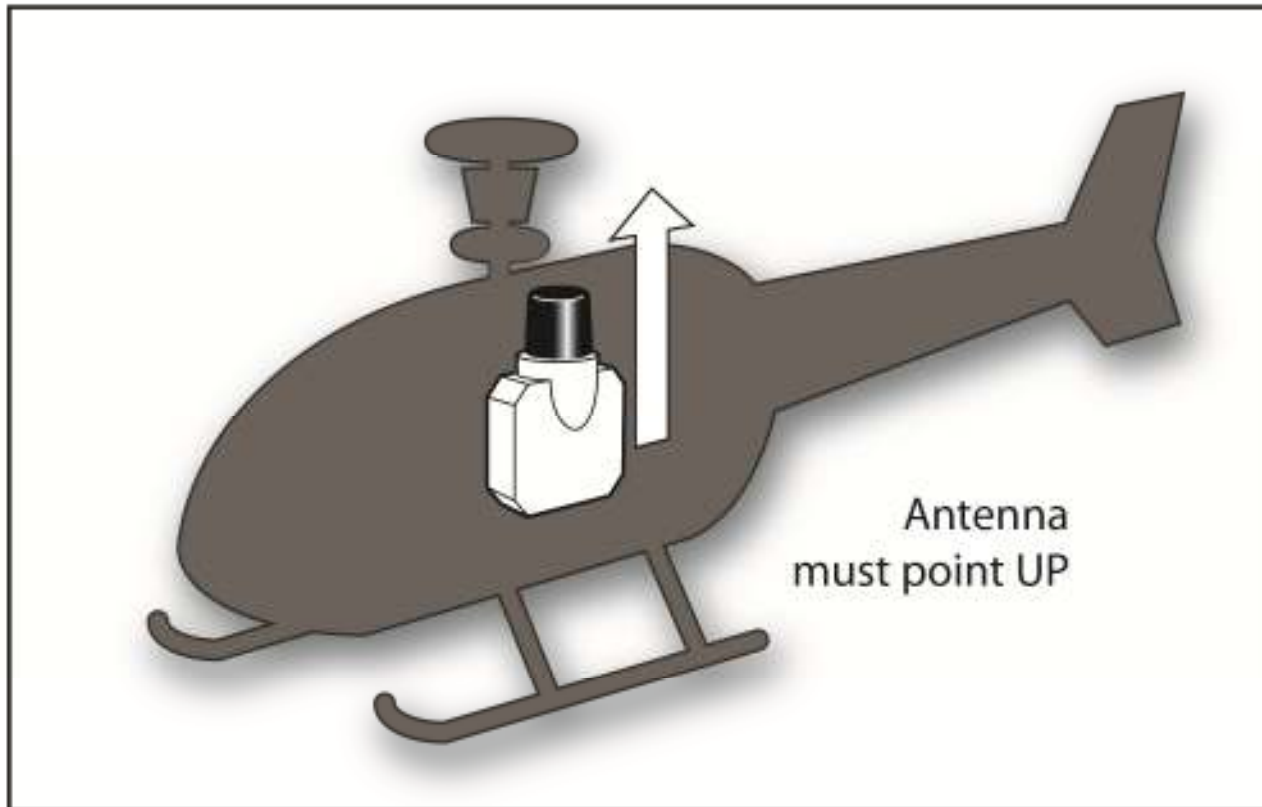




Figure 4 - Antenna Configuration





The 3-axis magnetic compass built into the SK-GPS is sensitive to some of the magnetic components on helicopters. Specifically, the SK-GPS should be mounted at least:

- 10cm (4") from ESCs
- 15cm (6") from motors
- 5cm (2") from servos

The cable for the GPS should also be at least 3cm (1") from motor or battery wires, and should be at least 1cm (0.5") from servo wiring. It is OK for the GPS wire to cross servo wiring at 90 degrees.

When mounting the GPS unit, it may help to watch the Magnetic Field Strength display on the GPS form in the setup software. Aim for a mounting location with a field strength under 2. Note that often bolts can be strongly magnetized, so replacing them with stainless steel bolts may help.



