Beginners Guide to Configuring

the T6 Program & Basic Helicopter Setup

Revision 1.3

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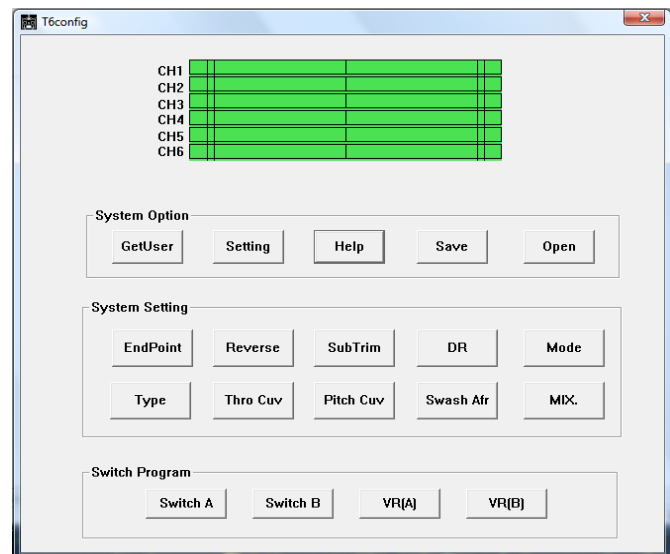
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Fig 1

Introduction

I was inspired to write this document on the T6Config.exe program and general RC Helicopter setup to help new comers to the this exciting hobby understand the basic usage and settings available in this radio and the T6Config.exe program used to configure this versatile but greatly undocumented radio.

This manual is intended to assist the beginner RC Helicopter hobbyist configure the radio and helicopter for general flight. We will not cover advanced control mixing ratios, however by reading this material you will understand the concepts behind each setting which will prepare you for advanced topics as your skill increases.

I am using the Fly-Sky FS-CT6A radio and receiver in this tutorial. This radio is re-branded by numerous vendors and may have a variety of decals. The one I am using is branded Exceed-RC.

This manual does not currently provide program installation steps or USB cable driver information.

There are helpful hints for installing the radio software, cable drivers, and alternative software to the T6Config application located on http://www.mycoolheli.com

Disclaimer

Use of this manual, settings, comments, suggestions or anything else within this manual is at the user's own risk. The authors and contributors of this manual take no responsibility whatsoever for the use of this information. We are not responsible for any damage or injuries that may result from the use of this information. Flying an RC helicopter or any remote controlled device has inherent risks. An RC Helicopter is not a toy. Please read the safety guides in this manual.

Table of Contents

Terms

- Radio – the FlySky CT6-A Transmitter

- Transmitter – same as Radio

- TX – same as Radio

- Receiver – the radio receiver that mounts on the helicopter.

- RX – same as Receiver

- Software – The T6Config.exe Windows application.

- Driver – The software that is used to install the USB cable and assign it to a serial communications port on the computer. The Radio is a serial device.

- There is a Glossary of Terms within this manual to help understand the additional terms used in this document. Another very useful resource is the on-line TREX 450 manuals. The first link has additional tuning information and parts listings, whereas the second link has additional measurements.

  - http://www.trextuning.com/Trex%20450SE%20Manual.pdf

  - http://www.heliguy.com/i/Trex450SE-V2Manual_ebook.pdf

Getting Started

Special Note: A new software package for the FlySky CT6-A radio has been created by Stephano Grassi named "Digital Radio" which is very easy to use and has additional functionality. All of the setting information contained in this manual can also be used with that software package. You can

Start the application, and plug your (already installed and configured USB interface) cable into the back of the transmitter. Turn on the transmitter.

There are four sections to the main screen (Fig 1).

- At the top is a graphical signal chart that represents the six signals this radio provides.

- Next section is the Software options (System Option)

- Next section is the Signal configuration section (System Setting)

- Last section is the Switch configuration settings (Switch Program)

Each of these sections and individual options will be described in detail.
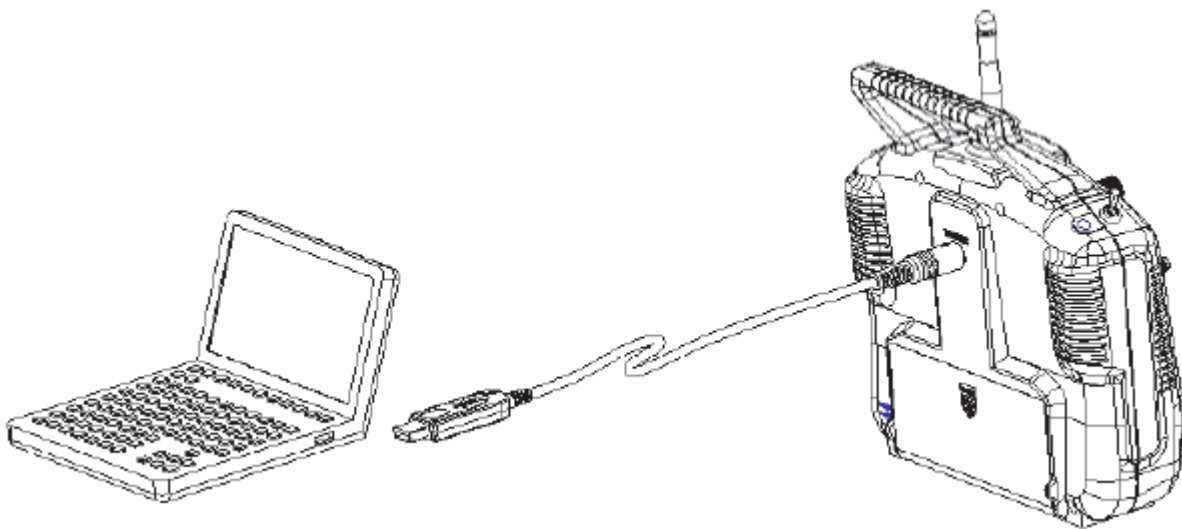
Connect the Radio to the Software

Fig 2

Verify that your radio is communicating with the software.

Not Communicating	Is Communicating

Fig 3

If your radio is not communicating to the software, you need to click the **Settings** button in the System Option section. This will display a serial port selection dialog where you can pick the serial port your computer assigned to the USB cable. Typically this will not be the first COM port, as any other installed computer serial ports will consume COM1 and COM2. The Fly-Sky cable that comes with your radio is a USB to Serial converter. There are two models of this cable, and they are not marked. Some use the Prolific USB Chip, and the later versions use a Silicon Labs Chip.

See http://www.mycoolheli.com/t6config.html for links to the drivers.
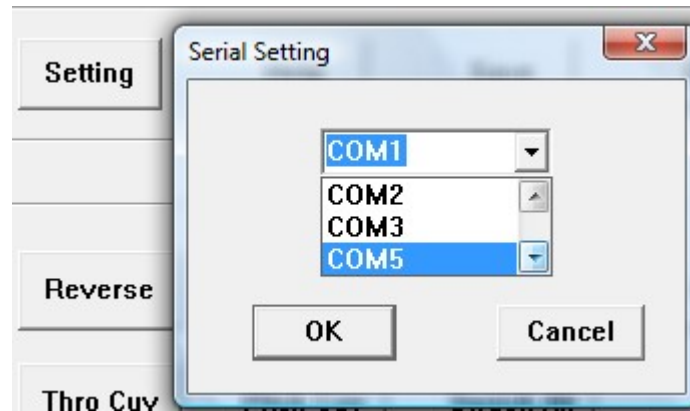
Fig 4

If you do not know the correct serial port, try all of them until your graphic signal chart displays with bars (Fig. 4). Wiggle the control sticks on the radio to confirm the radio is communicating (Fig.3). The bars will change if communications has been established.

*Note: It is a required to click the **Get User** button after establishing communications with the radio. This forces the T6Config.exe software to clear its memory and read the real settings from the radio back into the software. Failure to do this may cause issues or loss of configuration information when you make changes or save the information to a file. The T6Config setup memory contains 67 bytes of binary information. The Get User button replaces the software's 67 bytes of data with what it reads from the radio. If you do not use the Get User button immediately after you begin communicating with the radio, and you make some minor change, that change along with whatever the software has in its own 67 byte package is immediately sent to the radio replacing whatever it originally had stored.

At this point, you have learned how to connect your radio to the software, and force the software to read the settings in your radio. Before moving on to the System Settings section, lets review the remaining three buttons in this section.

- **Help** button – typically just shows the vendor's logo and any additional information the vendor would like to display to you.

- **Save** button – is used to save the radio settings to a file for later use. Use this option frequently (preferably changing names incrementally) so that if you mess something up, you can reload the settings back into your radio. Note: This action saves the values currently in memory of the software not the radio itself. Before saving, it is a good practice to click the Get User button to force the radio settings back into the software before saving to a file.

- Create a directory on your hard-drive for these setting files. Keep them in one place. If you have multiple aircraft models, then either name the files according to that model with some incrementing value or other indication as to what that file is for.

- The dialog box allows you to select an existing file, or create a new file. The "Open" button on this dialog is used to save the file. The author of the program decided to use the "Open" terminology instead of using the typical "OK" or "SAVE" terminology for this button.

- **Open** button – is used to re-load a previously saved configuration file from the hard-drive and load it into the software and radio. Note: The settings in the file are immediately passed into the radio overwriting all configuration settings.

At this point, you have learned how to save and load configuration settings from files on your hard-drive.

System Settings

The System Settings section has ten buttons. After a general description of the options, each one will be described in more detail.

- **EndPoint** – Servo Travel limits.

- **Reverse** – Servo direction settings

- **SubTrim** – offset signal level per servo to assist in centering the servo to the model.

- **DR** - double ratio controls CH1, CH2, CH4 servo rates

- **Mode** – Determines which servos are controlled by each joy stick

- **Type** – tells the radio the type of swash plate that is in use.

- **Thro Cuv** – Throttle Curve settings

- **Pitch Cuv** – Pitch Curve settings

- **Swash Afr** – used to adjust swash plate travel up and down.

- **Mix** – Provides the ability to assign a switch or another channel input to influence the signal on another channel. Typically used in the FS-CT6A radio to assign the Gyro Gain VR(B) dial to channel 5 in order to control Gyro Gain, but more advanced control methods can be configured.

New hobbyist are usually intimidated by all of these new terms and setting options available in this section. I hope to bring some clarity to their usage by running though a basic setup for a CCPM Helicopter. The buttons on the screen are not laid out in any particular order, so we will be jumping around during this setup.

The helicopter model I am using in this demonstration is an EXI 450 V2 Sport Edition. It is one of my backup helicopters that just so happens to be on the test stand at the moment, so it volunteered for this document.

Basic Setup

These instructions will assume a fresh setup as if this was a newly built helicopter and this is the first

time it was connected to the radio.

1. **MODE** - Set the Mode to Model 2. This is the configuration used in the the United States. If you are a European pilot, this is typically a Mode 1. In Mode 2, the Left stick controls the throttle and rudder, and the Right stick controls the swash plate through the Aileron, Pitch and Elevation servos. European (Mode 1) settings cause the right stick to control the throttle & rail rudder, and the left stick to control the swashplate. Once set, you will never again need to revisit the MODE option setting.

2. **TYPE** – this setting tells the radio about your type of swash plate. Refer to your model information on the type of swash plate installed. For the TRex and EXI, Blue Ray, Copter-X and most TRex clones using "CCPM mixing", this is a 120 degree swash plate. The Servo linkages are connected to the swash plate at 120 degrees apart. For the EXI model in this document, I will select the HELI-120 option from the drop down list. Check with your own helicopter documentation to verify the TYPE swashplate setting. Once set, you will never again need to revisit this option.

3. **ENDPOINT** – There are two columns of settings. The left column is the UP direction limitation setting, and the right column is the down limitation in percentage. Most helicopter servos are the 60 degree type. They have a center, and can move 30 degrees Clockwise (CW) and 30 degrees Counter-Clockwise (CCW). At this stage in the setup, set all values to 100%. Typically you will not have to revisit this setting unless you have a mechanical interference or some other limiting factor that you need to prevent the servo from traveling too far. Note: the "up" and "down" labels can be misleading. Up may not necessarily mean Servo horn UP movement. It merely means the travel limit in one direction (dependent upon Servo Reversal settings – covered later).

4. **DR** – Dual Rate setup. There are ON and OFF columns. This setting is only relevant if your radio is later configured to utilize dual rates by associating this function with one of the switches. Since we recommend you have one of the switches set for Throttle Kill, and you'll eventually probably want to use Idle-Up/3D mode with the other switch, there are no additional switches to provide this functionality. Dual rate can be thought of as selecting between two "sensitivities" of the rudder and cyclic controls. Reacting too abruptly to minor control movements can be difficult for a beginner or pilot who needs very precise control, while a stunt pilot may want intensely sensitive control to perform tight rolls and loops. The pilot that wants to loop and roll and *then* land on a dime would want to control how sensitive the controls are at different points in the flight. Thus, these fields set what percentage of full-rate is desired in each switch position ("on" and "off" are again misleading misnomers, since this is really an "A" or "B" choice when either position could be the more sensitive one). At this stage in the setup, set all the fields of at least one selection to 100.

5. **SUBTRIM** – these settings are used to center the servos. At this stage in the setup, set them all to zero (0). You will revisit this option many times as you fine tune the helicopter.

6. **MIX** – The T6Config program and FS-CT6A model radio support 3 mixes. A "mix" is when one channel affects another automatically, or to associate a physical transmitter control like a switch or dial to a certain radio channel. We will delve more into this option later in the setup, however for this initial setup stage, change the SWITCH setting for all three MIX settings to OFF. To do this, select the MIX 1 from the drop down list, and then select the OFF setting from the SWITCH drop down list. Now select the MIX 2 from the list, and set the SWITCH setting

to OFF, and finally select the MIX 3 setting and set its SWITCH setting to OFF. We will return to this option later in the setup.

7. **SWASH AFR** – As mentioned before this is the pitch limiter setting. It controls how far the swash plate can travel up and down the main shaft be controlling the cyclic servos (Cyclic servos are the Aileron, Elevation and Pitch servos connected to the swash plate). For this stage in the setup, set all three values to <u>100%</u>. We will revisit this setting when adjusting the pitch.

8. **THRO CUV** – The throttle curve setting has two modes. Normal (NOR) and Idle Up/3D mode (ID). At this stage in the setup, select the NOR option from the drop down list and set the values to a linear curve from <u>0 to 100 </u>(0-25-50-75-100). We will return to this option later to tune the throttle to your motor and flying needs. While you are here, you can set your Idle Up throttle curve as shown below (Fig. 5). Every pilot will defend their choice of throttle curves. This is only a basic setup instruction. Later I will provide hints as to how you can tune these curves to fit your needs, then you can experiment with them.

NOR – Normal Throttle Curve	ID – Idle Up/3D Throttle Curve
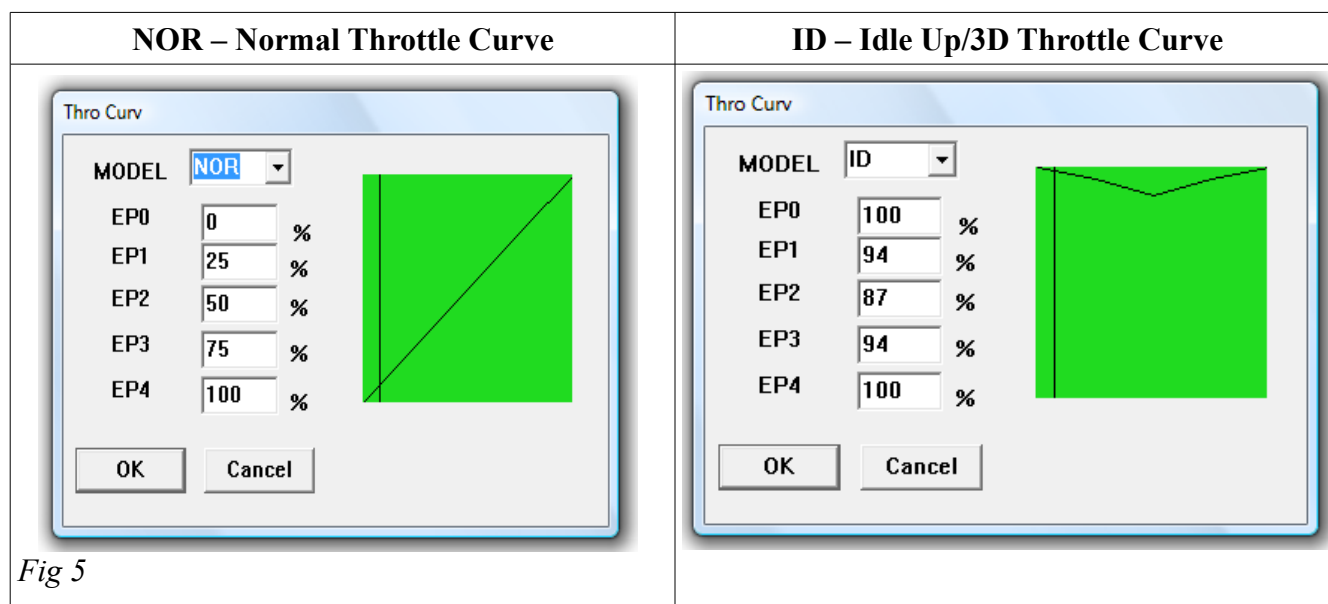
Fig 5

9. **PITCH CUV** – Pitch Curve settings. There are two modes for pitch settings. Normal (NOR) and Idle Up/3D mode (ID). At this stage in the setup, select the ID option from the drop down list and set the values to a linear curve from <u>0 to 100</u>. We will return to this option later to tune both of the pitch curves.

10. **SWITCH A** – The A switch on this radio is the top right On/Off toggle switch. Set the switch to the <u>THROCUT</u> setting. When the switch is in the ON position, it will turn off the signal to the ESC (Electronic Sensor Control) that control the motor. The motor will not turn when this switch is on, providing another level of safety while working on the helicopter or positioning it before flight. The ON position for this radio is the forward toggle position (towards the user).

11. **SWITCH B** – The B switch on this radio is the top left On/Off toggle switch. Set this switch to the <u>NOR/ID</u> setting. When the switch is in the ON position, it will use the ID throttle curve and ID pitch curve. In the OFF position it uses the NOR throttle curve and NOR pitch curve.

12. **VR(A)** – This is the dial located at the top right of the radio. Set this to the <u>PITH ADJUST </u>

setting. You will not have to return to this setting. This control will allow you to increase or decrease an equal amount of signal to all three cyclic servos. The result is more or less total pitch (as if you slid the entire pitch graph vertically). At this stage in the setup, adjust the dial so that it is mid point between its extreme CW and CCW positions. Typically this is with the indicator line of the dial pointed towards 9 o'clock, but this is NOT guaranteed to be true of your particular radio, so find your own midpoint.

13. **VR(B)** – This dial is used for Gyro Gain adjustment. It is not active at this time because in a previous step, we turned off Mixing to this switch. Set its value to NULL. You will not have to return to this setting.

At this point, you have prepared the radio for an initial setup. This is not ready for flight, but instead ready for setting the servo mechanically positions.

Setting up the Model

What this section covers:

- Servo horn positioned

- Centering the Swashplate

- Leveling the Swashplate

- Setting the Main Blade Pitch

- Blade Tracking adjustments

- Tail Servo setup

- Gyro Setup

Don't worry if you do not understand the terminology in the list above. Each will be explained in detail as we progress through the setup.

This manual is not intended to show you how to build a kit. However there is enough information contained here to build one. If you are working with an RTF (Ready to Fly) model, the following steps will allow you to confirm that your model was assembled correctly.

If you have the motor installed. Disconnect two of the three wires (it doesn't matter which ones). We will apply power to the helicopter, and do not want any chance of the motor starting up. This warning will be mentioned numerous times until we are ready for you to do something that requires the motor.

You should already have the servos installed, and the wires connected to the receiver as shown in Fig 6, and the wires secured to the frame so that they will not be caught in any moving parts. If not, then install the servos now. Refer to the TREX manuals, or your particular model manual to place the servos in the proper orientation. Use the same servo model for all three cyclic servos (Do not mix servo brands or sizes for your cyclic servos). These are the servos that will connect to and control the Swashplate.

If you have not installed the servos, I have found it easier to remove the right side frame(s) (on the seV2 stacked frame model) so that you can route the cables inside the frame and tie-wrap them down out of the way.

If you have removed the head, you will want it put back on temporarily until we have discovered the exact center of swashplate travel (part of the first servo alignment process).

Now that the radio is configured for an initial setup, we turn our attention to the model. The first thing we want to do is confirm we have the servos wired correctly and they travel in the right direction.

The servos should be plugged into the receiver in the following channels.

CH1 – Aileron servo black wire towards the edge of the receiver. (All connections will have the black wire connected towards the edge of the receiver (see Fig 6 below). (Note: The TREX manuals label the left side servo as Aileron, and the right side as the Pitch servo. We don't know if this is a typo, but the accepted name for CH1 right side servo is the Aileron servo.)
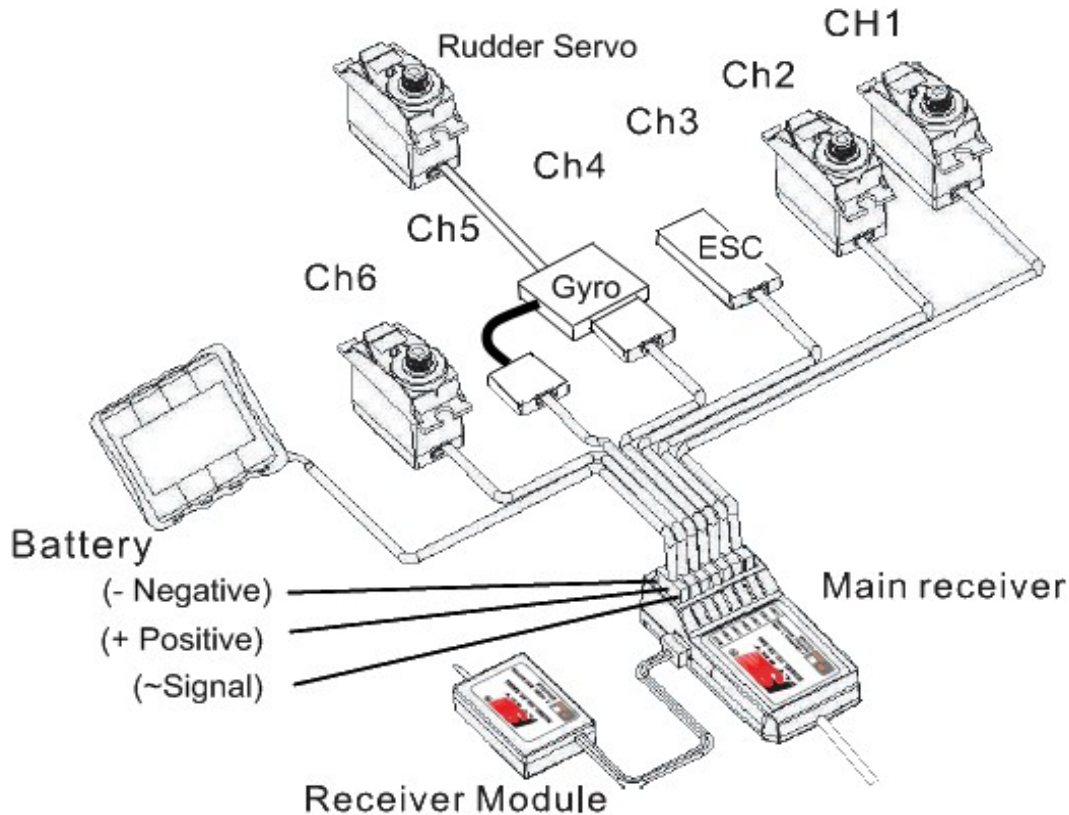
Fig 6

*Note: Some servo manufacturers use a different colors for the wires. Most of them use the Black wire for Negative, Red (center wire) for Positive, and a different color for the signal wire. Verify the wire color codes with your servo manufacturer.