The location of the GPS unit's magnetic sensor is shown in the image on the left, on the upper right corner of the unit. The sensor itself is on the underside of the circuit board.

The metal ring included with the GPS cable is a ferrite bead, not a magnet. This ring reduces high-frequency electronic noise. Other tips for reducing EMF and electronic noise include:

- If cables have to cross, they should cross at 90°
- Don't run ESC or main battery wires near servo cables, the SK-GPS, or its cable
- Don't run any other wire in parallel with the GPS cable
- Avoid mounting near magnets or bolts (any steel bolt can be considered a magnet)





## Connecting the SK-GPS

The SK-GPS module connects to the SK-720s GPS port using the included 4-pin cable. The second port on the SK-GPS module is used for future Skookum accessories.

Figure 5 - Connecting the SK-GPS to the SK-720

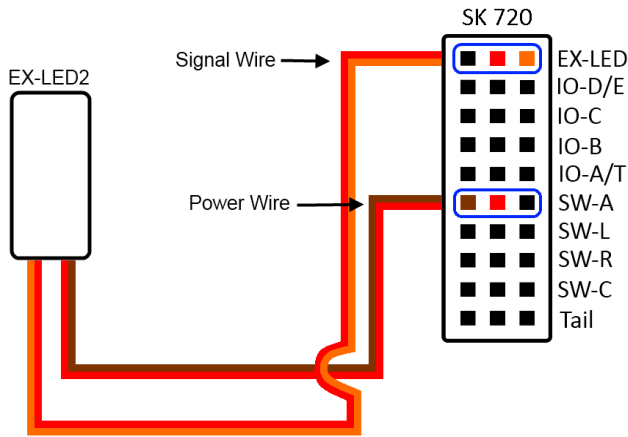




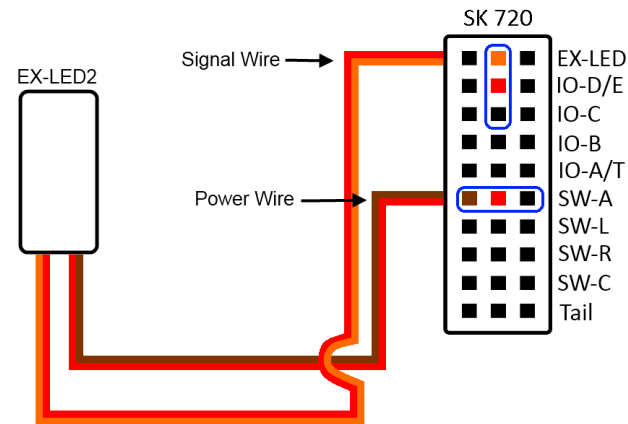
## Connecting the Superbright EX-LED

The SK-GPS comes with a super-bright tricolor version of the SK-EX LED (Red / Green / Blue). It has one 3-wire jumper that connects to the SK-720's EX-LED port, and a standard power cable that can be connected to any 5 to 8 volt source.

Figure 6 – Connecting the SK-LED2



All except blue SK-720's with a "Traditional Receiver"



Only blue SK-720's with a "Traditional Receiver"

Figure 7 – SK-LED2 Patterns

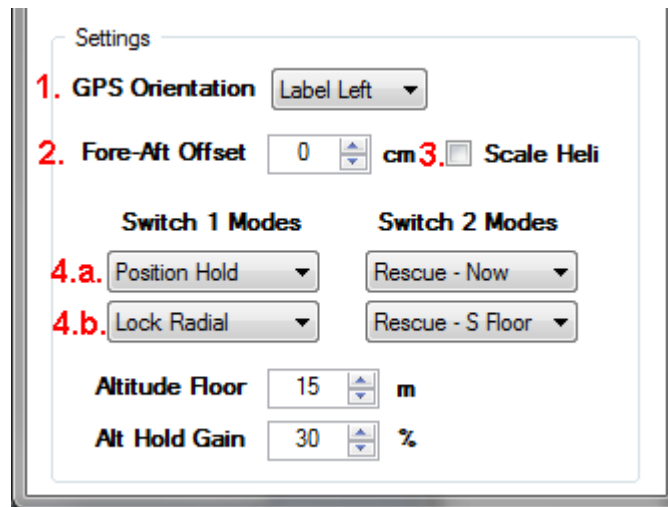
LED State	Mode
Solid Red	Initializing
Solid Green	Ready for normal flight (GPS not available)
Solid Blue	Ready for GPS assisted flight
Flashing Blue / Green	GPS has primary control of Heli
Green with Red flicker	Vibration Alarm

**WARNING:** DO NOT look directly at the Tricolor EX-LED. It is extremely bright and only intended for use while flying the heli.



## Configuring the SK-GPS Using the PC Interface

The interface used for setting up the GPS module is launched from the *Utility* menu of the setup software, under *Setup GPS*. The upper half of the GPS interface displays the live data from the GPS. This data can be used for general reference, and to double check position and compass data when desired. The lower half of the interface sets the orientation and functions of the GPS module.



### 1. GPS Orientation

The direction the GPS unit's label faces. Details regarding mounting the SK-GPS can be found on page 4.

### 2. Fore-Aft Offset

This is the distance of your GPS module from the helicopters centre of gravity (COG). On a single rotor heli, the COG will be the main rotor shaft. On a multirotor heli, the COG will be the balance point. **If the GPS is behind the main rotor shaft, this should be negative.**

### 3. Scale Heli

Click this box if you have a single rotor helicopter that hovers at or around mid-stick on the collective.

### 4.a. GPS Control Switch 1 Position 1 Mode

This box selects the GPS function for the *middle* switch position (for 3-position switches) on the Tx channel that you selected GPS switch 2 in the "Control" tab on the main setup software window. This switch mode is not supported on 2-position switches.

### 4.b. GPS Control Switch 1 Position 2 Mode

This box selects the GPS function for the *lower/down* switch position (for 2 and 3-position switches) on the Tx channel that you selected in the "Control" tab on the main setup software window.

**Note:** The *top/up* switch position on all GPS control switches is "Manual" or "Off" mode. No GPS functions are enabled when the switch is in the *top/up* position. Reverse the channel in your transmitter if you prefer the *lower/down* position to be off.



Settings

GPS Orientation Label Left ▾

Fore-Aft Offset 0 cm  Scale Heli

<p>Switch 1 Modes</p> <p><span>Position Hold</span> ▾</p> <p><span>Lock Radial</span> ▾</p>	<p>Switch 2 Modes</p> <p><span>Rescue - Now</span> ▾ <b>5.a.</b></p> <p><span>Rescue - S Floor</span> ▾ <b>5.b.</b></p>
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**6.** Altitude Floor 15 m

**7.** Alt Hold Gain 30 %

**5.a. GPS Control Switch 2 Position 1 Mode**

This box selects the GPS function for the *middle* switch position (for 3-position switches) on the Tx channel that you selected for GPS switch 2 in the “Control” tab on the main setup software window. This switch mode is not supported on 2-position switches.

**5.b. GPS Control Switch 2 Position 2 Mode**

This box selects the GPS function for the *lower/down* switch position (for 2 and 3-position switches) on the Tx channel that you selected in the “Control” tab on the main setup software window.

**Note:** The *top/up* switch position on all GPS control switches is “Manual” or “Off” mode. No GPS functions are enabled when the switch is in the top/up position. Reverse the channel in your transmitter if you prefer the *lower/down* position to be the off position.

**6. Altitude Floor**

The altitude floor sets the level where the SK-GPS will bail the heli out. The lowest setting for the altitude floor is 8m (25 ft), however we recommend setting it to at least 10m (30ft).

**7. Alt Hold Gain**

Altitude Hold Gain is similar to the Cyclic and Tail gain you set in your SK-720. While the cyclic and tail gains set how hard the SK-720 will try to control your heli in aileron, elevator and rudder, the Altitude Hold Gains set how hard the SK-GPS tries to control the collective.

Set the altitude Hold Gain the same way as you would the Tail or Cyclic. Increase the gain until the heli oscillates, then back the gain down until the oscillation stops. Cyclic and Tail gains for GPS control do not need to be adjusted for different helis.