CH2 – Elevation Servo. This servo is center line with the main shaft. Typically has a guide that prevents the swash plate from rotating. On the EXI seV2 it mounts behind the main shaft. Some models mount this servo in front of the main shaft.

CH3 – Throttle Speed, connects to the ESC. If the ESC has a built in BEC (Battery Elimination Circuit), then the three small wires go to the receiver Channel 3 to provide the main power for the receiver, servos and gyro. If you are using an external BEC or battery to power the receiver, then make sure that the ESC does not also supply this power. You can cut and terminate/insulate the center red

wire from the ESC.

CH4 – Gyro / Rudder control. Typically the Gyro plugs into CH4, and the rudder servo plugs into the Gyro. Most Gyros have a sense/gain control line (single wire) that will connect to CH5 to allow adjusting Gyro Gain settings from the radio. Older gyros only provide adjustment of gain at the gyro itself. If you have one of these older gyros, discard it, and purchase a gyro with a Gain Sense wire.

CH5 – Gyro Gain / Sense line. If your gyro is equipped with Sense / Gain control wire, then plug this into CH5. This is often a single wire without another +/- pair, so be extra careful not to damage this delicate connection.

CH6 – Pitch Servo. Typically this is the servo mounted to the left side of the helicopter swash plate.

At this point you should have the servos installed, and wired to the receiver, the servo horns are not attached to the servo, and the servo linkages are not attached to the servo horns. The radio has been setup for initial settings mode, and your motor wires have been unplugged.

Binding the Transmitter to the Receiver

The FS-CT6A radio is shipped with a matching receiver that has already been bound at the factory. Therefore you should not have to re-bind it. If you want to bind this receiver to another radio, or to re-bind this receiver follow these instructions: *(Note: This procedure is only for the 2.4ghz model)*

1. Install the battery to the 2.4ghz transmitter, and turn it off.

2. Insert the binding plug into the BAT port of the receiver (see Fig 6)

3. Connect the ESC to Channel 3, or an external battery (5vdc) to any one of the other channels observing the +/- polarity as in Fig 6. Power up the receiver using the external battery, or connecting the main battery to the ESC. The LEDs should start to flash.

4. Press and hold the lower left button on the transmitter, and then switch on the transmitter's power switch.

5. Observe the LED lights on the receivers (main and satellite). Once the LEDs stop flashing, the receiver is bound to the transmitter. It will take about 10 seconds (or less) for the binding process to complete.

6. Release the match button on the transmitter. Remove power from the receiver, and turn off the transmitter.

7. Remove the receiver binding plug. Connect your servos and other channels as described in Fig 6.

8. Test by turning on the receiver without pressing the match/bind switch. Power the receiver, and the LEDs should light steady meaning it is bound to the transmitter.

9. If the test failed, repeat this process.

Note: If the test fails, and you have other components plugged into the receiver, remove all other connections except the binding plug, and the power connection (ESC or external battery). A shorted component such as a servo can prevent the receiver from powering up, or binding to the transmitter.

Servo Centering

In this next step, we are going to center the servos and verify they are moving in the correct direction. Before making the adjustments, lets review the purpose and concepts behind this step.

This means we intend for the control horn to be in the middle of it's intended travel. However, the servo horn is mounted in a mostly random position at the factory since they don't know which way the servo will eventually be mounted, so this will most likely not be anywhere near where we want it centered for your model. The mounting position and built in tolerance of the servo may require an adjustment to position the servo horn so that it is perpendicular to the main shaft (parallel to the top main bearing block). The end result is to have the linkage connecting the servo horn to the swashplate to be exactly at a 90 degree angle (linkage will be parallel to the main shaft).

Note: the pictures below show the servo horns attached and linkage attached. This is to illustrate the end result after the settings are complete.
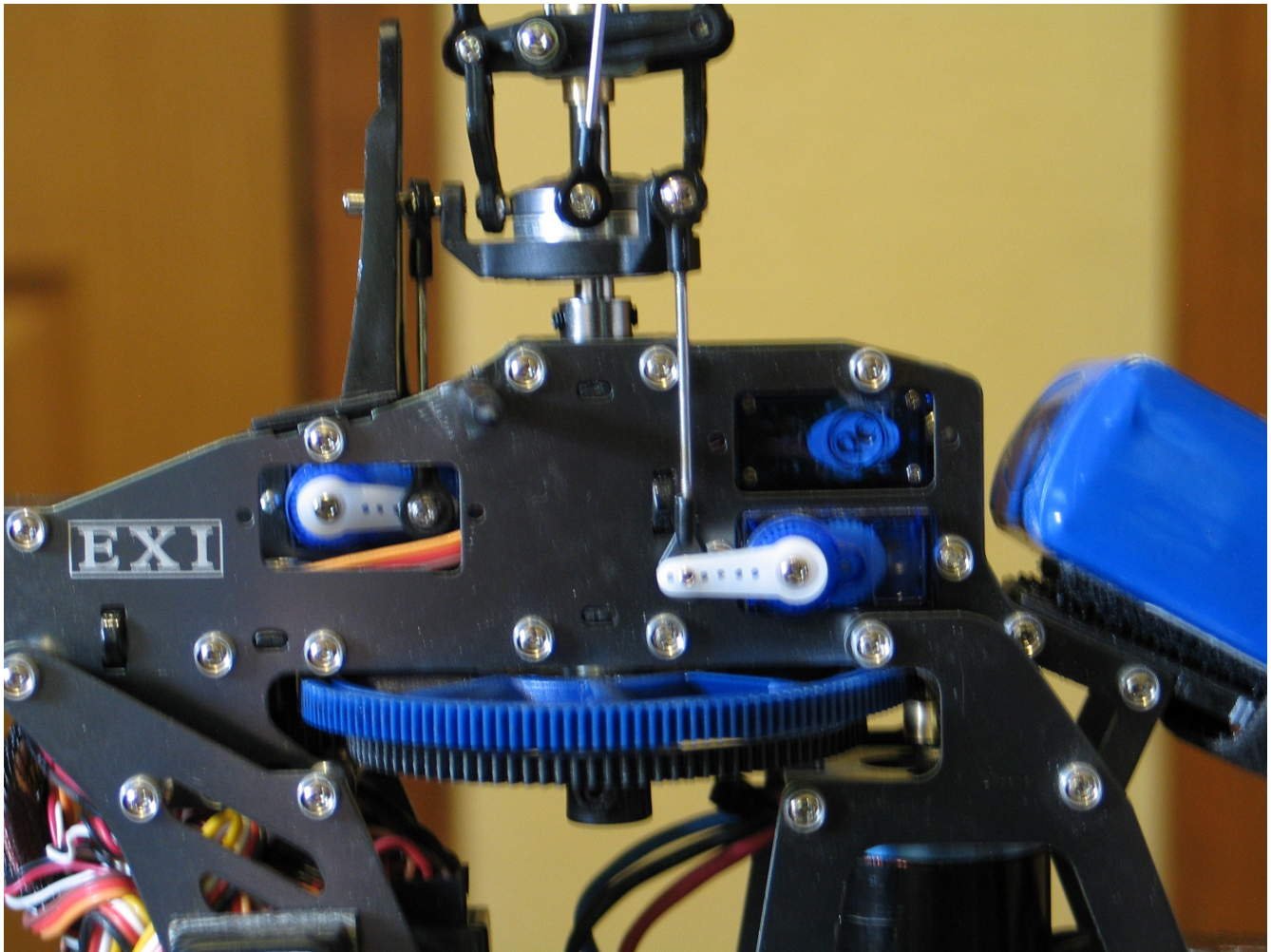
Fig 7

*Note – some models arrange the servos in different locations and orientation. Some models such as the TREX 600 (Fig. 8) have intermediate pivot arms and double linkage rods. The Black Hawk 450 (Fig. 8b) uses intermediate pivot arms and angled servo mounts. The same basic concept applies. All cyclic linkages must be parallel to the main shaft and remain parallel throughout their entire range of

travel.
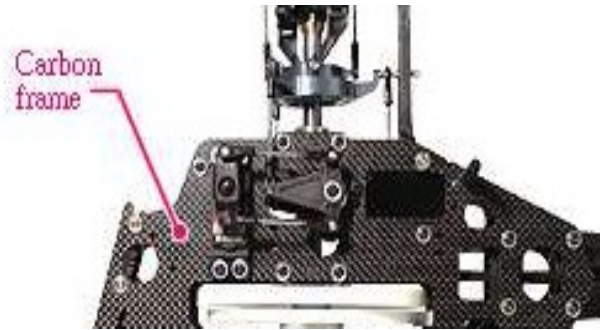
Fig 8
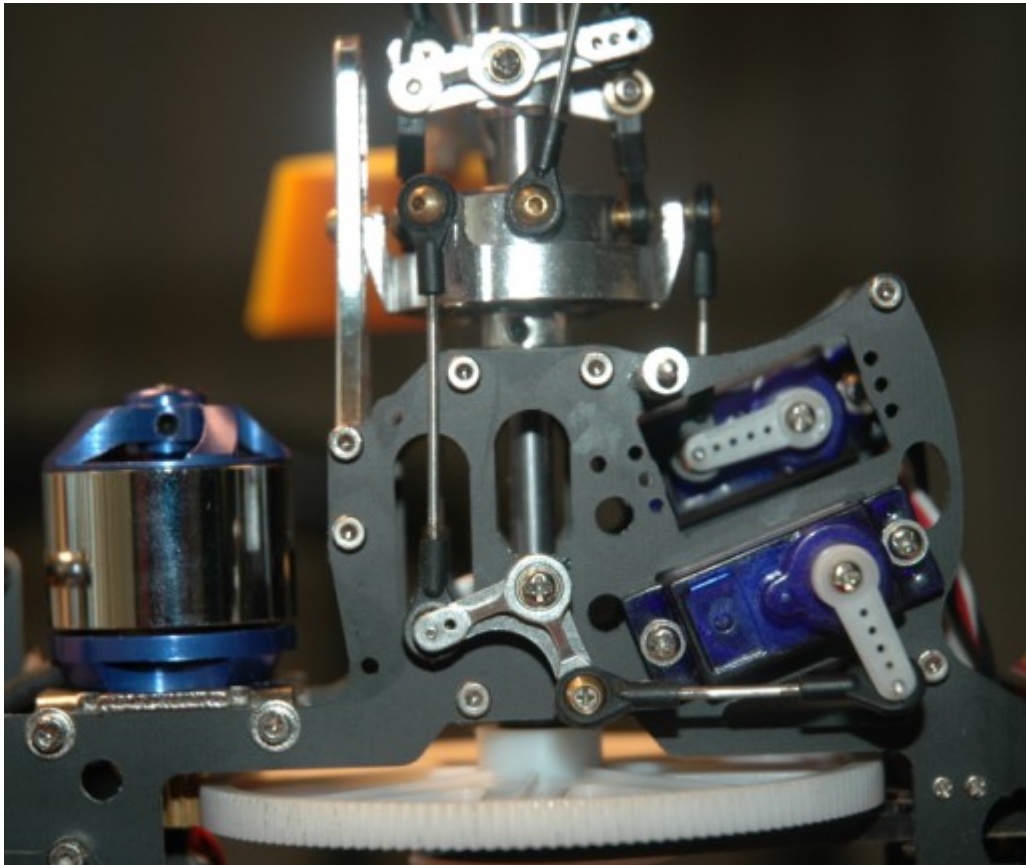
Fig 8b

Why must it be 90 degrees? This is important to understand. The servo horn travels on an arc from the servo hub gear. The distance the rod linkage travels is therefore not linear. The further the horn rotates the less amount of linear rate. In other words, the first 10 degrees of horn rotation will provide more linkage movement than the next 10 degrees, and so on. All of the servo horns must be as close to 90 degrees to the swash plate linkage rods as possible in both axes. If this is not obtained, the result will cause the swash plate to tilt towards the servo that is not suppling the same amount of travel for the same amount of signal input as the others. The model will start to slide forward or backwards, or left or

right in flight as you change the elevation (throttle input).

This inadvertent control is annoying at best, and nearly uncontrollable at worst, so therefore, take your time mechanically centering your servos here and electronically perfecting them later., and get them *perfectly centered.*

Selecting the correct mounting hole for the servo is very important. As described above, the distance the linkage rod travels must be the same for all cyclic servos. If one servo is using the last hole, and one is using the first hole, obviously the helicopter will be unmanageable in flight without some creative mixing and Swash plate AFR adjustments. This is part of what we call the mechanical setup. Without a correct mechanical setup, the radio settings may not be capable of overcoming the mechanically induced errors.

Which hole to use? This is (as in many other places) a trade off. The hole farthest from the hub gives you more control <u>range</u> and faster control response, but less precision and moderately more stress on the servo motors. The hole nearest the hub gives you less control <u>range</u>, slower control response, but more precision and less stress on the servo motors. Depending just how long your particular servo horns actually are, you may need to experiment with which one gives you "enough" control and speed without being "too much" or having controls physically hitting one another at extremes of movement.

To center the servo horns, first remove the horns from the servos. We are doing this to prevent a long servo horn, or a horn placed in the wrong position from making contact with another object. If contact is made, it can damage a servo gear.

Unplug <u>TWO</u> of the motor wires from the ESC (*A brushless motor can still run with only one lead disconnected)*. We will be powering up the model and do not want the motor to accidentally power up. Unplugging the motor wires is cheap insurance. Don't just rely on the Throttle Kill switch as radios can fall over, and Murphy's law takes over.

Plug the battery into the ESC and turn on your transmitter. Set the Idle Up/3D switch (SWITCH B) into the Idle Up mode (towards you). Set the left stick trims to center (All of the mechanical trims to center). Place the Throttle cut (SWITCH A) towards you just to be safe. Set the throttle stick to exactly center. The idea here is to use the middle of the linear ID pitch curve at 50 for centering the servos.

<u>Note: Throttle Trim Position during setup</u>

This is one of those controversial topics in this hobby. Some videos will ask you to place the TX throttle trim to the lowest position before centering the servos. Others will tell you to set the trim slider to the center position.

Lets take a moment here to examine this issue. The T6 Radio uses the same exact potentiometer component for all 4 trim controls. This is a three wire component where the center tap provides zero signal. Moving to one side or the other will increase the signal output a plus or minus value to the mixing controller electronics. At the center position there is no input to the controller an all influence of this value is taken out of the collective mixing logic. View the T6Config graph to see what this position does to servo input.

If you decide to place the throttle trim all the way to the bottom during this setup, and line up the servo horns to 90 degrees to the main shaft, think about what you have just done.

You have introduced a negative value to the collective mixing controller. This turns the servo motors

about 5 degrees which comes out of the 30 degrees available for the down pitch direction. This equates to about 3 degrees of blade pitch that you have removed from the possible negative pitch capacity.

The purpose of this setup is to get the swashplate exactly centered between the upper and lower limits of travel on the main shaft. You want the servo horns to be at 90 degrees from the main shaft, and the linkages as close to parallel to the main shaft as possible. Remember this setup is for the mechanical alignment so that you can later make adjustments with the radio to take advantage of pitch capacity of the design.

Another benefit of setting the radio throttle trim to the center position is that when you set the pitch to zero degrees at center stick, then by moving the trim adjustment to the bottom (after everything is setup mechanically), you automatically get about 3 degrees of negative pitch. Negative pitch is important in Normal mode for takeoffs and auto rotation landings. If you use the lower trim position in this setup step, then you will need to inject a <u>less than 50%</u> value in the normal pitch curve to get the desired 2~3 degrees negative pitch.

Where did this controversy start? I am of the opinion that Fixed pitch pilots are at the heart of this misunderstanding. Fixed pitch (and coaxial) pilots desire the throttle trim to be at the bottom because it controls the speed. An FP setup does not control the collective pitch like in a CCPM mechanism. So I think this is a carry over from so many FP pilots getting into CCPM, and sticking with old habits.

Note: Another popular option is to temporarily set the Idle Up Pitch Curve to 0,50,50,50,100 so that you won't have to guess what is exactly center stick. With this pitch curve setting, anywhere around center stick will provide 50% total collective pitch and provides very consistent checks.

The cyclic servos will find their centers. Press-fit (but to not screw in) a servo horn to the Aileron servo gear hub. The Aileron servo (typically the right side of the model) is the reference point. Everything else will be adjusted according to this servo. Place the horn on so that it is 90 degrees as possible to the linkage. Don't worry if it doesn't line up at a perfect 90 degrees yet. Due to the size of the servo hub's teeth, this is unlikely to be perfect yet, and we will use the radio SUBTRIM settings to obtain an exact position as part of the swashplate leveling exercise. Do not connect the linkage yet.

Optical Illusion

Perfection is the name of the game for setting up your helicopter. Eyes can play games with you when finding that perfect servo center position. To help get a more accurate reading, it helps to use a reference. The horns need to be 90 degrees to the main shaft, not the boom or body, but the main shaft.

An easy tool to help with this is a simple credit card. The edges are 90 degrees and it is long enough to give you a good reference. In the picture below (Fig 8c), I am using special card (same material and size as a credit card) to align the horn. When eye-balling the horn, I put in +40 sub-trim. But once I used this credit card as a reference, the sub-trim was readjusted to only +25.

Align the long end of the credit card to the main shaft, and the short end centered on the servo hub screw, and the ball link screw. As you can see in the photo, the eye-ball measurement was slightly off. After the adjustment, it was perfect.
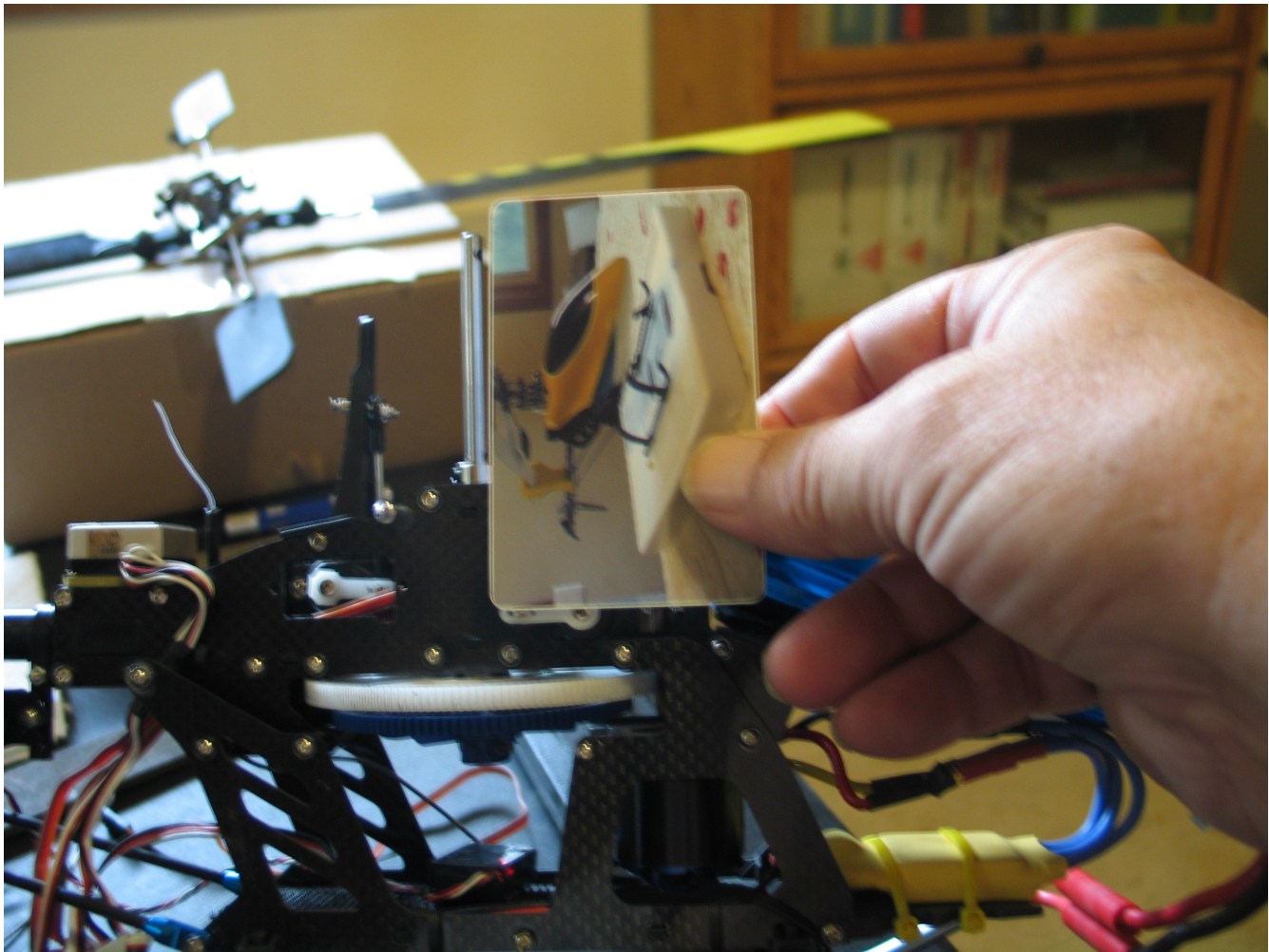
Fig. 8c

Checking for Servo Direction

When the throttle stick is moved up, all three cyclic servo horns are also supposed to move UP. As you test each servo in the following procedure, check the direction of the servo using the left stick. If a servo is not moving in the correct direction, visit the REVERSE button in the program and check or un-check that channel, and test again.

Now use the radio right stick to slowly move full left and full right. Make sure the servo horn will not make contact with any component on the model. If it does, consider changing the horn to a smaller size. As a last resort when there is no possible way of preventing contact with another part, you can use the ENDPOINT adjustment to limit the travel of the horn. As stated already, this is not the recommended approach. You need the proper servo horn.

Recenter the right stick and verify the mechanical sub trim sliders for the right stick are centered.

With the servo horn for the Aileron servo position as close to 90 degrees to the linkage as possible, go to the SUBTRIM setting for channel 1 of the T6Config application and adjust the value until your servo horn is perfectly 90 degrees to the linkage. Since this is the reference point for the remainder of the setup, it is critical to be correct.

Perform the same servo horn checking steps and 90 degree adjustments with the remaining cyclic servos. Remember to check for interference and without the linkage attached.

At this point, all the cyclic servo horns are exactly 90 degrees to the rod linkages. You have adjusted the SUBTRIM settings for each to accomplish this.

Unplug the model, and save the transmitter settings to a file as setup_step1 (see instruction on page 4 to save the configuration file). Then power off the radio if you would like to save the batteries.

Measure the Aileron Linkage to verify it is the correct length. The TREX 450se V2 Manual calls out for this linkage to be approximately 45mm (1.771609095 inches, or roughly 1 ¾ in.) from the center of the ball link to center of the opposite ball link. The intent of this length is to place the swashplate exactly center between its top and bottom travel limits. Before attaching the linkage between the servo horns and the swashplate, you should find the center of travel the swashplate can travel up and down the main shaft. You want to adjust the Aileron linkage length so that with the Aileron Servo horn at 90 degrees, the swashplate is at that center of travel location on the main shaft, and is level. It doesn't have to be exact, but the closer you get to perfect the better off you will be later on when you want to experiment with maximum blade pitch angles.

Connect the Linkage rods to the servo horns. All ball links are made with one side having a slightly larger opening (hole) than the other side. Link manufactures mark one side of the plastic link to indicate which a specific side. That side marking may be for the smaller or larger hole. Align uses a mark to indicate the small hole side, where the EXE links use a bevel or a circle around the larger opening. The link will go on one way with a little effort, whereas the other side is very difficult if not impossible. The link should make a snapping sound as it is fit over the ball. The ball should not have any play, but should also not be tight. It should move freely on the ball. If the fit is too tight, use a ball link sizing tool to correct the sizing issue.

Make sure you use the same hole on the cyclic servo horns or better described; the horn linkage connections are exactly the same distance from the center of the servo hub gear. Make sure the linkages are straight up and down. Look from the side and the front, rear (all angles) and verify they are as straight up and down as possible. Do not tighten the servo horns in place yet.

Note: If you are using the common Teflon/plastic servo horns, you make have to use a small 1/16th in. drill bit to open the hole, and then thread the horn screw through the hole threading as you go. I have never seen a screw back out of one of these horns, but it is possible. Check them as a part of your pre-flight inspection. Some old school modelers get longer screws, and place a Teflon nut on the other side. You can also purchase threaded balls.

At this point the cyclic servos are connected to the swash plate, the servo horns are at 90 degrees to the linkage rods, the linkage rods are parallel to the main shaft. And the swash plate is half way between its top an bottom travel along the main shaft. The servo horns travel in the correct direction.
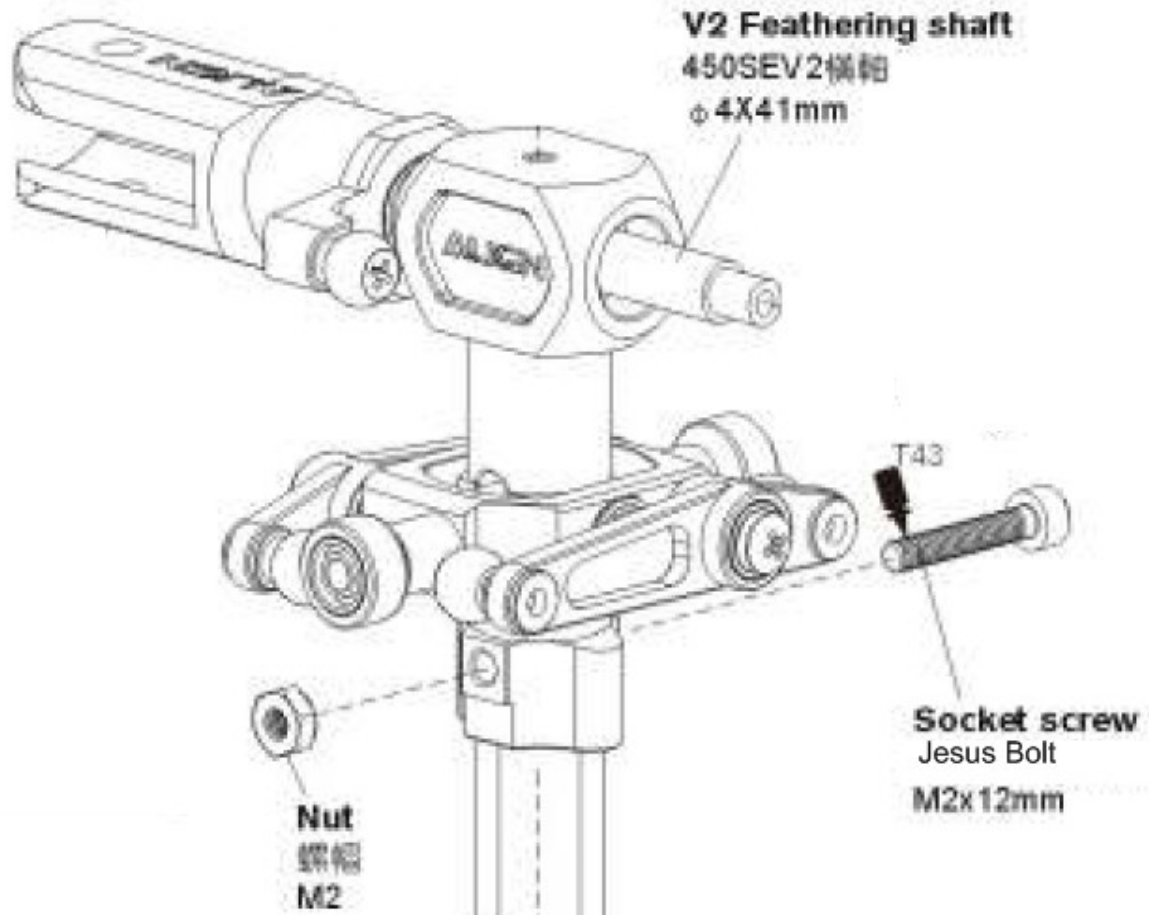
Fig 9

Leveling the Swash Plate

In the previous steps, the servo horns were all mechanically and electronically setup. The next steps is to level the swash plate. Leveling the swashplate is the process of adjusting the other (non referenced) linkages so that the swashplate is perfectly perpendicular to the main shaft. You do not want to adjust the reference linkage (our Aileron Linkage that was set to 45mm). There are two methods to level the swash plate. The first is to use a swash plate leveling tool. There are a number of vendors that supply this type of tool. I use the over shaft tool (see Fig 11). The second method is to visually inspect the swash plate for level. Obviously a tool makes this more accurate. To use the over shaft leveling tool, you must first remove the top "Jesus" bolt near the top of the main shaft (Fig. 9). This is typically just below the main head piece and below the fly-bar.

Note: The new 450 Pro swashplate has a taller center bearing that does not allow the Sport or seV2 style leveling tool to slide all the way down onto the perches. Some people have used a large drill bit to acquire the additional clearance by removing some of the material from the tool.

To remove the head, remove the Jesus bolt (you may need to apply a hot soldering iron to the nut side of the Jesus bolt for 10~15 seconds to loosen the Locktite. Disconnect the washout links and SF Mixing Arm (fly-bar control arm) links from the swash plate (Fig. 10).
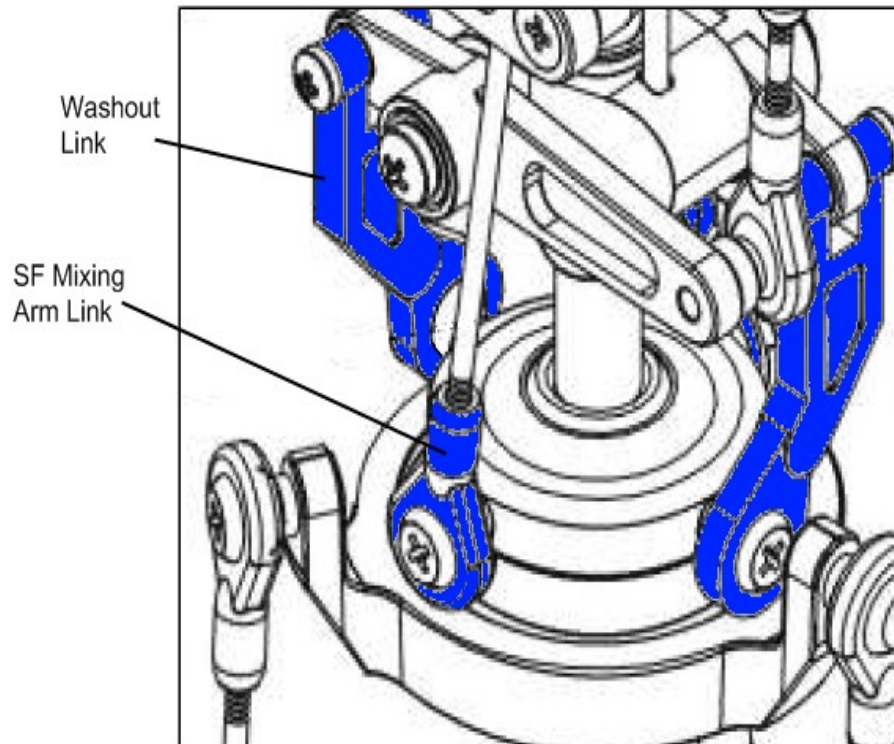
Fig 10

Decouple parts (Fig 10) marked in blue from the swash plate.

Lift the head off of the main shaft. This may take some slight force to accomplish.

Verify two motor wires are disconnected, and turn on the radio with the Idle Up and Throttle Cut switch ON (towards you). Center the throttle stick (left stick) and the throttle trim, and plug in the battery to the model.

Slide the tool over the main shaft and set the tool feet on top of the swash plate servo perches (Fig. 11)
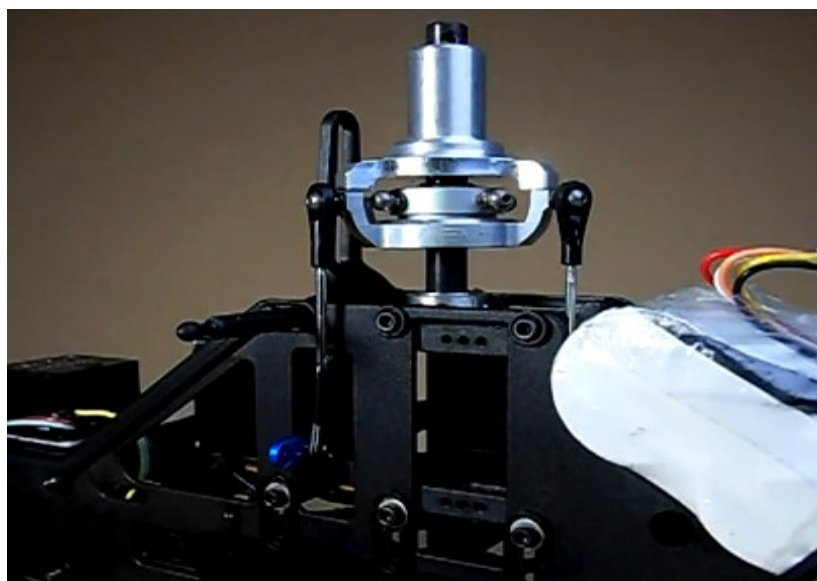
Fig 11

Inspect the clearance between the tool feet, and the swash plate perches. There should be no gaps. If there are gaps, then you want to adjust the rod linkage length to remove the gaps. You want to maintain the servo horn 90 degree position, and get the swash plate level at this throttle position (mid point throttle).

Note: An easy trick to keep your horns at 90 degrees, is to temporarily change your Idle Up Pitch curve to 0, 50, 50, 50, 100. This takes the guess work out of what is mid stick. Part of this setup is to move the throttle stick. If you do not bring it back to exactly the middle point, it can be frustrating. With this temporary pitch curve setting, the throttle stick can be anywhere near center and the horns will have the 50% position command at all times.

Addendum August 22nd 2010 – Because of optical illusions in setting up the cyclic servo horns to perfectly 90 degrees from the main shaft, you may have to adjust the sub-trims very slightly. Before doing that, put in your best effort to use the linkage lengths to get a level swashplate. When a turn of the linkage is too much, you can resort to using sub-trim to get the swashplate perfect. The tiny sub-trim adjustment will compensate for the optical illusion, and get your horns and swashplate perfectly aligned.

Once you have the swash plate level at the mid stick position, you want to slowly move the throttle all the way Up and all the way down observing that the swash plate does not bind at the top or the bottom of the travel. At or near the top of the travel, inspect the swash plate for level. Do the same for the bottom. If everything is mechanically perfect, and you have accurate (higher quality servos) there should be no gap throughout the swash plate movement up and down the main shaft. Try your best to get it level at all three positions. If this turns out to be impossible due to the quality of the servos (or your main shaft is not perfectly straight), then you can use the ENDPOINT travel limiting settings to restrict one or more of the cyclic servos. Reduce the ENDPOINT left side column for the channel(s) that do not have a gap. This will restrict those servos from moving as far, thereby closing the gap on the other swashplate contact points with the tool. Use the same technique at the swashplate bottom position to remove any gaps.

Typically you are not going to run at the highest possible pitch available with this design. The ENDPOINT limitations will most likely become a mute point once the SWASH AFR settings are used to restrict collective pitch later in the setup.

The Align or clone heads are capable of over 14 degrees of collective pitch so there is some margin at the top and bottom that is not used when we limit the pitch to about 12 degrees. When we adjust the Swash AFR settings, we will limit the pitch to less than what the full travel permits. Be sure that with the horns at 90 degrees, the swash plate is level, this is ultimately more important than at the top or bottom of travel because most of your flying will have the swashplate between ½ and ¾ of its travel. **Note: See "Setting the SWASH AFR" section below before re-attaching the head assembly.**

Once the swashplate has been leveled you should install and tighten the servo horn screws.

Unplug the model from the battery, and reassemble the head to the main shaft. Remember to apply

Blue Locktite to the end of the Jesus bolt after you have pushed it through the main shaft and before attaching the nut. Note: If your Jesus bolt is bent or damaged, replace it. A bent Jesus bolt means it has been stressed. It is normal for a Jesus bolt to become deformed with a lot 3D flying. Periodically check the condition of this extremely important bolt, and replace it when found to be deformed. If it ever lets go in flight, you will understand why it is called the "Jesus" bolt.

At this point you should have a level swash plate that has been mechanically trued. If you could not get it perfectly level, you will still be able to fly it, but you will have to manage the effects. Note: if it is not perfectly level, just be aware that on punch outs, the model may exhibit symptoms of moving off in one direction.

Verify the Mixing Arms, fly-bar cage, SF Mixing arms are all level.

Addendum August 22nd 2010 – Going from the ground up. Every EXI head I have worked on came to me with the linkages set to the wrong lengths. All paired links must be exactly the same length center ball to center ball. In this section I will describe the setup after the swashplate is level.

Note – during this procedure, you will detach and reattach links. I prefer to remove the ball screw instead of using the link pliers. The more times you use the link pliers, the more damage is done to the plastic link.

First thing I do is pull the flybar out, and loosen one side of the flybar cage and pull the cage off the head assembly. Then I remove the flybar links from the lower SF mixing arms.
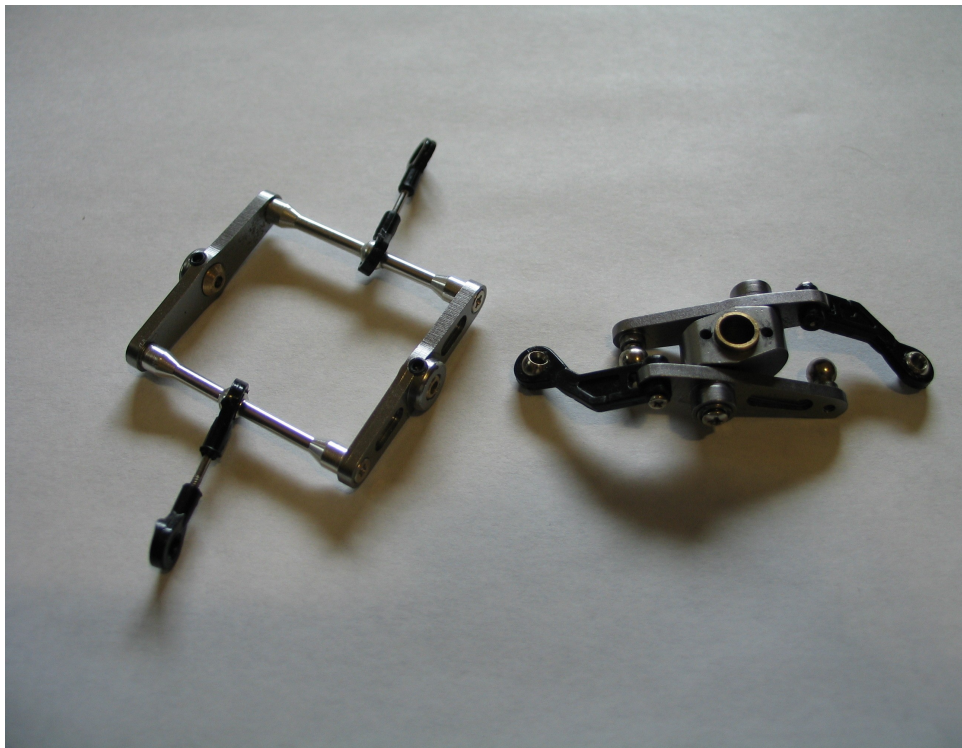
Fig 11a

Next, place the washout base onto the main shaft with the longer end of the brass bushing down

towards the swashplate. Attach the washout arms to the swashplate using Loctite on the screw ends. Use caution not to get any Loctite on the ball, or on the swashplate. Place the screw through the ball, and put a drop of Loctite on a flat coffee stirrer, then use the coffee stirrer to dab a little Loctite on the end of the screw for a light covering of three threads. Use a napkin to remove any excess.

Now measure the flybar links. From center ball to center ball they should be approximately 23.5 mm (0.925 in.). Adjust the links to be the exact same. Some heads (non TREX/EXI V2) are different and may require a different length. The important part is they are exactly the same length. If they are unequal; the flybar will not be level with the lower SF arms and swashplate. The result will cause head vibration, undue stress on the servos, over stress of the upper Jesus bolt and the model will tend to not be stable in a hover.

These links determine the center position of the swashplate on the main shaft. The lower SF mixing arms and the flybar cage need to be level with the swashplate at 50% collective. Before reattaching the flybar cage to the main head, go ahead and measure the long links. These links control the top SF mixing arms and ultimately the pitch. The V2 link from center ball to center ball is 42mm (1.65in).

Once the links are set to the same length, you can reattach the flybar cage to the main head. Go ahead and Loctite the flybar cage screws. It is usually easier to slide the flybar through the cage and main shaft before tightening the flybar cage screws. Now slide the head onto the main shaft, slide the Jesus bolt through the head and main shaft and snug the nut. Do not tighten or use Loctite yet.

Attach the flybar links to the SF Mixing arms. Turn on the radio and connect power to the receiver (plug the battery into the ESC). The radio should still be set to 50% collective (throttle) with the trim slider centered as in the previous steps. Use a ruler to check for the level of the flybar cage. Both mixing arms and flybar cage should be level (perpendicular to the main shaft). If the flybar cage is not level, then adjust the appropriate link to get the flybar cage level. It is more important in this stage to get the flybar cage level. Once the flybar cage is level, then determine if the lower mixing arms are level. If the lower mixing arms are not level, then you have two choices. You can either adjust all three servo links to raise or lower the entire swashplate or adjust the two flybar cage links. However before making any adjustment, check the amount of clearance between the Mixing block and the head (where the guide pins come out). Put the throttle stick all the way up, and move the trim slider all the way up and check the clearance. If you have about an $1/8^{th}$ inch between the brass bushing and the bottom of the head block, then you should adjust the flybar cage links to get the mixing arms level. If you do not have clearance, then you need to lower the swashplate by adjusting all three servo links equally. If you adjust the cyclic servo linkages, then you should go back through the swashplate leveling procedure with the new lengths. Remember to reset the throttle stick to 50% and the trim slider make to center.