## ***GPS Responses (Functions)***

The SK-GPS has nine available flight modes. Any two of the modes can be set to a three position switch on the transmitter. One position on the switch will always set the GPS to “manual” control to give full control back to the pilot. *We strongly suggest that your first flight test with the GPS system should be with Position or Altitude hold modes.*

If you have two channels available, you can use two GPS control switches, allowing four active GPS-aided modes. Note that switch 1 will always be dominant over switch 2. So if you select a GPS mode on switch 1, switch 2 will be ignored.

### **Home Positions Note:**

Each GPS switch can also have its own “home” position and direction, which is used for the Go-Home, Grid, Radial, and Point modes. Both home positions and directions are initially set the first time throttle is raised.

You can re-set the home position of a GPS control switch by toggling the switch from “manual” to position 1, then back to manual, 5 times quickly. The system will tell you that switch’s home position has been re-set by slowly flashing blue on the superbright LED.

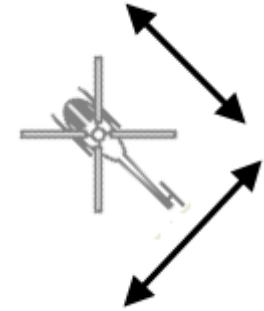
### **Altitude Control Note:**

The collective stick position controls altitude in all GPS control modes except for go-home or rescue modes. So it must be set to “zero climb” when you enable the GPS control mode. Otherwise, the altitude will slew down or up depending on the transmitter stick position. The system will hold altitude for up to 2 seconds before it responds to the stick position.

If you are flying a multicopter, or have selected “Scale Heli” on the GPS setup form, “zero climb” is at center stick, so be sure that the collective is centred while in any GPS control mode (except go-home or rescue). For other helis, the hold-altitude position is at about +1/3 positive stick (near the normal hover stick position for a 3D heli).

### **Aileron/Elevator Control Note:**

While in most GPS control modes, you can slew the heli around using the cyclic stick (aileron/elevator). There is a deadband near the center, so small stick movements will not change the set position. Do not make large stick movements, because 50% stick travel will give full speed, and more will be ignored. This is to prevent upsets if the GPS system loses its position fix and drops to manual mode.



### **Position Hold**

Setting the GPS to *Position Hold* will cause the SK720 to automatically hover the helicopter at one position. While in this mode, control inputs from the transmitter are interpreted as “slew” commands. Up/down collective slews the helicopter position up and down while the cyclic slews the helicopter’s position set point in the direction of the cyclic control input, as illustrated at right. Yaw (rudder) control will still work normally while in position hold.

### **Altitude Hold Only**

Setting the GPS to *Altitude Hold Only* will take collective control away from the pilot. Up/down collective commands from the transmitter will slew the altitude set point up and down. Cyclic and tail control will work normally.

### **Rescue Modes**

The SK-GPS has three different rescue modes. All will stop the heli’s motion, level it out, and orient it tail-in (tail towards you). The difference between the three modes lies in when the SK-GPS bails the heli out. Once the heli is stopped level and above the altitude floor it will go back in position hold mode until you reset by going back to manual mode. The tail-in direction is set when the SK-GPS first gets its satellite lock.

#### **Rescue Now**

This version of the SK-GPS’ rescue functions allows you to fly normally until you flip the switch to trigger rescue mode.

#### **Rescue Hard Floor**

This version of the SK-GPS’ rescue functions allows you to fly normally until you go below the set minimum altitude. Once the minimum altitude is reached, the SK-GPS will stop the heli’s descent and go into rescue mode (described on the page above).

#### **Rescue Soft Floor**

The ‘soft-floor’ rescue bails your heli out **at or before** it reaches the set minimum altitude. In this mode, the SK-GPS will calculate how much distance is needed to stop in time, and will activate rescue mode if it thinks it is running out of room to recover before going below the floor. This allows you to set the rescue floor lower, however it gives less control to the pilot.

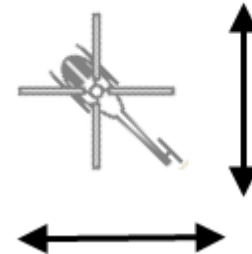


### Lock Grid

Setting the GPS to *Lock Grid* will cause the SK720 to automatically hover the helicopter at one position. While in this mode, control inputs from the transmitter are interpreted as “slew” commands. Up/down collective slews the helicopter position up and down, and cyclic slews the helicopter’s position in the direction of the cyclic control input, as illustrated at right.