Note, a little trick that helps in getting the flybar and lower mixing arms level is to suspend the helicopter from the flybar so that the links, servos and all components are holding the static weight of the helicopter. I am using $1/8^{th}$ in cotton rope, however fishing line is a better choice. Also move the rope or fishing line up against the flybar cage. This technique allows you to keep the flybar from moving so that you can get accurate measurements.
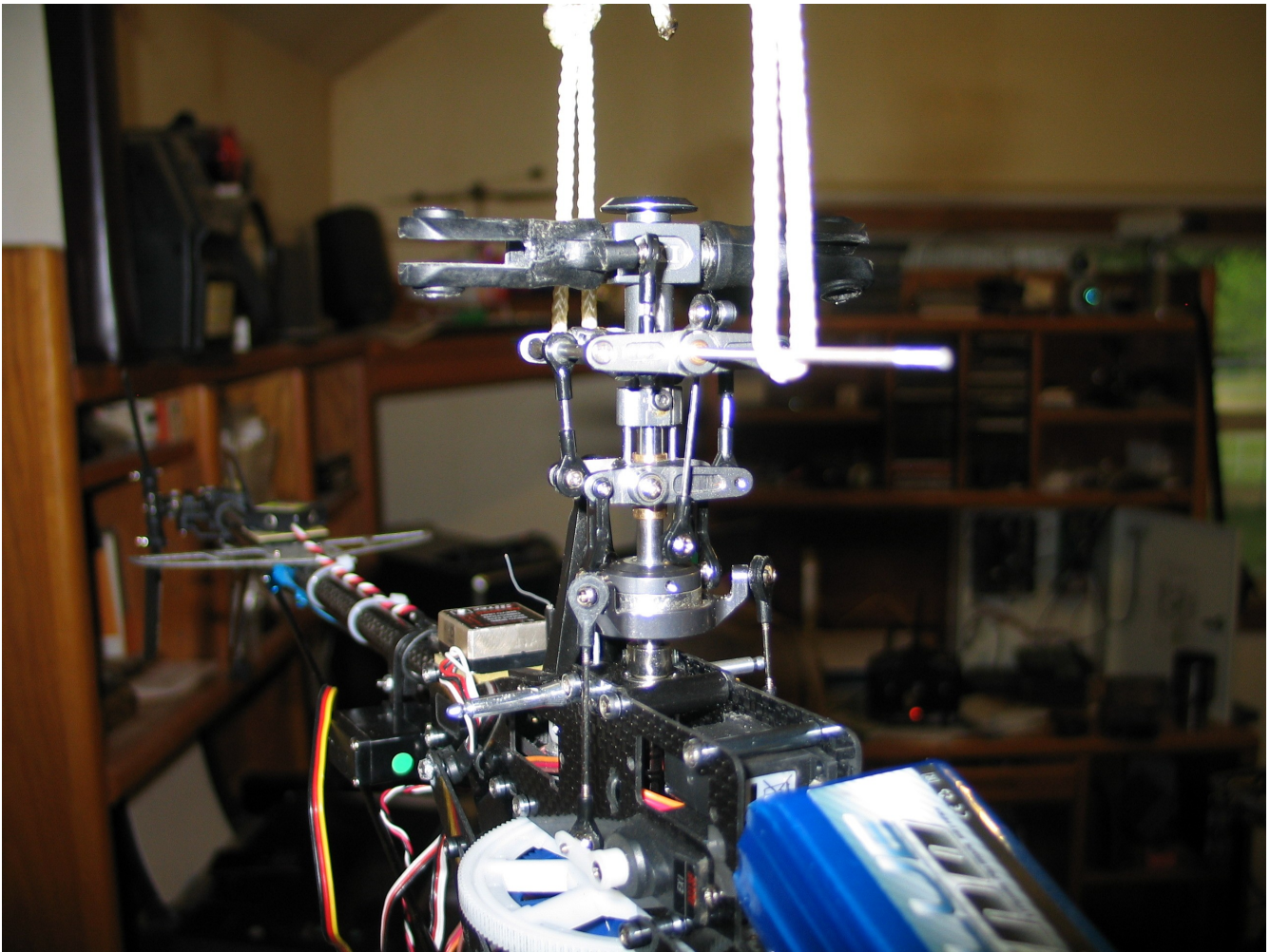
Fig 11b

Now that the swashplate is level, the lower mixing arms are level, and the flybar cage is level, we can move on to the upper mixing arms. Attach and snug tight one of the long links from the upper mixing arms to the swashplate. Do not apply Loctite yet.

The upper mixing arms need to be level. The bottom of the upper mixing arms are straight. We will not level against the bottom, but the center of the long link ball, and the center of the mixing arm mounting screw. We want the blade grip link screw to be lower than the mixing arm mounting screw to give us adequate adjustment capability for the blade grips. The flybar control rods make a nice point of reference.

One end of the mixing arm dips down and is used for the Blade Grip links. When checking level, use the center screw, and the long link screw. If both of the long links were set to the same length 42mm (1.65in), the arms should be level. If not, then adjust the long links equal turns until the mixing arms are level. Suspending the helicopter from the flybar helps this measurement as well. When the mixing arm mounting screw and the long link screw line up with the flybar control rod (both mixing arms) then we can move on to the blade grip link adjustments.

With our current 50% throttle setting, and everything up to this point is level, it is time to adjust the blade grips. We want the blade grips to be level. There are a few ways of doing this. You can slip a long small diameter rod (like a screwdriver) through the blade mounting holes and adjust the links until the

rod is parallel to the main shaft, or you can place a blade sideways in the grip (thick end) and adjust the link until the blade is level. Another way is to attach the blade normally and use a pitch gauge to adjust the link to get zero pitch on both blades. I do all three methods in that order.

Now that you're head is setup, you should go back through the head, and use Loctite on all metal to metal screws. If you find a screw that is just too tight, don't force it. More than likely it already had Loctite applied at the factory. Let the Loctite dry for a minimum of two hours before firing up the motor.

Setting the SWASH AFR / Pitch & Cyclic Pitch

This setting is for managing the swashplate mixing. It is typically used to limit the amount of travel the swashplate moves, and therefore control the maximum amount of pitch. As stated before, the TREX clones are capable of setting a pitch level to over 14 degrees. More than 12 degrees can stress the entire drive train. AFR settings are for the cyclic servos. These are Channel 1, 2 & 6. The values than can be applied are in the range of -100% to +100%.

The AFR settings go beyond limiting the amount of pitch. To explain it, I have inserted an article from "dkshema" on the Run Ryder forum http://rc.runryder.com

Author: dkshema, Cedar Rapids, IA - http://www.slyster.com/heli/mix.html

If you were flying a standard mix, non-CCPM helicopter, if you needed more
or less aileron or elevator CYCLIC movement of the swashplate, you would
adjust the ENDPOINTS/ATV for the AILERON or ELEVATOR channel. If you needed
more or less collective PITCH, you'd adjust the ATV/Endpoints for the
collective pitch channel. If you needed to REVERSE the servo movement for
one or all three of these channels, you would do the reversing in the
REVERSE menu of your TX, for the channel that needed to be switched.

But, since you have a heli whose swashplate is setup for 120 degree CCPM
control, it requires that three servos work in unison to move the swashplate
correctly. The individual control adjustments take on new meaning, as you
have to deal with the electronic mixing that is occurring in the radio.

The electronic mixing requires a few things to work differently in your
transmitter. First, the channel reversing function in your TX ONLY affects
one of the three servos, not the action of all three. The channel reversing
feature in your TX ONLY allows you to get the three servos moving correctly,
with respect to each other, and has nothing to do with them moving correctly
with respect to the function they are controlling.

For instance, for aileron control, two servos need to move in opposite
directions, one up, one down. The third servo does nothing. But if your
servo reversing switches are in the wrong position, those two servos may
both move up, or both move down. Fix THAT using the reverse function for ONE

of the TWO servos.

Elevator requires that two servos move up (or down) in unison, while the third moves opposite (generally the elevator servo). IF all three move UP (or down), you reverse the elevator channel.

Collective requires that all three move up, or down in unison. Generally, if you get the elevator and aileron channels moving correctly with respect to each other, the collective takes care of itself.

BUT -- you may find that although the servos move correctly with respect to each other, they may move opposite of the direction required for the FUNCTION.

This is where the SWASH MIX/SWASH AFR menu comes into play. By simply changing the SIGN of the aileron, elevator, and/or pitch function, you reverse that function instead of messing with the channel reversing stuff.

The ATV/Endpoints no longer adjust the travel of the FUNCTION, they only adjust the travel of an individual servo. So, if you find your swashplate level at mid collective/zero degrees, but that it tilts as it goes full up or full down, you use the individual endpoint/ATV settings to correct the movement of the individual servo that is moving too far, or not enough. You don't affect the other two servos in this manner.

The SWASH MIX/SWASH AFR menu is also where you control how much total collective travel you get (full stop to stop) with the SIZE of the pitch number, and how much aileron and elevator CYCLIC pitch you get by adjusting the SIZE of the AILE and ELEV numbers in the swash mix menu.

Finally, the numbers in the swash mix menu do NOTHING to center the swashplate in its travel range for that zero degree setting.

This is accomplished by making sure your servo arms are where they are supposed to be AT NEUTRAL (generally horizontal, parallel to the ground unless your pushrods have some weird geometry). When you have all three SERVO ARMS properly positioned at NEUTRAL (mid-stick on both sticks), you adjust the pushrods controlling the swashplate to get the swash not only level, but in the center of its overall travel range.

When you have accomplished THAT, you then adjust the pitch links up on the

head generally to get all mixing arms level, and ZERO degrees pitch in BOTH
blades.

Barracuda mentions the idea of setting your pitch curve to a big FLAT LINE
at 50%. I picked this idea up from Ron Lund's Heliproz South website. If you
have a 5-point pitch curve radio, set points 2, 3, and 4 at 50%, and point 1
at 0, point 5 at 100.

In doing so, as long as the collective stick is anywhere between points 2
and 4, the servos will be centered (neutral) and you can make your pushrods
to level the swash, and center it in its overall travel range. You can set
the rest of the pushrods to level the various mixing arms, and to set ZERO
degrees pitch in both blades.

Finally, you can go to points 0 and/or 100 to set the overall pitch travel
using the PITCH number in the SWASH MIX/AFR menu.

To figure out what the AILE and ELEV numbers "should" be, use your pitch
gauge to figure out what your cyclic pitch is.

If you turn the head so that the flybar is perpendicular to the sides of the
heli (main blades -- one in front, the other over and parallel to the tail
boom), set your collective stick to the ZERO degree setting, you can measure
CYCLIC PITCH values for the AILERON function.

Put the pitch gauge on the MR blade sticking out front, about mid-way on the
blade. MOVE THE AILERON stick side to side. Go full LEFT (or right) and
measure the amount of pitch from ZERO degrees that the blade moves. Adjust
the AILERON number in the SWASH MIX/AFR menu to get +/- 6 or 7 degrees of
aileron cyclic.

Turn the head 90 degrees, keeping the collective at the ZERO degrees pitch
setting. The flybar is now over and parallel to the tail boom, and sticking
out in front, the MR blades are perpendicular to the sides of the heli.

This time, move the ELEVATOR stick to its full extreme, measuring the amount
of pitch the MR blades get as you do. This time, set the ELEV number in the
SWASH MIX/AFR menu to get that same +/- 6 or 7 degrees of cyclic.

For the FS-CT6A radio, the AFR settings per channel can be a little confusing. A lot of new pilots get
End Points and AFR settings mixed up. I will speak to End Points in a moment, but lets consider what
the AFR settings do. They provide scale settings to the collective mixing processor. When you set an

AFT channel to 50% (for example) the collective signal will make a calculation that will limit that collective input to only 50% travel, but more than that, it will create an internal linear curve (scale) for that 50%. Basically, it tells the controller that instead of 30 degrees of motion for the servo at full stick, it should only move the servo motor 15 degrees at full stick. Now this is where it gets different than an end point. The new scale will divide that 15 degrees across the total stick movement, spreading it out evenly. It changes the speed and distance and direction the collective moves. Notice I did not say channel.

The channel labels in the swashplate AFR settings are misleading. Channel 1effects collective right aileron, Channel 2 effects collective Elevator, and Channel 6 effects left aileron (also called pitch).

 To experiment, set the AFR channel 1 to 25%. Watch the graph, and notice that it not only effects channel 1 but also channel 6 by. Return CH1 to 100, and experiment with CH 2. Set it to 25% and notice how it effects all the channels for right stick up and down, but not right and left.

So with that experiment, you can now see that the Swashplate AFR settings control the mixing controller for all the collective pitch servos, not just one.

End points only effect individual channels. The Endpoint will scale the input for each servo independently. It does not have the same intelligence as the AFR settings. You will hear pilots tell you to adjust the End points to limit the amount of pitch. Be aware, that if you do that, you are also changing the scale for each servo with no collective intelligence to correct for rates between the servos. Yes it will fly, but you will notice the helicopter will bank better in one direction than the other, or go backwards faster than forward, or bank to one side as you ask for forward movement. On punch outs, you will see the helicopter do something other than go straight up.

Only use Endpoints to prevent binding or servo horn to gear contact, and then keep the collective channel endpoints the same value so they maintain the same rate/scale.

Setting the Blade Pitch

In the next step we are going to set the initial blade pitch. Select one of the blades as your reference blade. This is the one we are going to get to zero pitch with the servo horns at 90 degrees. Mark it with a dry erase mark, or a piece of tape. I typically have to balance the blades, so one will already have the red weight decal applied and that will be my reference blade.

With the blades attached. Set the radio Throttle Cut switches ON (towards you). Power up the radio and then the model. Set the Idle Up switch.

Safety Reminder - it is much safer to keep the motor wires detached during setup. Always turn on the radio first and wait for at least 5 seconds. Always set the Throttle-Cut switch to On, and then you may safely connect power to the helicopter.

Power up the model and attach a Pitch Gauge to the reference blade about 1 ½ to 2 inches from the end. You want to tighten the gauge down on the zero setting. Make sure the fly bar is perpendicular to the main shaft. Look down the blade and observe the top of the pitch gauge as it lines up with the fly bar (Fig. 12). It can be handy to use tie-wraps with a blade holder connected to the fly-bar paddle to hold the fly-bar steady (see Fig 12a). This is another area where the Idle Up pitch curve of

0,50,50,50,100 comes in handy.

*Note – The Swash AFR setting has a range of -100% ~ +100%. A Negative setting has the same effect as reversing a servo.
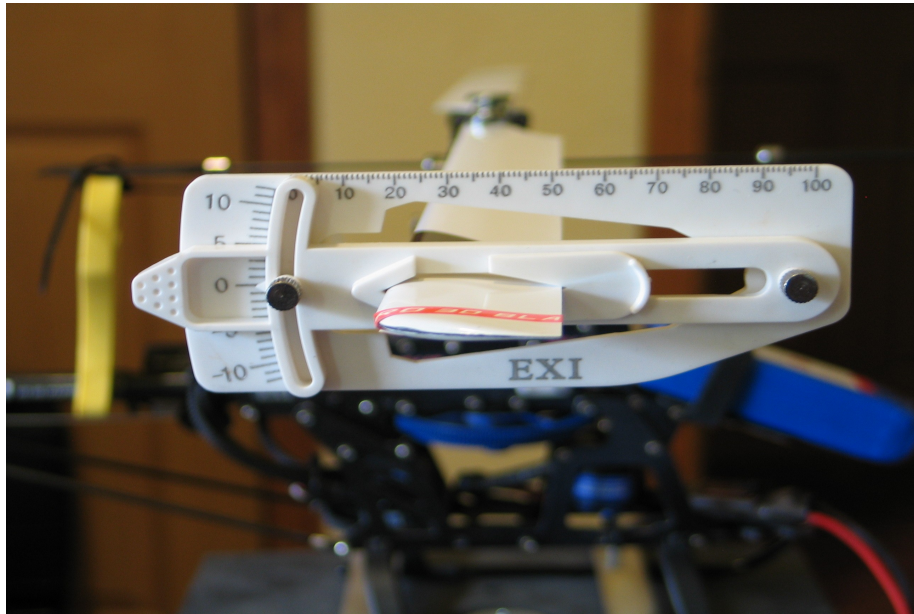
Fig 12
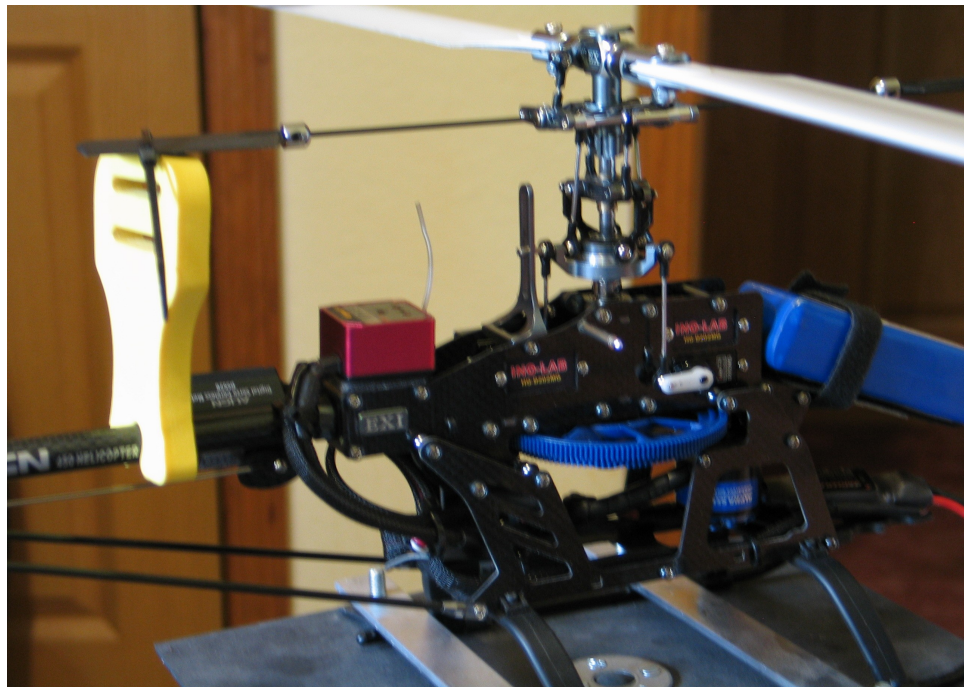
Fig 12a

If they are not lined up, then you need to adjust the top blade grip to fly bar control lever link until you reach to zero pitch or as close as possible. If you are real close, then you can use the VR(A) dial to tweak it in, but only if it is real close. You do not want to use up all of your VR(A) setting just to get to zero pitch. The lower fly bar control level link is used for fine adjustments. It is preferred to keep the VAR(A) dial close to 9 o'clock or mid way in its potential travel.

Fig 13

Test for zero pitch at multiple locations as you rotate the blade a full 360 degrees. This is to verify your swashplate is properly leveled. If you keep a constant zero degrees throughout the full rotation, you can be certain that the swashplate is indeed level.

Now that the reference blade is at zero pitch, you can move the left stick all the way to the top. Measure your pitch at this setting. You do not want the pitch to be more than 12 degrees unless you are a serious 3D pilot in which case you have a better radio and are not wasting your time with this set of instructions. I typically keep the total pitch at 11 degrees.

We will use the SWASH AFR setting to limit the upper and lower pitch. The setting here effects both positive and negative pitch. Typically on the EXI head, the SWASH AFR is set to ~83% to provide a maximum of -11 and +11 degrees pitch. Your particular head assembly may differ in the SWASH AFR settings. If the swash plate level was perfect throughout the travel, then all three SWASH AFR settings should be the same percentage. If not, this is an area you can compensate a little by allowing slightly more travel percentage for the lowest servo during the leveling exercise.

Everything so far in this procedure has been using the reference blade. It is a good idea to check the pitch of the other blade at mid stick for zero. It needs to be as close as possible to the reference blade. In the blade tracking step you may be required to adjust this blade, however if you get the two blades dead on, it greatly minimizes the need to adjust your blade tracking.

If the opposite blade is wildly off pitch from the reference blade, you need to check for out of tolerance parts. Typically the main shaft will be the problem, however, a worn or weak set of dampers (rubber o-rings in the head), a bent feathering shaft, or a bent head can cause this offset.

Note: Dampers do wear out with use. Align makes a couple different stiffness rated damper sets. I

prefer the #80 dampers. Keep a couple sets in your parts bin. Periodically check the dampers for wear. An easy check is to lift a blade with your hand to see how far it picks up the feathering shaft in the head mount. A health set of dampers will only allow a small amount of movement. As dampers wear out, you will notice blade tracking changes.

At this point you should now have -11 pitch at full bottom stick and 0 at mid stick, and +11 pitch at top stick. Your AFR settings have been set to limit the amount of pitch, and your VR(A) dial is at or around mid point. You have removed the pitch gauge from the blade.

Blade Tracking and Pitch Curve

Up to this point all of the setup was done without the motor connected, and using the Idle Up Pitch curve. Now it is time to set the blade tracking, but before we do that we need to setup the Normal pitch curve. Select the Normal Pitch curve button, and we are going to set the curve for a simple linear baseline for testing the blade tracking. We want a curve that will give us enough blade and damper flex at mid to slightly higher than mid throttle. This is typically the hover stick location, and that means the blades are lifting the full weight of the model. This is where we want to observe the blade pitch.

Note: Experienced pilots can manage tracking errors in flight, and will typically check their blade tracking in the air rather than mounting the model to a test stand or weighting the model to the ground. Checking it in the air is by far much safer than on a stand or on the ground because blades can and will come off. When they do, people and property can be damaged.

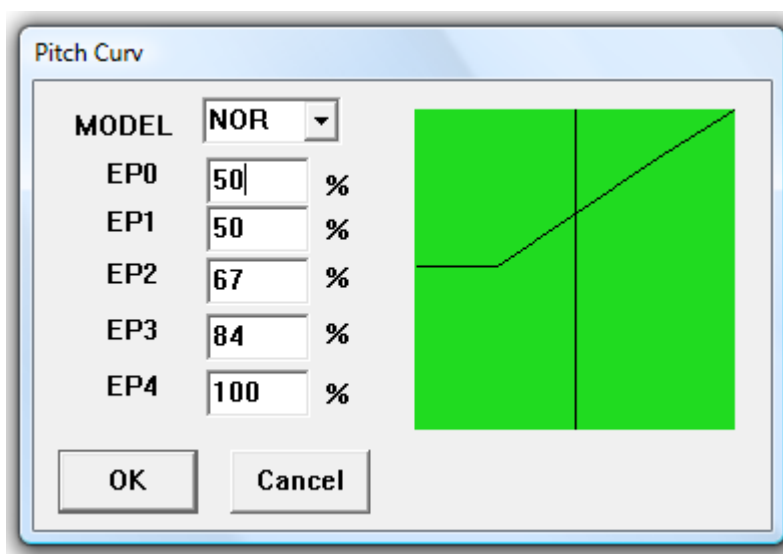Setup the Normal settings as illustrated below (Fig 14).

Fig 14

Warnings: The following procedure requires the motor to be running. This is a dangerous process. Take all precautions so that you do not incur injury to yourself or others, or property. You will need to secure the helicopter to an immovable object. I use a home made test stand made of common parts such as 1 1/2" irrigation (PVC) pipe with a plexiglass platform mounted with a light weight gimbel (Fig. 15).

Some users tape the landing gear to the floor, and lay a heavy tool through the landing skids. Whatever method you use, be sure the helicopter will not come loose. Some people perform this test in flight. If you do not feel comfortable with performing this test with the helicopter mounted to an immovable object, then perform the adjustments between test flights.

Do not rely solely on the four tiny skid mounting screws to hold your model to the ground. Place a strap through the frame under the main gear as a precaution.

Do not trust brand new blades or blades that were used during a crash. They may appear perfectly healthy, but tiny fractures can instantly become a full blown disaster. When testing blades, always stay at a safe distance the first time you engage the throttle. We are speaking here from experience.

Fig 15

Warning: Blades are held on by small screws or nuts. They have been known to come off at high RPM. The first time (and actually anytime) you startup the helicopter motor, be at a safe distance to minimize injury or damage. Where safety goggles as you will be looking down the business end of the blades as they rotate at a very high speed.

Power everything off. Make sure the radio's Idle Up switch (SW-B) is set to OFF (away from you).

Set the Throttle Cut switch (SW-A) to ON (towards you). Connect the motor wires to the ESC. Mount the helicopter to a test stand or some immovable object (see warnings above). The objective of this test is to adjust the blades so that each blade passes through the same location at the same place. As the blades rotate and apply lift, they will flex as they take on the weight of the model. The blades must follow each other to evenly push the air. If one blade is tracking higher than the other, it is robbing the lower blade of its lifting capability. This results in reduced overall lift, unstable flight, and vibration.

Set the radio left trim slide for throttle (vertical trim on the left stick) to the bottom position. All other trims in their centered position. Set the throttle stick to its lowest position.

Turn on the radio transmitter first. Attach the battery power connector to the ESC connector on the helicopter. Move to a safe distance from the helicopter. Switch the Throttle-Cut (SW-A) switch away

from you to the OFF position. Slowly power up the motor. Bring the motor up to slightly more than mid stick. The blades should start applying pitch and will lift in the blade grips.

Increase the throttle to about ¾ throttle and observe the leading edge of the blades. You will notice the blades begin to flex upwards as they take on the weight. This test must be done with the blades producing thrust (lift) so that end play is removed from the blade grips and feathering shaft and the dampers have the full weight of the model.

Determine which blade is traveling higher than the other by looking at the leading edge of the blades. The main blades travel in a clock-wise direction looking from above the helicopter. If you are facing the nose of the helicopter, the blades leading edge will be coming towards you to your right (the helicopter's left side). The reference blade we used earlier had the red decal. You want to determine which way to move the non-referenced blade to get it tracking with the reference blade.
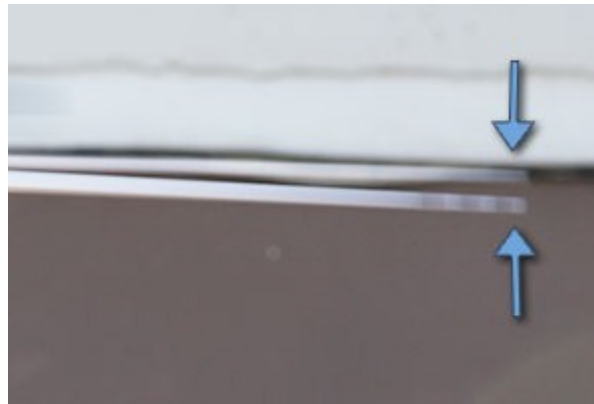
Fig 16

In the illustration above (Fig. 16), the lower blade is marked with three black lines that are visible as the blades rotate at high speed. This is observed by looking at the leading edge of the blades.

If the black marks in Fig. 16 were on our reference blade, then we will want to adjust the opposite blade to have less pitch (leading edge needs to be lowered). Keep in mind that our referenced blade was used for setting our pitch, so we want to bring the other blade into the same tracking as our referenced blade. Since the opposite blade is tracking higher, we will need to reduce it pitch. This is done by removing the blade grip link off of the blade grip ball, then lengthening that link to force the leading edge downwards. Increasing the length of this link will bring the leading edge of that blade lower.

Rod ends are built to access the ball from only one direction. The manufacturer will provide a mark such as a ring around the larger hole. When adjusting the rod length, make complete turns so that the correct hole of the rod end is facing the ball. Only adjust one turn at a time, and retest the blade tracking.

Note: In some of the forums, remarks have been made that the small links at the blade grips (Fig 13) are for fine adjustment, and the long links to the swashplate are the rough adjustment. This is not the case. The SF mixing arm is a fulcrum with the short end connected to the blade grip with a link. With the long end of the SF mixing arm is connected to the swashplate with the long link. The way a fulcrum works is it takes more movement of the long end to produce a small movement on the short end. Therefore the long end produces less change per turn of its linkage. Less change means finer adjustment.

Adjust the proper linkage so that at ¾ throttle the blade tips line up as they spin around.

At this point you should now have the blade tracking set so that you only see one blade as it rotates around with enough throttle speed to lift the helicopters weight.

Tail and Gyro Setup

This is an area that confuses a lot of new hobbyists. It is not complicated if you understand that the Gyro is responsible for most of the work of keeping your helicopter pointed in the direction you intend.

Two new terms to understand is the Gyro **Rate Mode**, and **Head Holding Mode** (HH).

Rate mode will try to compensate for unintended tail movement but does not remember the actual starting position and therefore can not bring the tail back into the last known heading. HH mode on the other hand remembers the last heading (when the stick was last centered) and unless it is instructed to get a new heading, it will aggressively attempt to bring the tail back to the saved heading. The HH mode has a signal gain setting that is controlled (the amount of gain) through channel 5 of the receiver. The gain value sets the sensitivity of the HH mode. Too little gain, and the margin (degrees) of off heading increases, too much gain, and it will fight itself trying to maintain a heading (resulting in what is called Tail Wag).

Note:Flying manually without any gyro is possible, but *incredibly* difficult even for experienced pilots. The gyro helps the pilot by comparing the rudder signal you provide from the transmitter ("what you want the helicopter to do") with the actual detected motion of the helicopter ("what it's actually doing" or what was done to it by environmental factors or inherent counter-forces of rotary flight). So, if you told the helicopter to stay pointing (center stick) in one direction and the gyro knows the helicopter is actually rotating anyway because of wind or main blade torque, it will add or subtract from the rudder servo signal until the helicopter actually stops rotating, just like you asked it to. As an example, if you're in a stable hover when the wind gusts, the gyro will automatically fight to prevent the wind from blowing the tail around downwind ("Weather-veining"). If you increase or decrease throttle, the gyro will automatically try to keep the tail from swinging around due to the reactive torque from the main rotors.

A bit of history: "Gyro" is actually short for "gyroscope"… the same instrument you might have played with as a kid in the form of a top, or used in physics class to learn that a spinning object "wants" to maintain it's orientation, and will expend rotational energy to do so. Traditional helicopter gyroscopes actually had a motor-driven spinning flywheel weight surrounded by bump switches to detect when it's orientation was changing. This was an unreliable, slow, and heavy device, but far better than manual rudder control. Modern gyros are lightweight piezo-electric force gauges with no moving parts, and a bit of computer intelligence that allows for a really cool function called "Heading Hold." Not all gyros have a Heading Hold mode, but it's a shame to use a gyro without HH mode on a good helicopter.

Because the gyro is now a small computer, it can not only know that the gyro is moving, but how fast and long it's been moving. This means it mathematically integrates the simple rate changes over time, and because it can keep track of all these changes, it knows "where it actually is" vs. "where it should be" according to what you've told the helicopter to do. As a result, when the servo fails to react fast or powerfully enough to overcome an undesired motion, the gyro knows it's not where it should be and

continues to adjust until it achieves the original position. This means any time you're not telling the helicopter to rotate, HH mode remembers the last commanded heading and will aggressively attempt to bring the tail back to the saved heading, regardless of how long it has to work to get there. The HH mode has a signal gain setting that is controlled (the amount of gain) through channel 5 of the receiver. The gain value sets the motion sensitivity of the HH mode. Too little gain, and it won't notice small movements that can still add up to being off-heading. Too much gain, and it will see it's own corrections and fight itself trying to maintain a heading (resulting in what is called "Tail Wag" when it overshoots repeatedly).
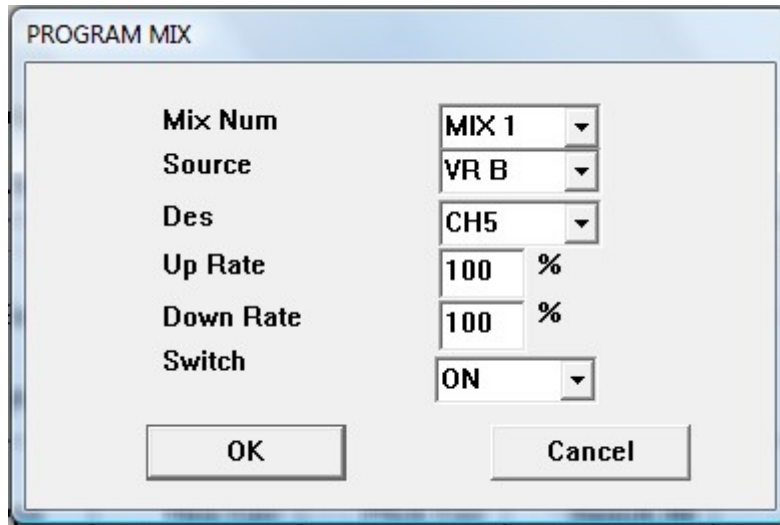
What is Drift?

Drift is a term used by pilots to describe the tail wondering off from the center position when there is no rudder input. There are a few things that can cause drift. First not all gyros are of the same quality. Economy gyros are effected by voltage and temperature. As the battery drains during flight, the gyro gain is changed internally. Once the gain reaches a threshold it can actually induce drift. During setup, you can adjust the gain to its edge, and you will notice the servo start to move on its own, and sometimes it will move all the way to one end of travel just sitting there. This is why you will be asked to adjust your gain until you experience an aggressive tail wag, then back off the gain just enough until it stops. This will give you enough margin to keep it from reaching the low voltage threshold where drifting starts. Temperature effects gyros as well. If you fine tune your gyro at one temperature, and then (like the next morning when the temperature is different) fly in a different temperature, you may either see tail wag or drift depending on how the gyro electronics are effected by the temperature. It is a good practice to let the gyro adjust to the current temperature before putting it into flight. In other words, don't just run outside with your room temperature gyro, and start flying in 50 degree skies. You will find yourself fighting for tail control right off the start. Instead, take it outside, and give it ten minutes to adjust to the temperature before flying.

Lets move on to adjusting the tail. Most of the tail setup is done in Rate mode. However for the Gyro to properly initialize, we need to start the model up in HH mode. We need to return to the configuration program to assign the VR(B) dial to channel 5. This is done using the MIX settings (Fig. 17).

Select the MIX option, and select MIX 1 from the drop down list.

Fig 17

Set the source to be the VR B dial, the destination to be Channel 5, with 100% for both rates, and the Switch to ON.

Save this settings to your configuration file.

Gyro Gain VR(B) Setup

There does not seem to be a standard on which direction the VR(B) dial should be turned to set the gyro into Head Holding (HH) mode, or Rate mode. I prefer that the HH mode is obtained using a clockwise (CW) rotation, and other pilots prefer to use a Counter Clockwise (CCW) rotation. The Blue Ray 450 RTF package includes this radio, and it is typically setup to use CCW for HH mode.

In some documentation on the Internet, the instructor will tell you to set the dial to 10 o'clock and use CCW to adjust the gain. Others such as this document will demonstrate a method that will work on any FS-CT6A radio. Do not rely on information stating you should set the dial to a specific clock position. That position depends on the way the VR component is installed, the type of gyro, and the reverse setting for channel 5 in the radio, and the reserve setting of the gyro itself.

The VR dials are potentiometers. This is a Variable Resistor hence the abbreviation of VR in the manual, and labeled as such on the radio. Some FS-CT6A radios have the VR dial installed with the halfway point (dial position indicator) pointing straight up. Some have the indicator pointing to 9 o'clock for the mid-point. Some may be different all together. Test your dial by rotating it in both directions to find out the end points, and the halfway point. The VR value at mid-point is the zero voltage setting. At zero voltage signal, the gyro will be on the edge of HH and RATE mode, and will typically default the gyro into rate mode because there is no signal at the zero or halfway position.

To determine which direction your radio uses to obtain HH mode, turn the dial all the way in one direction. Then (with the throttle cut switch On – safety measure) turn on the transmitter, and then plug the battery into the helicopter. If the Gyro HH indicator (light emitting diode - LED) illuminates, then you have found the direction for HH. If you do not like that direction, you can change it very easily. Simply use the RESERVE button in the program to change the CH5 check box, and set the physical REVERSE switch (or dial) on the gyro. Those two settings allow you to set the direction of VR(B) to your preference for HH mode.

The remainder of this document will use the CW direction for HH mode.

On the radio, turn the VR(B) dial to the mid-point and then turn it CW 60 degrees (2 hour markers) to make sure the gyro initializes in HH mode. You can also leave it at the mid-point, then turn on the radio, and rotate the dial until the gyro light illuminates, turn it 60 more degrees, and then disconnect, and reconnect the battery so that the gyro initializes in HH mode.

If you have attached the servo horn to the tail servo, then remove it. Verify the tail linkage rod is not binding, and can easily travel to both extremes available by the tail slider. Set the Throttle Cut switch (SW-A) toward you to prevent the motor from turning. Set the Idle Up switch (SW-B) to OFF away from your. Left stick horizontal slider is centered, and the vertical trim slider (on the radio) is all the way down.

Power up the helicopter. Let the Gyro initialize, typically with a three beep signal, and the servo find its center . Attach the servo horn at 90 degrees to the tail rod linkage (Fig.18)

*Note - you can use the boom as your 90 degree reference since the tail rod linkage is supposed to be parallel to the boom. Some servos such as the Align DS-520 (Fig. 18a) need to be mounted at an angle, however the ball link is still 90 degrees to the boom.
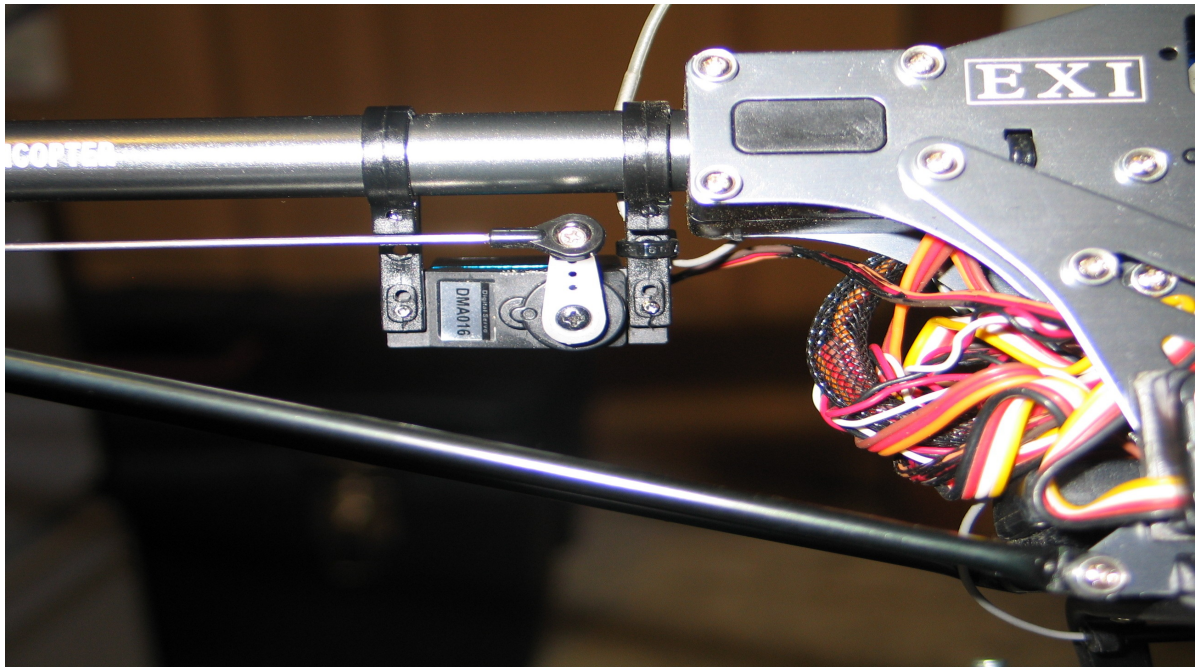
Fig 18
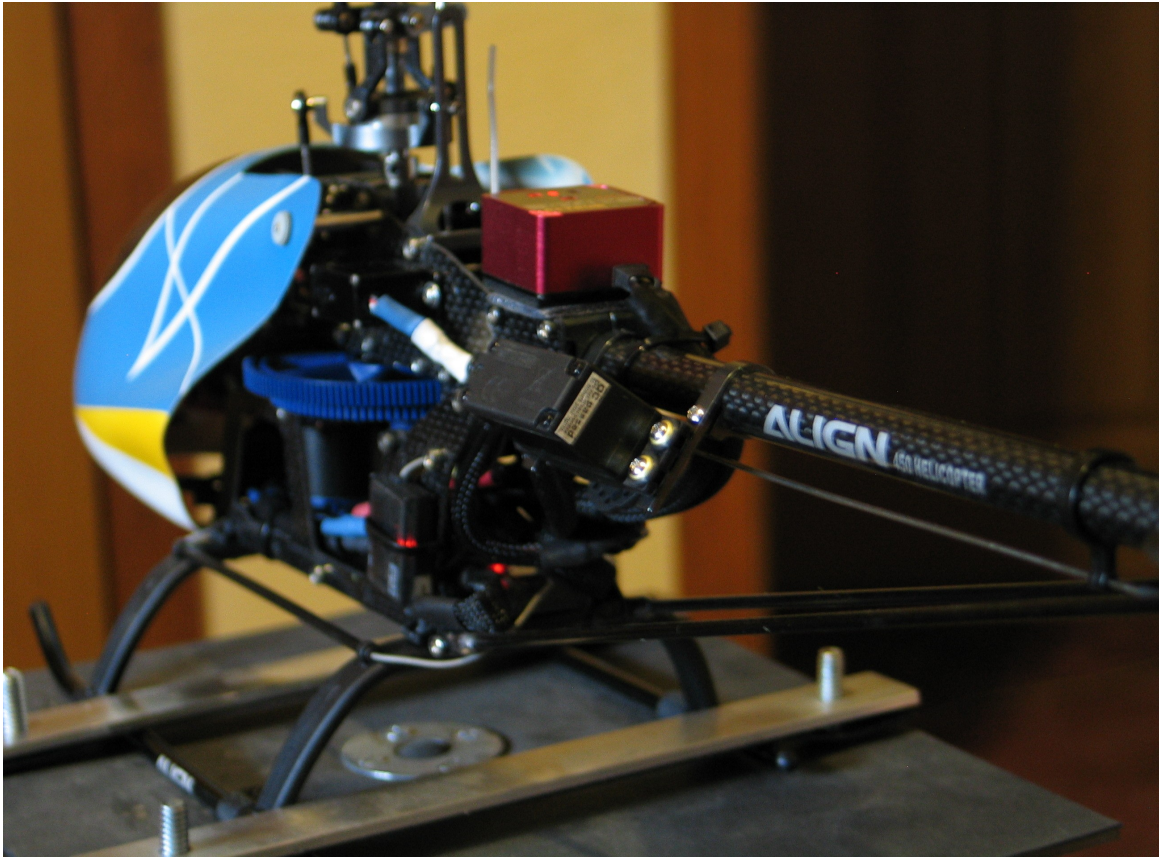
Fig 18a

Hint: if you have a slow servo, then using a longer horn will help in maintaining position. If you have a fast digital servo then using a hole closer to the hub will help. The horn and hole position should allow the servo to move the tail slider completely against each side of travel without binding the servo. Verify the servo horn does not come in contact with any part that would result in a stripped servo gear.
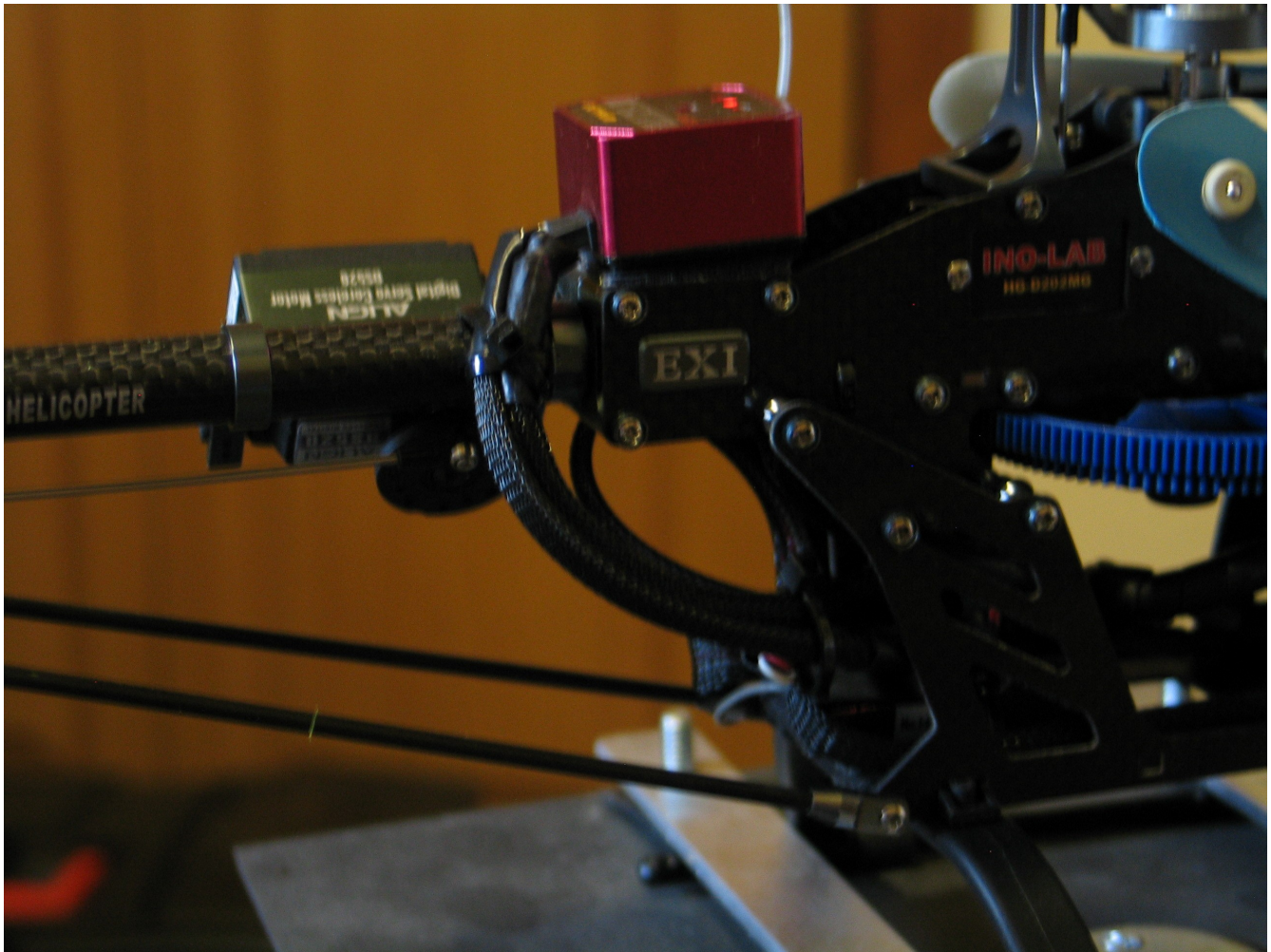
Loosen the two screws that mount the servo to the boom. Move the servo along the boom so that the tail slider is slightly closer to the boom from center of the shaft. The tail blades should have a slight pitch.