This mode differs from normal position hold mode in that cyclic commands slew the helicopter’s position the same direction, no matter which direction the nose is pointed. So for example if you first throttled up with the nose pointed away from you, then left cyclic moves the helicopter to your left, regardless of which way the nose is pointing.

In "Grid Lock" mode, aileron is left/right vs the home nose direction. Elev is towards/away.

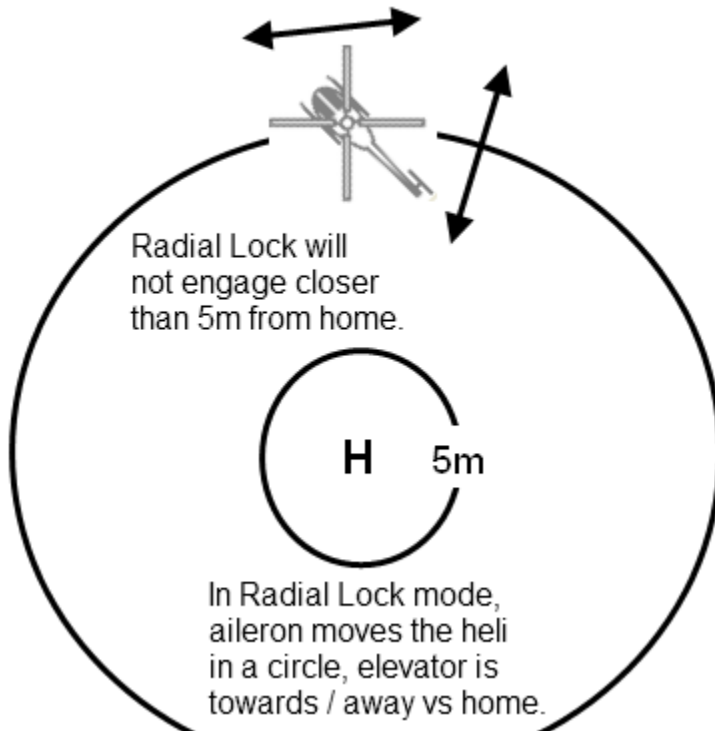




**Lock Radial**

Setting the GPS to *Lock Radial* will cause the SK720 to automatically hover the helicopter at one position. While in this mode, control inputs from the transmitter are interpreted as “slew” commands. Up/down collective slews the helicopter position up and down while the cyclic slews the helicopter’s position set point in the direction of the cyclic control input, as illustrated below.

This mode differs from normal position hold mode in that left/right cyclic commands slew the helicopter’s position in a circle about the home position and fore/aft cyclic slews the helicopter’s position away or towards the home position. Similar to the “Lock grid” mode, the helicopter slews the same direction, no matter which way the nose is pointed.