Snug up the rear mount screw so that the servo does not move on the boom. Now we want to check for correct movement direction. Some Gyros have a reverse switch, others do not. If your gyro does not have a reverse switch, you will need to use the reverse (servo) option in the program for channel 4.

To determine if the servo is moving in the correct direction, power up the helicopter, and apply slight left stick towards the left. If the tail slider (looking from behind) moves to the right, then it is correct. In other words, the tail slider should move in the opposite direction as the radio stick. If your physical arrangement is different than a TRex or clone, then observe the tail pitch. The left stick controls the Nose of the helicopter. With Left stick towards the left, it is responsible for flying the nose of the helicopter to the left or CCW looking from above the helicopter.

*Hint – To keep yourself oriented between the radio controls and the helicopter, always fly the Nose of the helicopter. NEVER fly the tail. This is a common problem for new pilots. Using the left stick pushed over to the left should cause the nose to go left CCW. Right stick with the stick leaning towards the left causes the helicopter to slide to the left. When both sticks are going to the left, you get a nice banking left turn with the tail following the nose. When you start flying "Nose In" (flying towards you), the nose orientation will be even more important. So don't pick up a bad habit of concentrating on the tail. Put your mind's eye in the nose of the helicopter (Fig. 18b)
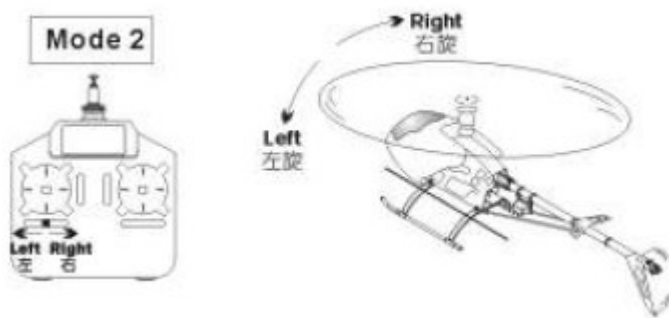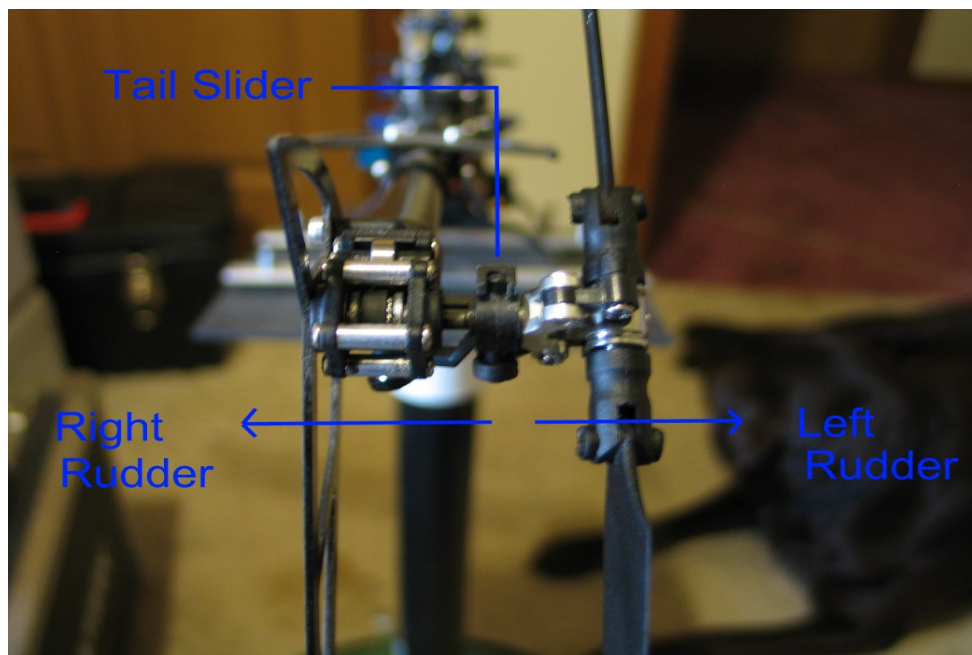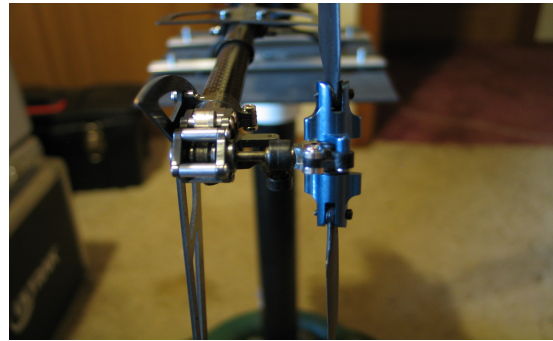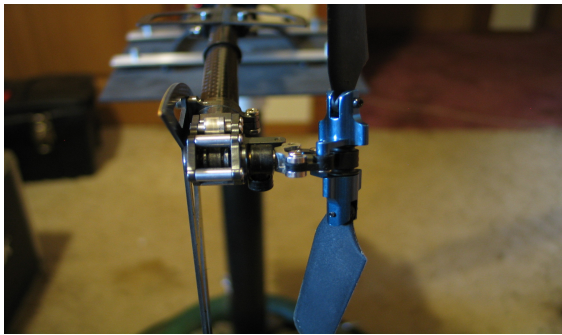

Fig 18b

Fig 19

Fig 19a - Full Right Rudder (stick right)	Fig 19b – Full Left Rudder (stick left)

Setting the tail slider limits

Some Gyros have the ability to limit the amount of rotation of the servo. To use this option, first slowly apply left stick (towards the right). If the tail slider makes contact before the stick is all the way to the right, then use the limit settings of the gyro to back it off. The idea is to barely touch the end points of the tail slider travel in both directions. Use the gyro limitation as your first option, and if that is not enough, then you can use the End Points option of the program to prevent the tail slider from binding against the end of travel. You may have to use a combination of both Gyro limits and End Point settings to achieve full tail slider movement.

Hint. Once you have the limits set, it is a good practice to back the limits off slightly so that the tail slider as a tiny gap between the end points of travel. The reason for this is because we have not performed the initial test flight so we will more than likely have to move the tail server on the boom and this will affect the tail slider limits.

Place some training gear on the helicopter, and find a hard level surface such as a patio or garage floor to adjust the tail servo position. All we need to do is get the servo into the spot along the boom where the helicopter does not spin at a hover.

We will not be using the HH mode for this part of the setup. We will initialize the Gyro in HH mode, but before lifting off, we will change to Rate mode. Once the Rate mode is dialed in and the helicopter does not spin or drift (with no wind conditions) we can finalize the setup and move into the fine tuning stage.

Note: some pilots believe that you can just set the tail slider in the center, and let the gyro HH mode figure out what to do. That does work, until your gyro falls out of HH mode unexpectedly, and then you are in for a fight to get her landed. Also using that approach puts more work on the gyro and servo than is necessary. By following the following instructions for setting up in Rate mode, you will be able to maintain total control of the tail even if the gyro falls out of HH mode. You may not even notice it fell out of HH mode until you get her on the ground and see the red light flashing at you.

Power up the helicopter and turn the VR(B) gain dial CCW until the Gyro light goes out. When the Gyro light goes out, the Gyro is in RATE mode. Bring the throttle speed up until the helicopter is sitting light in the skids. It is normal for the helicopter to want to spin 45 to 90 degreed on a hard surface with training gear attached. Just bring it back using the left stick and increase throttle a little

more. If the helicopter begins a high speed spin, it means the gyro needs to be reversed. In that case, power down, set the reverse, and try again.

If it takes a lot of left stick to prevent the helicopter from spinning, then adjust the servo position on the boom. Small increments until it takes little or no stick to keep it straight while on the ground.

Once you have the steady tail in Rate mode on the ground, the next step is to perform a hover in Rate mode. The same process you performed to get the tail steady on the ground also applies in the hover.

Once your Rate mode can hold a descent tail position at a 4-5 ft hover, you are ready to place it into HH mode. First tighten both servo boom mounting screws.

With it landed, turn the Gain dial VR(B) CW until the HH mode light on the gyro lights. This is the lowest gain setting. If the horn starts to drift, use the horizontal slider to stop the drift. Now with no throttle reset the HH setting by toggling the gyro in and out of HH mode three times in less than two seconds. This can be done with either the VR(B) dial, or using the left stick by rapidly moving left and right three or more times in under two seconds. Test the hover again. Each time you test hover, land and increase the gyro gain CW a little at a time. At some point the gyro will begin to perform a Tail Wag. This is cause by the gyro commanding a fast movement of the servo, and over-compensates. This in turn causes the gyro to command the opposite signal, again over-compensating. Turn the gain CCW until this stops, and then turn it about 10% more CCW.

Note: Gyros are effected by your radio rudder trim slider switch. There is a threshold at which the gyro will assume you are applying stick movement and falls out of HH mode. When you first power the helicopter, the gyro takes a reading of the current software and hardware SUBTRIM setting from the radio. That becomes its reference point. It tells the computer that at this heading I should have that SUBTRIM value. The Slider trim throws off that original value, and too much of a change will cause the gyro to display a high speed indication (led flashing) to show it has lost its reference, and will no longer attempt to go into HH mode without a reset. If you have a radio that has a Gain toggle switch, you can quickly toggle that switch 3 times to tell the gyro to reset, and re-read your trim settings. Don't try this if you are a beginner pilot, instead, land and use the dial (between rate and HH within two seconds) to reset the gyro. Another way of resetting the gyro is to rapidly toggle the rudder stick max Right then Left three times in two seconds. Remember that once the gyro enters reset mode, it needs to be steady in one position with no rudder stick to establish its new heading. That operation can take up to 7 seconds.

At this point your helicopter is setup for typical beginner flight. Your Tail servo and gyro settings are complete. Before going off an starting to fly you need to perform some fine tuning.

Fine Tuning & Radio Hints

Up to this point we have been using basic throttle and pitch curves with no mixing other than setting the Gyro gain potentiometer. Now it is time to fine tune the settings for your flying level.

You should be comfortable enough with your radio so that you can reach all of the sub-trims, switches and dials while in flight. Specifically the sub-trims.

Note: The following instructions assume you already have the skill necessary to maintain a steady hover. If you lack those skills, I highly recommended that you take the **RADD'S School of Rotary Flight Training Courses** located at: http://www.dream-models.com/eco/flying-index.html

The first step in tuning is to get the helicopter to hover free hand for at least two seconds. Place the helicopter into an eye level hover and use the right side sub-trims to get the helicopter to hover level, Apply as much sub-trim as required to accomplish this. Once obtained, go back to the computer, and adjust the electronic sub-trims to that you can bring those cyclic sliders back to center point.

You may need to test fly and readjust the software multiple times to get the mechanical sub-trims back to center.

At this point you should have a well behaved albeit wimpy helicopter hover. Now you can adjust the throttle curve to provide more head speed in the range of flying you intend to work in. We originally set the throttle curve to a linear 0-100 setting. With higher head speed, the model will have crisper control at the same pitch. You can alter the curve to give yourself a nice head speed at your normal hover zone of the left stick. You will notice that it takes less throttle to maintain a hover, and the helicopter is more controllable. We started off with the lower throttle and pitch settings to help avoid too fast a reaction from the helicopter as we made adjustments.

Throttle curves and Pitch curves are joined in their operation. Each has an effect on the other, therefore as you tune the helicopter to your flying skill keep in mind that adjusting one curve may require adjusting the other as well.

You can return the pitch settings of the software and dial in a negative starting pitch to something like -2 (physical pitch) for the NOR setting on EP01. This is done my setting the value to something around 40. Then position 2 to something like 50. Depending on what you want to do, you can ramp up the pitch quickly for more radical jumps, but be aware of the limitations of your tail gyro and servo. It may not be able to compensate for the rapid increase in pitch and the tail will blow out on a vertical punch out. Make sure you adjust the throttle curve to give your tail rotor a chance in countering the increasing resistance as the blade pitch increases.

Negative pitch in normal mode always causes controversy in RC Helicopter groups. For anyone that has ever had a gust of wind come up and pop your helicopter into the air will appreciate the ability to apply negative pitch to get the helicopter to counter the updraft.

VR(A) Pitch Adjustment

This dial will allow you to modify the pitch. For example, Too much pitch with a slow head speed will cause the helicopter to be unstable. You can turn down the pitch (CCW) which will allow you to apply more throttle with less pitch. If the helicopter doesn't want to lift at mid stick but has plenty of head speed, you can turn up the pitch (CW). To test this (on the ground), turn the VR(A) dial CCW to 7 o'clock and bring up the throttle up to mid stick or until the helicopter is light in the landing skids. Start turning the dial CW to apply more pitch while maintaining the same throttle input. You will see the helicopter begin to lift as more pitch is applied with the VR dial. More advanced radios will allow you to create multiple pitch curves and switch between them with a toggle switch. The FS-CT6A only supplies this dial for in-flight or pre-flight pitch adjustments.

VR(B) Gyro Gain / Rate Mode

There is nothing wrong with flying in Rate mode. Typical backyard and park flying can be a little smoother in rate mode than in Head Holding mode. HH Mode is more desirable when performing more radical flying especially in 3D mode. Know your optimum gain position of this dial. In more advanced radios, there are options for more than one gain setting. With the FS-CT6A radio, the dial is not as convenient, but does allow you to change the gyro gain on the fly, or slip into Rate mode.

SW(B) Idle Up / 3D Mode

New hobbyists are intimidated by this control. And for good reason, using the stock Idle-Up Throttle and Pitch settings, the motor is going to jump into high speed. The pitch will jump to the location specified by the Idle Up (ID) pitch curve for that throttle location. The result can be a dramatic reaction by the helicopter.

It is not advisable to start the helicopter in 3D (Idle-Up) mode when first taking it to the field. If you watch a Pro, he will first spin up under normal mode and lift the helicopter into a low hover, sit it back down, and then switch to one of his 3D modes. The reason he (or she) does this is for safety. It is a quick check to make sure the helicopter is flight worthy before asking it to switch into an extreme operational mode.

Starting in Idle-Up mode is hard on the entire drive train, the motor, and the ESC. Consider the head will instantly accelerate to 85% or higher of the total motor speed. The blades will fold back in their grips during acceleration and may cause an out of balance condition further subjecting your model to extreme stress. The blades will eventually return to the correct position due to centrifugal force.

To reduce stress on the drive train, you can start the Helicopter in normal mode, bring the speed of the head up slowly to mid point and then toggle the SW-B switch (Idle-Up). Before attempting this, you should verify your NORM pitch and ID pitch settings are not too far off at mid stick. To test the difference, set the Throttle Cut switch (SW-A) to turn off power to the motor. Place the throttle stick to mid stick, and toggle the Idle-Up switch (SW-B) several times observing the amount of pitch change. There should be little difference in swashplate movement. The overall amount of pitch should be low. Keep in mind that the Idle-Up throttle speed is much higher, so the amount of thrust produced with this small pitch angle is magnified in comparison to the lower speed of the normal switch setting.

If you are intent on starting the helicopter in 3D (Idle-Up) mode, then use the Throttle Cut SW-A switch to prevent the motor from turning (switch towards you). Turn on the Helicopter power, set the throttle stick to just below mid point (slight negative pitch), and then flip the SW-A switch (Throttle Cut) to normal. This procedure will place the blade pitch to just below zero before power is applied. The slight negative pitch pushes the model into the landing skids sticking it to the ground thereby reducing the amount of tail spin on start-up.

To minimize the stress of start-up in either Normal or Idle-Up mode, you should use an ESC that supports a slow start-up feature. The Align and Castle Creations ESC models use a very slow ramp feature to virtually eliminate the start-up stress on both the mechanical and electronic components. If you have one of these advanced ESC models, you can configure the ESC to lock out this slow start-up

mode once the motor reaches operating speed. The lockout prevents the ESC from accidentally resetting into slow start-up during flight in case there is an electronic glitch or the Throttle-Cut was applied as part of a stunt. If your ESC does not have the ability to lockout this setting, then research how long the throttle can be set to zero before ESC re-arms the slow-start function. This will also be important information to know if you practice "auto-rotation" landings, as using throttle kill too long may commit you to an under-powered landing.

*Note – some ESC manufacturers have a safety feature built in that will prevent the motor from starting in 3D mode.

*Safety Note – NEVER stand close to a helicopter during motor start up in Normal or 3D mode.

Note: The Norm / Idle Up switch simply swaps settings between the available throttle and pitch curves. The more exact meaning of this switch is Throttle-Pitch-Curve #1 and Throttle-Pitch-Curve #2. With that in mind, you can program each set of curves, and test each in the field to experiment with how each curve behaves. For example, you can set both NOR and ID pitch curves to be the same, and just change the ID throttle curve to be slightly different than the NOR throttle curve. Switching SW-B allows you to experiment with the different settings. This is an excellent way to compare potential new curves, and choose which values work best for your model and your skill level.

The T6 configuration uses a graphical representation for Throttle and Pitch curves. The Throttle curve graph can be confusing. EP0 represents bottom left stick, and EP4 represents full top throttle stick.
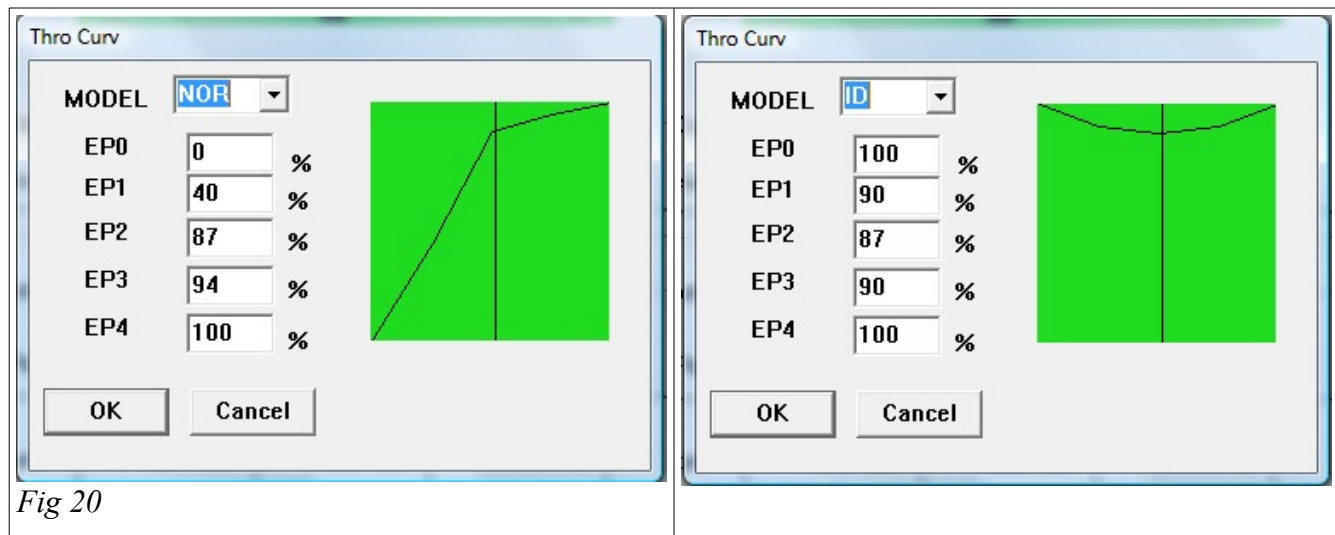
Fig 20

The vertical line is the throttle stick of the radio. Move the stick and watch the vertical line move across the graph. In the curve graphs above, the mid point throttle is 87% for both Normal mode and Idle Up mode (Fig. 20). With the curves setup this way, the SW(B) switch will not have a dramatic affect when toggles at throttle mid point.

*Note – Some pilots recommend a [NOR] throttle curve as 0,70,80,90,100 to reduce tail spin as you lower the throttle stick. I know of pilots that use a straight curve with all points set to 100%. DO NOT

use these high throttle settings until after you have setup the tail servo and gyro.

*Safety Note – Whatever throttle settings you use, Never connect power to the helicopter without the transmitter powered on, and the Throttle Cut switch set to on. When you are ready to fly, stand back from the helicopter, and in NOR mode left stick is all the way down, or if in ID mode set the left stick to mid point. Switch the throttle cut switch to off. The ESC start mode (Very Soft) will gently spin up the motor.

Now that the Throttle settings match, let us turn to the Pitch curves and alter them to match at mid point throttle.
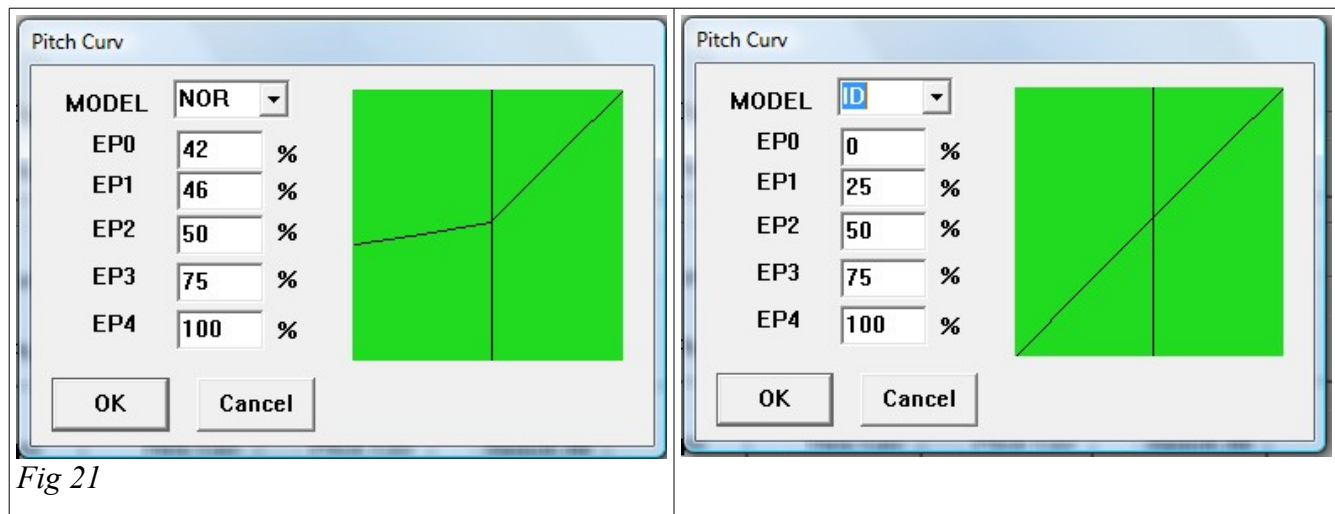
Fig 21

The NOR (Normal) pitch curve (Fig. 21) has been altered so that it maintains 50% or zero pitch all the way up to mid throttle. EP2 on both NOR and ID modes are the same. This coupled with the altered throttle curves will provide a smooth transition from Normal to 3D modes at mid stick.

*Note – with these adjustments, the motor will be running at a very high speed in both normal and 3D modes. This can be intimidating at first. With the higher speed, the helicopter will react to pitch input with more response.

*Note – The NOR pitch curve above is only an example of matching the mid point throttle between normal and 3D modes. Typically the NOR curve should provide some negative pitch below mid throttle. The negative pitch has several advantages. It will keep the tail from spinning too much on start-up because of the down force on the landing skids, and there will be occasions when negative pitch will assist the pilot flying in windy conditions by allowing the pilot to counter up drafts.

Dual Rate Settings

Definition: Provides two selectable "Response Rate to Input Rate" settings.
During initial setup, you were told to set the Dual Rate fields to 100% to avoid having more than one variable involved in the control-to-actuator translation. You can leave them all set to 100, or you can reduce the values to smooth out the effect of stick movement.

Most 6 channel radios have a function called "Exponential" (fondly called EXPO in RC Clubs) that will reduce servo responsiveness in the area around the stick center position. This feature provides a (smooth) transition from user input to servo response without effecting the crisp responsiveness desired at the ends of stick travel. Unfortunately, the Fly Sky CT6-A transmitter does not support the EXPO feature. The Dual Rate feature supports similar functionality as the EXPO feature with the exception of Dual Rate values effect the full range of stick travel instead of just around the neutral stick area.

DR is not free. This radio only supports two toggle switches. Both of these switches control software in the radio and do not transmit anything to the receiver. To utilize the DR feature, you must decide which switch functionality you are willing to give up. The Throttle Cut switch is a safety issue, so you are only left with using the Idle-Up switch for DR mode selection.

Now that you have spent some time hovering, and have experienced its response to stick input, you may want to fine tune the stick movement sensitivity to your own comfort level.
Ideally, you have a muscle-memory sense of how far you would ever need to push the sticks while landing, and can observe what level the moving bars on T6config move to at that stick position. This should give you some idea of what percentage to reduce response.   We've found about 75% is still controllable with good responsiveness to landing in winds, but you may find you want the helicopter *really* precise and consequently give up even more endpoint-control.   Be careful… the less the helicopter moves per unit of stick movement, the less it CAN be told to move at full stick. Below about 60% rate, the helicopter may be too sluggish to reliably counter winds or correct other effects, and you could lose control.
You may be wondering why you have four physical servos operated by five radio channels… and then only three fields for Dual Rate. This is because Dual Rate is one of the only control inputs that ignores and operates outside of knowing anything about CCPM mixing, and instead operates on the radio between stick and pre-mixer. This means you're entering the sensitivities for X-axis (aileron) and Y-axis (elevator) on the right stick, and X-axis(rudder) on the left stick, and we don't care how the CCPM servos actually accomplish control. Channels 1 and 2 set your cyclic sensitivities, and channel 4 sets the rudder response. None of these fields have to match if you don't want even responsiveness, but I generally keep at least CH1 & CH2 values the same. You may instead want to be able to raise or tip the node with elevator (CH2) much harder than you drift left and right with aileron. You may wish to slow down the tail from pirouetting fast every time you try to turn a little bit. Note that this setting should not have any effect on the gyro's ability to prevent unwanted rotation, as it can operate the servo as hard as it pleases without your control input, up to it's own "limits" setting – you're suppressing your own maximum control inputs while it's engaged, but the helicopter remains capable of flying just as aggressively the instant you turn off Dual Rate and allow your radio to give it full-magnitude commands.
The ON and OFF values are directly related to the assigned switch ON and OFF setting.

SAFETY

Every manual that is associated with a mechanism capable or producing injury and property damage should provide a safety guide section. An RC Helicopter is not a toy. Even the smallest model can cause the loss of an eye or worse. The following guidelines should be strictly followed .

Mechanical Safety

Because the helicopter has many parts moving traveling at extremely high speed, always perform pre-flight checks.

Grab the main blades and verify the blade grips are connected properly. If one of the bolts holding the blade grip to the feathering shaft snaps, strips, or just loosens up, the blades will become lethal projectiles.

Verify all of the connecting links are correctly mounted on the link balls. Verify they do not have sloppy movement, and they are secure. Dropping a link in flight may quickly cascade into an injury, and will certainly cause the model to crash.

Main blade holder bolts are not too tight, and not too loose. They should be snug in the blade grips. You should be able to move the blades without force.

Take a screwdriver or whatever tool is required to check all of the hardware, especially on the head and tail assemblies. This doesn't need to be done every pre-flight, but as a minimum, every ten batteries. Every three batteries on a new helicopter (minimum).

Tail blades should be checked in the same way as the main blades. Verify the grips are tight on the tail hub. Inspect the belt for wear. Tail blades should move within the blade grips with a flick of your finger. A tight tail blade grip will cause vibration, and tail bobbing.

Powering Up / Start-up Safety

The very first time you power up a freshly built helicopter, or even an RTF it is highly advised that you remove the main blades. Place the helicopter into a test stand or weigh down the skids so that the helicopter will not move. Test the direction and operation of the Throttle Cut Off switch. Test the direction of the main blades (should be CW looking down on the helicopter). If the rotor turns the wrong direction, reverse two of the main motor windings. Test the Idle Up switch to verify which direction is Idle Up (high speed).

Always power up the radio first. Never power up the helicopter without the radio being on, and within distance to bind with the receiver. Stray radio signals can and will cause an unbound helicopter to violently come to life at the worst possible moment.

Always set the Throttle-Cut switch to ON (prevent motor power) before connecting power to the helicopter and before approaching the helicopter.

Wait for the transmitter to initialize before plugging in power to the helicopter. Usually five to ten seconds.

Always verify the Receiver, ESC and Gyro has initialized properly before flight. Typically the ESC will sound a series of beeps (most common is a three beep signal). The Gyro usually has an LED (Light Emitting Diode) that will show a steady light indicating it has initialized in Head Holding mode. The receiver will have a steady light. If using a satellite receiver, it typically also has an LED to show that it is bound to the transmitter.

Wait for the gyro to obtain control of the tail servo. This usually occurs within seven seconds after the gyro LED has a steady light. Do not move the helicopter during this initialization phase.

Do not force the situation. If the helicopter does not initialize properly, unplug it, and start over.

Never switch off the radio while the helicopter is plugged in. Turn on the Throttle-Cut switch before approaching the helicopter, remove power from the helicopter, then power off the radio.

Note: the radio should be at least two feet away from the helicopter when attaching the battery and during initialization. Further distance is better.

Flying Safety

Academy of Model Aeronautics – AMA has published safety guidelines for remote controlled flight models at http://www.modelaircraft.org/files/105.pdf

It is in your best interest to review these safety rules even if you do not intend on becoming an AMA member. DO NOT TAKE HELICOPTER SAFETY LIGHTLY!

These are not toys. Numerous innocent bystanders have been badly injured because of careless and non-indoctrinated pilots. (see http://greenmountainrc.org/node/101)

Quick List of Safety Tips: http://www.buyrchelicopters.com/helicopter-safety.htm

Note: Did you know that you are required to have your name and address affixed to any outdoor helicopter? Not having this is reason enough to have your AMA membership revoked!

Avoid flying an outdoor helicopter in tight quarters such as in your living room. Circulating currents are often 10X as wide as the rotor span, so a helicopter with 12" blades (a 24" span) would require a 20x20 foot room just to hover dead-center without it's own re-circulated downdraft shoving it into the ground. Unless you have access to a large enclosed building, refrain from attempting indoor flight of a 450 (or larger) helicopter.

Avoid flying the helicopter in proximity of other people. Murphy's Law.

Never Ever fly your helicopter around pedestrians, children, livestock, Eagles, Falcons, Geese, pets, your Porsche, your next door neighbor's flower garden, swimming pools, bird baths, shooting ranges, or any location where guns are easily accessible.

Make sure you are flying in an RF friendly environment. Schools, Fire stations, and emergency services buildings are known to use high powered wireless network transmitters that will easily overpower your transmitter's output causing your expensive helicopter to lose control.

Minimize your risk by standing in a location where your helicopter or some other aircraft won't find you an easy target. Be aware of your surroundings. Barns and trees have been known to jump right in front of a perfectly good flying helicopter.

Be RF friendly even in designated RC-friendly environments. Modern 2.4GHz transmitters usually won't interfere with one another, but Murphy's Law has a whole chapter dedicated to "It Shouldn't Have". Radio Frequencies of 27MHz, 36MHz, 72MHz (really, anything MHz) transmitters *will* interfere with one another, and more than one should never be powered on within 1.5 miles of one

another. These MHz-band receivers are also extremely prone to receiving interference, so your neighbor's cordless phone probably can crash your helicopter.

Know the reliable range of your transmitter. Have a buddy watch your helicopter while you walk far, far away from your takeoff point carrying the transmitter and wiggling the servos. When they stop wiggling reliably, walk halfway back and plant a flag or at least note that distance. Now don't ever fly beyond that flag/landmark. Uncontrolled flying lawnmowers raining down on their children result in uncontrollable neighbors flying over to your house. Periodically RE-check the range of your transmitter – what worked well out to a mile when it was new instantly loses most of it's range for unknown reasons. Note: Some 27MHz transmitters are only reliable about as far as you can throw the helicopter. To test, simply throw the helicopter as far as you can, then if the transmitter works, throw it again to be sure. Continue as many times as needed until the helicopter stops working, then go buy a 2.4ghz replacement helicopter.

Don't fly too close to the ground, especially when inverted. It is better to fly 15 feet or higher (above your head) so that you have time to recover.

Be aware of your OWN body's surroundings – if you're going to rotate to track your helicopter, make sure you're not stepping into a gopher hole or a gift from your beloved dog that is going to divert your attention while the helicopter doubles back to your forehead.

Know your vision limitations. Really. Don't be like grandpa who will tell you he can see fine. If you can't see your helicopter's orientation clearly at a given distance, you can not safely fly it that far away. Get yellow-tinted glasses, prescription if needed to help with contrast and color on gloomy days.

Verify all of your controls are functioning properly before leaving the ground.

- Tail Slider is not binding.

- Tail control rod is not bending under servo load.

- Gyro is initialized and functioning properly. Tail slider moves in the correct direction when the helicopter is rotated by hand.

- All servos are healthy (never fly a servo that has any stripped teeth).

- Before leaving the ground, increase throttle to get the helicopter light in the skids. Test your right and left yaw control (Helicopter should lean left and right in the skids). Test your forward and reverse control. Test that your tail responds in the correct direction. Stand behind and slightly to the side (not directly behind the helicopter), and lift off. The helicopter may want to slide to the left because of the ground wash effect. Lean it back towards the right a little and continue the ascent. A 450 helicopter will be effected by ground wash by up to three feet above the ground. The ground surface will also effect the amount of ground wash.

- DO NOT fly if the controls are not reacting correctly.

- Hover to five or six feet before attempting to adjust trims. Watch the helicopter orientation. Adjust trims to keep the helicopter in one place with the main shaft straight up and down. Once your tuning experience increases, you should be able to get the helicopter to maintain a hands off hover for two or more seconds.

  *Warning – once you get your helicopter that finely tuned, don't get lazy fingers. It is easy to zone out when it flies that easy. That is when disaster can strike, such as a gust of wind comes

out of nowhere and you were not ready.

Battery Safety

Lithium-Polymer – (Li Po) is currently the most popular battery used in RC aircraft. The amount of energy they store is impressive. If handled correctly, they will serve you well over 300 recharge cycles.

Most batteries are hazardous. Lithium Polymer (Li Po) batteries are especially dangerous when abused. They are susceptible to heat, so never leave a Li Po battery in direct sunlight for extended periods of time. If you take an arsenal of batteries to the flying field, take them out of your car, or you may find yourself walking home after the car roast.

Once you have witnessed the flammable and explosive potential of these batteries, you will gain a new level of respect for this little power plant.

http://www.youtube.com/watch?v=-DcpANRFrI4&feature=related

http://www.youtube.com/watch?v=37w8nzgcr9c&feature=related

Purchase a set of LiPo bags, and keep them in the bags when they are not in the helicopter. Especially when charging the battery. They are most susceptible explosion during re-charging.

Designate a charging area (preferably outside). Make sure there is nothing flammable in the charging area. If you do not have a Li-Po bag, get a ceramic flower pot that has a ceramic lid. Dangle the battery inside the flower pot, and gently lower the ceramic lid over the opening so that you do not damage the battery wires (you can use a ceramic bit to gut notches in the lid for the wires).

Never use a puffed up battery pack. It is puffed up because it was over-discharged or over-recharged resulting in over heating and the laminates begin to separate. Overheating usually occurs because it was used near or below it's 3.1v per cell minimum voltage rating, or it was over charged beyond 4.2v per cell maximum voltage rating or used in an application that called for a higher C (current) rating than the battery could handle. Once a battery has "puffed", the internal damage has been done. The battery may shrink back to its original size, but it is no longer safe to use because the internal laminates have become damaged and pose a serious out of the blue fire at anytime. Chemical reaction takes time, but once it is on its way, it can quickly escalate into fully functional chemical fire.

Time your flights. Most modern radios have built in timers just for this purpose. The objective is to never get the battery drained to the point where the ESC starts to shut down. Less is better. It is better to fly for 5 minutes at a time, and make the battery last for years, rather than over fly it, and kill it in a couple months (or less).

*Note – your throttle curve directly contributes to the amount of time you can fly. Higher speed, means the battery is draining faster.

Balance your battery at least every 5 discharges. Modern chargers use the main battery cables to supply recharge power, and a connector with 4 or more wires (called the balance plug) to monitor the balancing progress. If one cell is less than the others, the charger stops charging through the main cables, and applies charge (through the balance plug) to the single cell needing to catch up until it is even with the others, then full charging resumes until one of the cells again drop below the others. Lower cost battery chargers either only use the balance plug to charge the battery, or only the main cables. If you have a low end battery charger, do yourself a big favor and buy a real LiPo battery charger (I highly recommend the Thunder AC6 charger).

If you crash the helicopter. Remove the battery and set it aside for 15 minutes. If it does not explode or puff up in that amount of time, you can return it to service. Continue to monitor the battery closely the next time you charge it – oddly, you can often more safely discharge a battery than recharge it.

Never dispose of a LiPo battery with the common waste. Soak it in a salt water solution for 7 days, then it can be safely disposed of.

Never leave a charging battery unattended. I know of one story where the battery was left unattended for 15 minutes in the garage while the owner went into the house to get something. The battery burst into flames, and ignited other flammable containers in the garage, and lost the entire house. Chemical fires are difficult to put out.

Never charge a hot battery. It's tempting to plug it in again right after you flew it, but give it a rest until it's cooled to room temperature. Do not become impatient, wait for it to cool before starting a recharge. Alternate flying batteries per flying session. Number or tag your batteries, and use them and charge them in the same order.

Batteries should not get hot while charging. If they do, immediately unplug the charger. Do not move them until they return to room temperature. If you see the battery starting to puff up or smoke, it is an imminent fire.

A fully charged LiPo battery holds 4.2 volts per cell. If you are using a 3S LiPo, it will have a full charge of 12.6 volts.

*Note – Buy a good battery charger. The inexpensive chargers that come with RTF models are inadequate for this hobby. A good balance charger has built in safety features, and superior battery monitoring and charging capabilities. Your batteries will last for hundreds of cycles when using a good charger. It will easily pay for itself. These better chargers can also safely charge your larger/"higher C" batteries faster than more conservative chargers.

Summary

This document did not go much into the Mixing settings other than setting up the CH5 to VR(B) connection. I consider other mixing to be more advanced than is needed for this article and general flying.

I also did not go into detail for the DR settings. With the level of quality in the FS-CT6A radio controls, I prefer to keep the DR settings to 100% as I prefer to have as crisp control as I can get from this radio.

I hope this document has been of help to the RC Helicopter community. I only wish this was available when I started out.

Glossary of Terms

3D / Idle Up

Throttle and Pitch Curve setting that provides higher motor speed, and full range Plus and Minus pitch.

Aileron

This term originated from fixed wing aircraft.

Ailerons are hinged control surfaces attached to the trailing edge of the wing of a fixed-wing aircraft. The ailerons are used to control the aircraft in roll. The two ailerons are typically interconnected so that one goes down when the other goes up: the down going aileron increases the lift on its wing while the up going aileron reduces the lift on its wing, producing a rolling moment about the aircraft's longitudinal axis.[1] The word *aileron* is French for "little wing". - WIKIPEDIA

For the Helicopter application it performs the same function as the fixed wing aircraft in that it will create more lift on one side of the helicopter, and less lift on the opposite side. This is accomplished by inducing positive blade pitch on one side, and negative pitch on the other side. As the blade rotates from one side of the helicopter to the other side, it will change its pitch based on the swash plate orientation. Consider this effect for a moment. The blade grips are constantly changing their angle as they rotate around the head. In slow motion you would see a washing machine effect as the blade grips rotate back and forth on the feathering shaft as it takes a roller coaster ride around the swash plate.

ARF – Assembly Required to Fly

This is a kit model that need to be assembled. In reality, all models include the Ready To Fly (RFT) require that you take it apart and reassemble with blue Locktite before flying. NEVER trust someone else to assemble your helicopter unless they have a trusted reputation. Do not trust an unknown factory assembly line worker to assemble a safe and reliable helicopter. It is your investment, and your own physical well being at risk.

Auto Rotation

The purpose of the auto rotation feature is to allow the main blades and tail blades to continue to rotate when the main drive motor stops or slows down. This feature allows the pilot a brief amount of time to land the helicopter after losing main power. After losing power, the pilot applies UP right stick to place the helicopter in to a forward and down glide path, and continue to control slight positive pitch with the left stick. Too much pitch, and the blades will stall (slow down) and the helicopter will fall out of the sky. As the helicopter approaches the ground, the pilot will perform a flare maneuver by pulling back on the stick to level or slightly nose up, and apply additional left stick (collective pitch) to gently setting the helicopter to the ground.

The way auto rotation is achieved is through the use of a One Way Bearing installed between the main gear and the auto rotation gear. The auto rotation gear is (typically the lowest gear on the main shaft and is bolted to the main shaft (Jesus Bolt). The sole purpose of the main gear is to drive the auto rotation gear through the one-way bearing. When the motor stops, so does the main gear, however the one-way bearing allows the auto rotation gear to continue rotating.

Belt Drive

RC Helicopters have three basic tail drive systems.

- Electric Motor directly attached at the end of the tail boom

- Shaft driven (also called Torque Tube)

- Belt driven

The Belt Driven tail rotor uses a cogged belt connected between two belt pulleys whereas one pulley is driven from an Auto Rotation gear powered by the main motor, and the driven tail pulley and shaft that connects to the tail rotor blade pitch control assembly.

Blade Tracking

The action of two or more blades following each other in the same exact path, and at the same angle of attack. Many factors effect blade tracking.

- Blade rigidity (both blades should have the same flexing characteristics under the same load)

- Blade Balance - each blade weighing the same, and the weight is distributed across the blade

- Individual Blade Pitch at the same location in the blade path

- Blade leading edge contour. A blade with chips or missing material on the leading edge will effect the aerodynamics of the blade.

Always use the same matches type of blades. In other words, do not mix different blade manufacturers. Use the same part number for each blade mounted to the helicopter.

Verify the weight of the blades match using a blade balancing tool. For larger blades (especially greater than 335mm) insure the blades are balanced in the same spot between the blade grip mount and the tip of the blade.

Blade tracking is correct when you see a single fine tip of the end of the blades under high speed blade rotation.

CCPM - Cyclic Collective Pitch Mixing

Conventional model helicopters use three independent servos to manipulate the swashplate. One is used to tilt the swashplate forward and aft (longitudinal cyclic), varying the aircraft pitch. Another is used to tilt the swashplate left and right (lateral cyclic), varying the roll. The third servo raises and lowers the entire swashplate, varying the collective, and hence the pitch of the rotor blades. An intermediate mechanical mixing system is used to transfer the control inputs from the servos to the swashplate. This requires an elaborate system of control rods and levers, which often contains many ball bearings. -

To reduce the mechanical complexity of the helicopter, a CCPM system mixes the control inputs using software (usually running on the transmitter) and typically uses three interdependent servos to control the swashplate, with three linkages arranged around the swashplate at 120° intervals (there is a variation that uses 140° + 140° + 80° intervals). In addition to lower mechanical complexity, the interdependent servos share the workload. - WIKIPEDIA

Coaxial

The common use of term Coaxial as it is applied to the RC helicopter is in reference to the blade configuration. A Coaxial configuration uses two sets of blades rotation in opposite directions. The bottom set of blades are controlled by a swashplate supplying pitch and speed. The top set of blades

are used to counter the centrifugal force of the lower blades, and provide turning capability. The controller of a coaxial helicopter will increase or decrease the speed of the lower and upper set of blades to provide turning without the need for a tail rudder.

Configuration File

A 67 byte binary file used by the FS-CT6A radio to store settings to an electronic computer media such as a hard-drive.

Curve

A curve is a mathematical SIN calculation between 3 or more points. The RC helicopter radio provides a number of Throttle and Pitch curves based on 5 or more reference points. The purpose of the calculation is to provide a smooth transition between the reference points. Curves are based on two variable axes. For example the Throttle curve is represented with a vertical axes of motor speed, and the horizontal axes represents the joy stick input position.