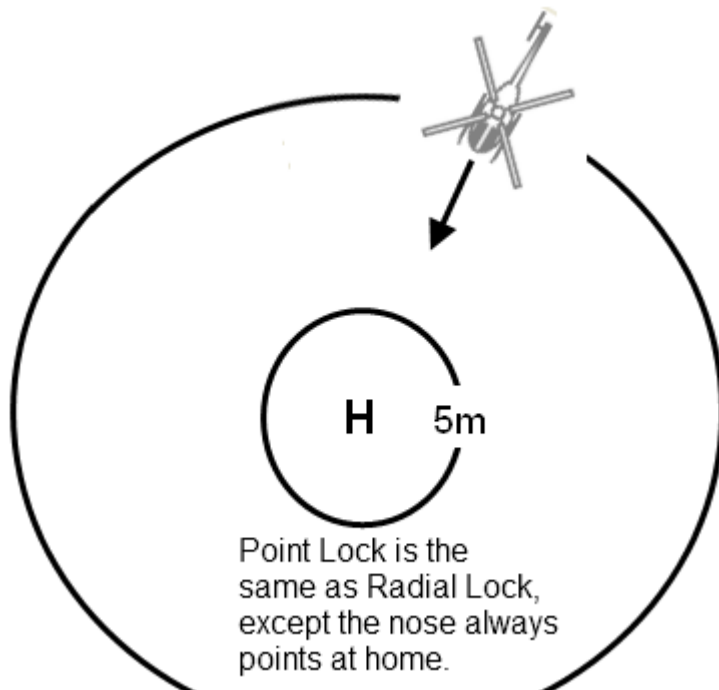




### Lock Point

Setting the GPS to *Lock Point* will cause the SK720 to automatically hover the helicopter at one position. While in this mode, control inputs from the transmitter are interpreted as “slew” commands. Up/down collective slews the helicopter position up and down while the cyclic slews the helicopter’s position set point in the direction of the cyclic control input, as illustrated below.

This mode differs from normal position hold mode in that left/right cyclic commands slew the helicopter’s position in a circle about the home position and fore/aft cyclic slews the helicopter’s away or towards the home position. While in this mode, the SK720 controls the helicopter’s heading so that it always points nose-in towards the home position





### Return Home

When home is set, the  
nose direction is saved



Home is set when the throttle  
is first increased, or when you  
toggle a GPS switch 5 times.

Selecting the GPS to *Return Home* mode will take all control away from the pilot. The helicopter will climb in altitude, fly the heli back to a predetermined 'home' position then descend to the 'fail-safe' altitude. It will then orient the heli tail-in and hover above the home position. Due to safety concerns, the SK-GPS will not land a heli automatically.

The home location must be set before *Return Home* mode will work. The home position is set when the throttle is first increased after the GPS external LED turns solid blue. The home position can be reset to a new position (one position for each GPS mode switch) after the initial home position has been set. Do this by quickly toggling a GPS mode switch on and off five times.

**NOTE 1:** Please make sure your home position is a safe distance from other pilots or spectators. Stored home positions are not saved between flights. The home position location is deleted when the power is turned off.

**NOTE 2:** As of firmware release 4.0, fail-safe return-home after receiver signal loss will only work for multicopters.



## Calibrating (Swinging) the Compass



Swinging the SK-GPS' 3-axis magnetic compass allows the SK-GPS to learn the local magnetic field distortion caused by your helicopter. You do not have to swing the compass every time you fly the SK-GPS. You do need to swing the compass when you:

- Have moved the GPS module to a different helicopter
- Have mounted the GPS module on a different location on your helicopter
- Are using the GPS with a different SK-720
- Have changed any major equipment on your helicopter, such as servos, ESCs or motors.

To swing the compass, the heli needs to be rotated in yaw (rudder axis) and then pitch (elevator axis). This should be done outdoors, at least 10m away from power lines, cars, or large metal objects or concrete pads that may contain rebar. You should also remove your wristwatch and any keys from your pockets (think airport security). The swing is completed in 7 steps:



1. In the *Utility* menu, select *Swing SK-GPS Compass*.
2. Power the SK-720 and GPS. You can do this with your main flight pack, but be sure to disconnect motor wires for safety. We recommend, especially with multirotors, powering the SK-720 and GPS with a BEC. Your transmitter doesn't need to be on.
3. Wait for the SK-720's LED to turn green, and the SK-GPS to show blue.
4. Hold the heli in a level attitude and start rotating slowly as shown in the top image at left. The SK-GPS' LED will give short single blinks to show that it is in compass swing mode. You can rotate left or right, and the rotations should take about 10 seconds each. Turn around until the SK-GPS' LED blink pattern changes to a short double-blink, normally 2 turns.
5. Tumble the heli on its pitch axis, taking care not to wobble the heli in the roll and yaw axes. You can rotate nose up or nose down during this phase of the swing. Like the horizontal swing, this should take about 10 seconds per rotation. Keep tumbling the helicopter (see



image on the previous page) until the SK-GPS' LED blink pattern changes to slow blinking or a steady blue. Normally it takes only 1-2 rotations.

6. Place the heli back on the ground, and wait 10 seconds. You can check the status of your compass swing by connecting the helicopter to a computer to view the "Setup GPS" window in the setup software.
7. If the compass was swung properly, the LED will have returned to the solid "good satellite lock" LED. A fast flashing SK-GPS LED means that the compass swing failed.

Any failure related to swinging the compass will shut down GPS functions. Compass swing failures include:

- Compass not done at all
- Changed GPS orientation
- Failed compass swing

Compass-swing related failures are indicated by an "*Invalid Compass Swing*" warning in the GUI's setup window, or an error flash from the GPS unit itself.



## Using the SK-GPS

### Cyclic and Tail Settings on the SK720

Changes to the cyclic control-rates or self-level modes on the SK-720 should not have any effect on SK-GPS position-hold performance. However, faster control-rates will allow the SK-GPS rescue mode to level out the heli faster.

### Control Switch

The SK-GPS is controlled by any 2 or 3-position switch on your transmitter. One extreme of the switch positions is manual flying mode. Whether “manual” is the upper or lower switch position is determined by the direction of the channel set in the transmitter. To change the switch’s “manual” position, reverse the channel in your transmitter.

Since the middle position with a 3-position switch can be difficult to find quickly when the heli is in trouble, we recommend putting rescue settings to *Response B*. Then to rescue the heli, you just need to flip the switch all the way.

### Pre-Flight Testing

Before flying your SK-GPS equipped helicopter for the first time (or any time after changing any settings), we recommend that you connect your SK-720 to a computer and check that the information displayed in the SK-GPS Setup window’s “live data” area is correct:

- Check that the compass heading is reasonable and changes smoothly as you rotate the helicopter through 360 degrees. The displayed heading is *magnetic heading* until the GPS position is acquired. It switches to *true heading* once the GPS has a lock.
- Check that the altitude value responds when you lift the helicopter up a metre (3 ft) or so off the ground.
- Check that the GPS latitude and longitude values are correct for your location.
- Use the GPS mode switch that you assigned on your transmitter to ensure that your desired GPS modes are available.

You can try out the GPS-system’s control of the swash on the ground, but be aware that it will not engage unless it sees more than 10% on the throttle channel (for electrics you will need to disconnect the motor for safety).



### **Flight**

When you first try SK-GPS features, we suggest you first try Altitude hold, then position hold, and only then test the other modes. Be sure the heli is at a safe altitude and a safe distance from any people, including yourself.

If the SK-GPS is connected, the SK-720 will wait until the SK-GPS has a satellite fix before “bumping” the swashplate. If the SK-GPS loses its satellite fix while a position-hold mode is enabled, the system will switch over to altitude-hold only mode.

Note that when you set either altitude or position hold mode, the collective stick no longer controls collective. It instead *slews* the *setpoint* in position and altitude. *Slewing* means that the aileron, elevator, and collective sticks don’t control the heli directly, they move the *setpoint*. Note that slewing is damped for position, to prevent overshoot

Only the 50% of stick travel around the “zero” stick position has any effect, in case the GPS loses its satellite lock and drops to manual mode. For collective, it will hold the same altitude at mid-stick for multicopters or if the “scale” option is checked, otherwise it will hold the same altitude with collective at +1/3.

When you turn off altitude or position hold, you should be ready to take manual control of collective again right away. Also, if you hit throttle hold, the GPS system will drop to manual mode.

### **Limitations**

At the present time, no SK-GPS feature except for return-home will work at more than 500m from its initial location, or more than 300 metres above ground level. This is for the protection of the public and person-carrying light aircraft. The return-home function will work from up to 2 km away.

### **Loss of Signal, or High Vibration**

If the GPS loses its satellite lock, it will not be able to hold its position or stop motion in rescue mode. If you have position mode set and it loses satellite lock, it will then switch over to altitude-hold only.

The GPS features rely on the SK-720’s sense of level, and use the accelerometers to help hold position and altitude. If the heli has excessive vibration for more than a few seconds, the SK-720 will turn both position-hold and self-level features off. Aim for a vibration score under 5, as measured by the SK-720. If your heli has a problem with vibration, your first suspect should be the tail.



## Warranty and Technical Support

### Warranty and Repair:

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

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

Skookum Robotics will provide customers with technical assistance by email free of charge. If a product'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 GPS unit or related product, please write "WARRANTY RETURN" clearly on the shipping box, and mail it to the address given below.

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