Cyclic

Represents a group, whereas each member of the group can affect a common element. In the RC helicopter terminology, the cyclic references two or more servos (typically three) that control the swash plate. Input is sent from the radio to each of the of servos in the cyclic group at a high frequency rate at the same time. As a group, the servos control the swash plate orientation thereby affecting blade pitch throughout the 360 degrees of rotation. The Tail servo is not a part of the Cyclic Servo group.

DR - double ratio controls CH1, CH2, CH4 response rates

Elevator

One of the Cyclic Servos controls the center point of the swash plate. This is the swash plate linkage centerline with the main shaft. Either directly in front of or behind the main shaft.
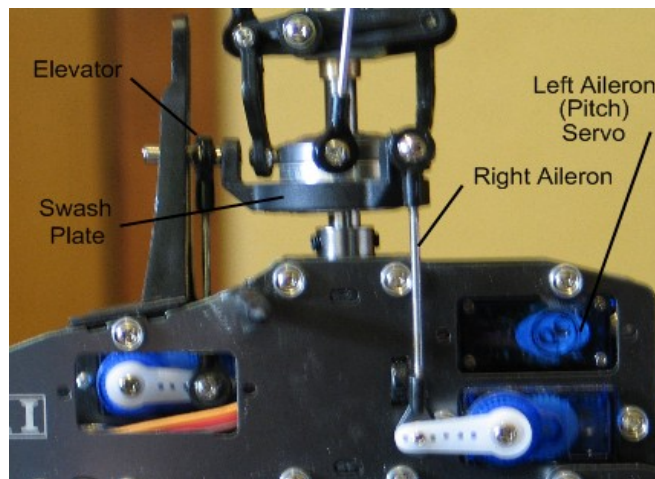

Fig 22

End Point

Controls Servo Travel limits. A typical servo can travel -30 degrees and +30 degrees from center for a total of 60 degrees of travel. Setting the End Point value will reduce the degrees the servo can travel.

ESC - Electronic Speed Controller

Responsible for receiving throttle input signal from the receiver, and controlling the current to the motor. Most ESC units also have a built in BEC that supplies regulated DC battery power to the receivers and all devices connected to the receiver. If the ESC does not have a built in BEC, the receiver will require an external BEC and battery pack.

The ESC should be sized according to the motor it will control. Motors have amp ratings as do the ESC. It is advised to use an ESC that has a higher AMP rating than the motor.

The ESC can become very hot in operation. If the unit gets too hot, it can damage components and result in losing all motor and servo control. If this happens in flight, the helicopter will crash. For this reason, many hobbyists chose to use an external BEC so they can retain servo control in the event of an ESC failure.

Helicopter ESC devices come with a variety of features. Some provide logging, and more advanced features. The basic ESC has the following features.

- **Brake** (causes the motor to rapidly stop) Recommend to be set to Off for Helicopters.

- **Battery Type** is automatically detected by all modern ESC units. However you still should set it to the type of battery you are using.

- **Cut Off Type** – controls what the ESC will do when it reaches low battery power. For Helicopters, you want to use the Soft-Cut option. This will cause the ESC to reduce power to the motor gently as it reaches a low battery power level. You will notice that it takes more throttle stick input to maintain flight. Quickly land the helicopter under this condition. Determine the amount of time you have been flying, and in the future, try not to reach this condition by monitoring your flight time.

- **Start Mode** – controls how fast the motor will spin up from a dead stop. For Helicopter models, select the softest possible setting.

- **Timing Mode** – is based on the motor. Typically the Low setting is used for todays electric motors, however better performance can be achieved by using the timing for your motor. Check with the motor manufacturer for the correct timing to use.

   *Note - many ESC devices have become damaged using the Medium timing setting with the wrong motor. Only use the Medium timing if your motor specifies its use. The Timing is similar to a car distributor. It will excite the correct windings in the correct order at the right time. Check with your motor manufacturer for the correct timing.

- **Governor Mode** limits the maximum amount of power sent to the motor. Typically this setting is turned off.

Feathering Shaft & Dampeners

Also called the Horizontal Shaft. The Blade Grips connect to the feathering shaft. The feathering shaft runs through the main head and sits inside of rubber dampeners (sometime these are O-rings). The dampeners come in different hardness ratings. The soft dampener is the most common for general park flying and moderate 3D flying. Harder dampeners are used for extreme 3D flying. The Dampeners should be greased to prevent galling, and eventual failure. Soft dampeners transmit less stress and vibration to the main shaft and other head components.

Fixed Pitch

A helicopter is labeled a Fixed Pitch (FP) model when the blade pitch is set to a predetermined angle and the rotor speed determines the amount of lift. The faster the blades travel the more lift. Most FP models control direction (yaw and forward / reverse) by tilting the blade holders so that one of the blade's leading edge will dip down, and the other will dip up causing less lift on one side, and more lift on the opposite side.

Fly Bar

The Fly Bar on the Bell & Heller head assembly is an integral part of the pitch control. Do not attempt to fly your helicopter without the fly bar attached and properly adjusted.

The swashplate does not directly control the main blade pitch. Instead, the swashplate controls the Fly Bar control arms, and fly bar carriage. The fly bar is a canceling device. It slows down the reaction of the swashplate input to smooth out the input request. The fly bar will attempt to maintain its current direction of travel. When input is applied it will begin to adjust to the requested position thereby soothing the change. The more weight that is added to the ends of the fly bar result in smoother (or less responsive) transitions from the control input. As the pilot advances their skill level and want to work in more extreme 3D maneuvers, they will move the weights closer to the main shaft, or remove them entirely. Fly bar paddles are rated in weight. The Extreme 3D pilot will use very light weight and rigid fly bar paddles such as Carbon Fiber versions. The purpose is to eliminate as much weight as possible (to a limit) for extreme 3D flight.

The fly bar setup is correct when:

- The paddles are the same size and weight, with the same length and leading edge contour.

- Are exactly the same distance from the main shaft.

- Weights are the same, and exactly positioned the same distance from the main shaft.

- The fly bar moves freely up and down. Link balls with too much resistance will hamper the operation of the fly bar assembly. If they are too tight, use a link ball tool to remove burs and excess material from the plastic ball socket to provide the fly bar free movement.

Gain

The Gyro uses a voltage gain to increase or reduce the sensitivity of the gyro to lateral movement in Head Holding Mode. Too much gain will result in the tail rapidly wagging from side to side. Too little gain and the tail will wag slowly from side to side, or fall out of Head Holding mode.

The rule of thumb is to adjust the gain until you obtain a rapid tail wag, then reduce the gain until it stops wagging then reduce the gain by an additional 5~10 %.

Gyro

A device that is placed between the receiver input, and the tail servo. Its purpose is to assist the pilot in maintaining a steady tail position in flight. In Head Holding Mode, the gyro will remember its last "Non" input position, and attempt to bring the tail back to that position if something such as wind has cause the tail to move off of position.

Rate mode is similar to HH mode in that it will counter external forces such as wind, and try to keep the tail in one position. Rate mode does not have the previous position memorized and will only provide servo adjustment based on the amount of external force movement detected. After countering the external force movement, rate mode will return the servo back to its (servo) center position which may not be the original tail position.

You can determine if the gyro is in HH mode by moving the tail, and the tail slider will move to one side compensate, and it will stay in that position until the tail is returned to the original position. In Rate mode, you will notice the tail slider will move to compensate, but once you stop moving the tail, it will return to center even though the tail is not back in the original position.

Jesus Bolt

There are two Jesus bolts on a main shaft. One at the top and one at the bottom. The top bolt holds on the Head assembly, and the bottom bolt holds the Gear assembly. The term "Jesus bolt" came from the last words spoken by the pilot before the helicopter crashes due to a Jesus bolt failure.

Lift

If the fluid is air, the force is called an aerodynamic force. An airfoil is a streamlined shape that is capable of generating significantly more lift than drag.[2] Aerodynamic lift is commonly associated with the wing of a fixed-wing aircraft, although lift is also generated by propellers; helicopter rotors; rudders, sails and keels on sailboats; hydrofoils; wings on auto racing cars; wind turbines and other streamlined objects. While common meanings of the word "lift" suggest that lift opposes gravity, lift can be in any direction. When an aircraft is flying straight and level (cruise) most[3] of the lift opposes gravity. However, when an aircraft is climbing, descending, or banking in a turn, for example, the lift is tilted with respect to the vertical.[4] Lift may also be entirely downwards in some aerobatic manoeuvres, or on the wing on a racing car. In this last case, the term downforce is often used. Lift may also be horizontal, for instance on a sail on a sailboat

Non-streamlined objects such as bluff bodies and plates (not parallel to the flow) may also generate lift

when moving relative to the fluid. This lift may be steady, or it may [oscillate](#) due to [vortex shedding](#). Interaction of the object's flexibility with the vortex shedding may enhance the effects of fluctuating lift and cause [vortex-induced vibrations](#). - WIKIPEDIA

In layman's terms the leading edge of the air foil (the blade) is contoured to produce a small amount of drag over the blade as what is occurring under the blade. This causes the blade to have more pressure under the blade. As the blade changes its angle of attack (Pitch) the pressure increases under the blade causing the blade to move away from that pressure. A positive blade pitch will produce more pressure on the bottom side of the blade lifting the helicopter upwards.

Locktite

A chemical compound that bonds to the material is is applied to fill the non tensioned space between threads on a screw. The filling of the thread space reduces the potential for vibrations to release the spring tension of the threads thereby maintaining the original torque applied to the threads.

It is recommended to use the Blue Locktite compound on all metal to metal screws. Blue Locktite has a

lower heat tolerance than Red Locktite. This allows hobbyists to use a small amount of heat on a screw treated with Blue Locktite to break down the bonding capacity of the compound and extract the screw.

Use of a soldering iron for 10 ~15 seconds on the thread tension area is enough to break down the compound and allow for screw extraction.

*Note – Never let Locktite come in contact with plastic parts. The compound will weaken the plastic as it bonds. Locktite can also scar carbon fiber materials if it is allowed to bond and harden on the carbon fiber material.

Main Shaft

The vertical shaft that is attached to a drive gear on one end, and the Rotating head assembly on the other end. Main shafts can be purchased in different metal densities. The harder shafts usually have a higher carbon composition, and are heavier. Soft main shafts bend easier than the harder shafts. The harder shafts do not flex as much as the soft shaft, therefore the harder shafts provide very accurate head spin. The down side of the harder shafts is they weigh more, and are less forgiving in a crash. Some hobbyists believe it is better to use a soft main shaft, and let it bend in a crash and possibly save other more expensive components.

Mixing

Provides the ability to assign a switch or another channel input to influence the signal on another channel. Typically used in the FS-CT6A radio to assign the Gyro Gain VR(B) dial to channel 5.
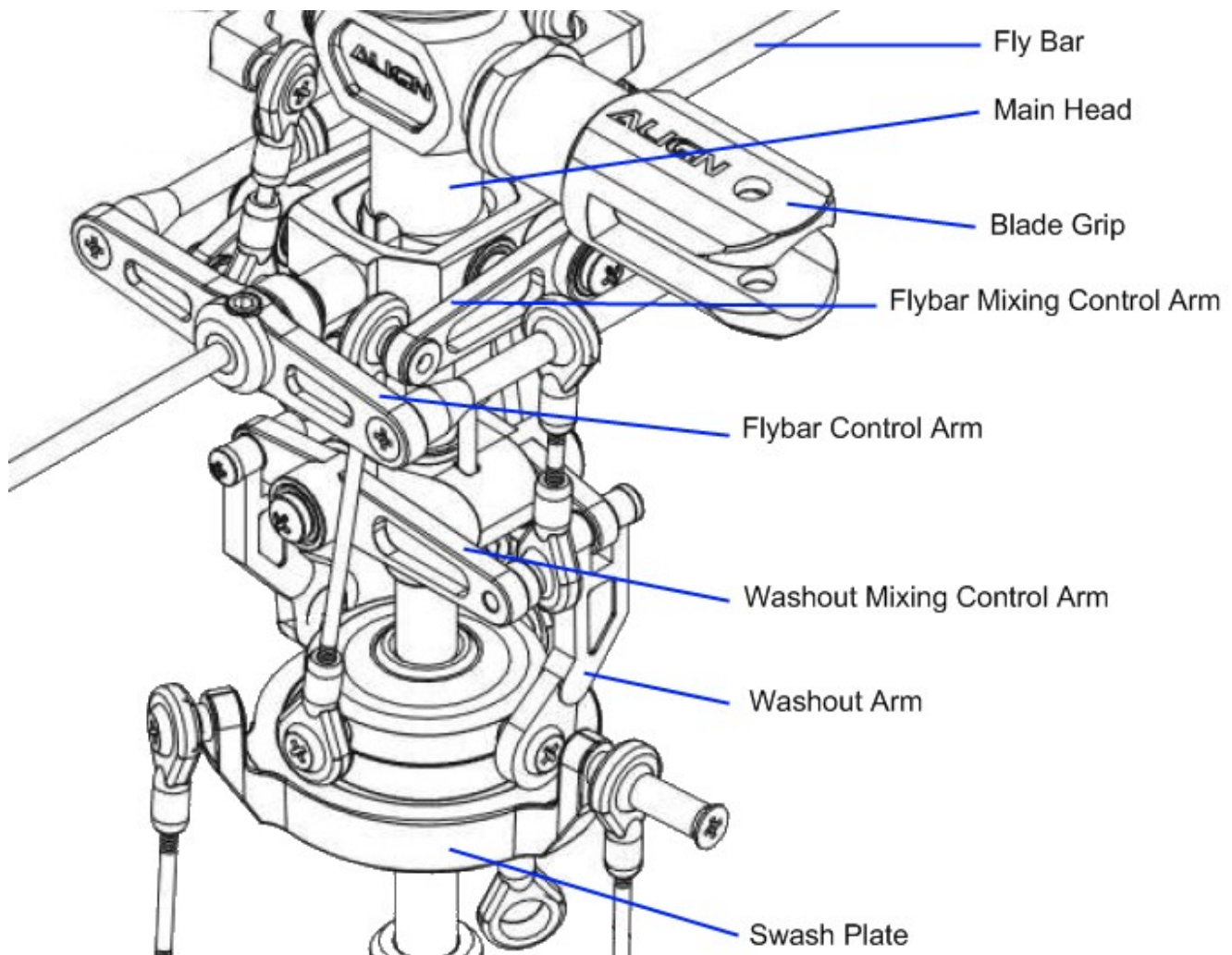
Fig 23

Mixing Control Arms

There are four mixing arm controls on a Bell Heller configuration (Fig. 23). The two at the lower section translate swash plate input through the Washout arms to the Washout Mixing Control Arms then to the Fly bar Control Arms which rotate the fly bar paddle pitch.

The upper set of mixing arms translate swash plate input through long links to the Fly bar mixing control arms that are then connected to the Main Blade Grips.

Pitch

The angle of leading edge of an air foil (the blade). Neutral or zero pitch provides no lifting capability. As the pitch angle increases, the air pressure on one side of the blade surface increases to produce Lift (see Lift above) or lateral movement (for tail blades).

Pitch Curve

A pitch curve is a set of 5 or more points measured at equal distances for the full travel of the input

device (the joy stick). The Radio will calculate the signal strength between each reference point.

Pitch Gauge

A tool used to measure the blade angle from a reference level (the fly bar).

Radio Binding

The process of connecting the radio identification signal with the receiver in wireless applications.

Receiver

Wireless Electronic radio component that receives signals from a radio frequency transmitter. Signals are distributed to separate channels of the receiver to control other electronic devices.

Reverse – Servo direction settings

The configuration option to reverse the polarity of the input signal to an electronic device such as a servo.

Rod Linkage

A mechanical component consisting of one or more connector points that is used to transmit torque and direction between to points. Make sure you have the same number of threads showing on each end.
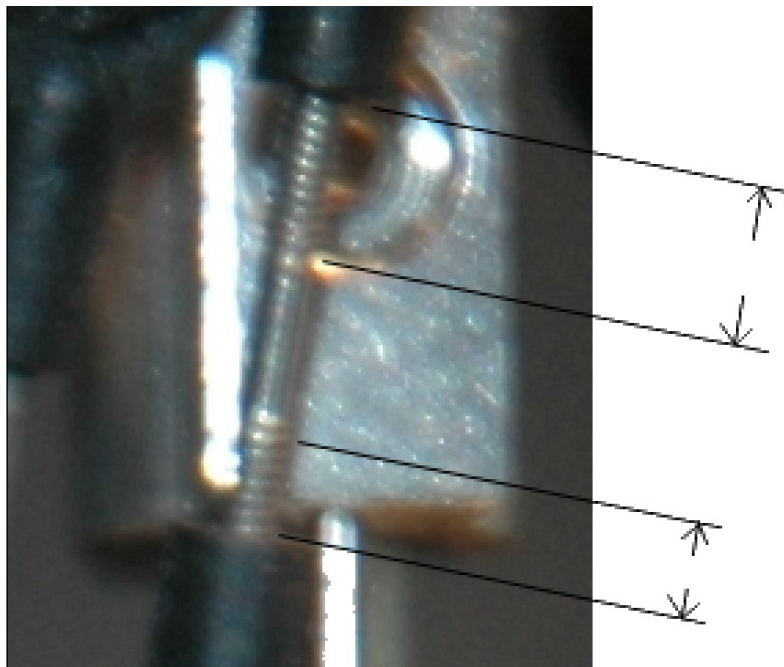
Fig 24

As a minimum, you want 5 or more threads (turns) screwed into each plastic ball link end. Figure 24 shows an link rod that should be adjusted. The easiest way of adjusting the link is to use a set of needle-nose pliers to rotate the rods at the non-threaded center portion of the rod. You can make this

adjustment with the rod installed on the helicopter.

RTF – Ready To Fly

A packaged model claimed to be ready to fly out of the box. This is a myth. Always check every fastener for tightness, proper assembly and alignment, and that all metal to metal fasteners have the proper amount of Blue Locktite applied. Check that all linkages and bearings move smoothly, and there is no binding anywhere. I have experienced Locktite in bearings, missing screws, loose screws, and missing parts on both kits and RTF models. There have been many new hobbyist who actually slap a battery into their new model, and man the controls only to find out that their RTF model became Ready To Fix, or Refuses To Fly out of the box.

Rudder

A mechanical device that is used to steer or change the rear position of a movable object. Helicopters use a variable speed and typically variable pitch set of blades to provide lateral tail movement by varying the speed and pitch or direction of the tail blades.

Serial Port

Computer In/Out port used to communicate with external devices. Two way communications are provided through a serial protocol (one byte at a time).

Servo

Electronic device that takes a digital or analog signal and convert it so mechanical movement.

Servo Binding

Servo binding occurs when the servo movement is stopped before the requested servo position request has been completed. Servo binding can result in damaged servo gears, overheating of servo electronics, and servo failure.

Servo Horn

A mechanical connection between the servo output and the linkage that it controls. There are four basic servo inner hub configurations measured by number of splines and diameter. The servo horn may be a lever design or a circular design. The purpose of the device is to transfer rotating movement to a linear movement for controlling linkage.

Sub Trim

Provides small incremental adjustments to the signal level to a servo. It will cause the servo position to change by small degrees.

Swash Afr

Used to adjust swash plate travel up and down and direction.

Swash Plate

The intermediate control device whose level is transmitted to the fly bar for controlling pitch and yaw of a helicopter.

Tail Slider Control

A mechanical device that is connected by a rod linkage to the tail servo and tail rotor grips. Its purpose is to change the tail rotor blade pitch to produce lateral thrust.

Test Stand

A tool that allows for mounting the helicopter for testing under power without the potential for crashing. Some test stands provide vertical movement for safely test hovering the aircraft.

Throttle Curve

A throttle curve is a set of 5 or more points measured at equal distances for the full travel of the input device (the joy stick). The Radio will calculate the signal strength between each reference point.

Torque Tube / Shaft Drive

A Shaft driven also called a Torque Tube driven tail rudder uses a shaft to power the tail rotor blades. The advantages of a shaft driven tali rotor is smoother operation with less noise. The down side of this type of drive system is the cost for replacement parts.

Washout Arms

Fig 25

The washout assembly (or lower mixer) is a set of linkages in the rotor head that serve to mix out collective pitch inputs from the swashplate, and pass the remaining cyclic pitch inputs to the flybar control arm.
The washout assembly consists of three parts:
The washout guide (often also the phase ring) that keeps the washout aligned with the rotor head;
The washout arms that connect the swashplate to the flybar control arm linkages;
The washout base to which the washout arms are mounted, and which slides up and down the main mast.
The washout also often serves to rotate the cam follower of the swashplate with the rotor head.
A few helicopters do not have a traditional washout, and either transmit collective inputs to the rotor head via a push rod separate from the swashplate (such as the Falcon 3D), or use a flybar that can move up and down inside a guide (such as the Gazur Mars).
Washout also refers to changing blade pitch or profile along the length of a rotor blade, as the tip of the blade is moving much faster than the root. Typically model helicopter blades don't have this type of

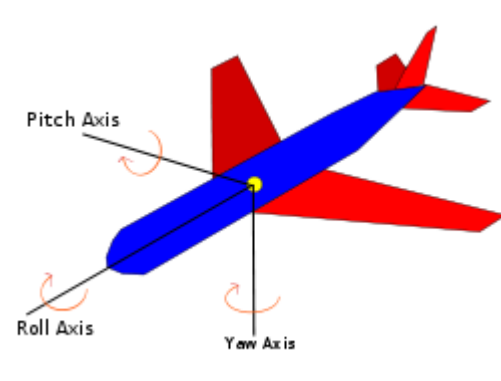washout, as the blades are symmetrical to allow for inverted flight.

Yaw

Fig 26

Yaw axis is a vertical axis through an aircraft, rocket, or similar body, about which the body yaws; it may be a body, wind, or stability axis. Also known as yawing axis.

The yaw axis is defined to be perpendicular to the body of the wings with its origin at the center of gravity and directed towards the bottom of the aircraft. A yaw motion is a movement of the nose of the aircraft from side to side. The pitch axis is perpendicular to the yaw axis and is parallel to the body of the wings with its origin at the center of gravity and directed towards the right wing tip. A pitch motion is an up or down movement of the nose of the aircraft. The roll axis is perpendicular to the other two axes with its origin at the center of gravity, and is directed towards the nose of the aircraft. A rolling motion is an up and down movement of the wing tips of the aircraft. - WIKIPEDIA

TID-BITS – Extra Information from users of this manual.

When I am emailed a hint or some information that may be useful to others, I post it in this section.

- Wires between RX and the little satellite receiver broke. The part I bought from Hong Kong was "JR & Spektrum Remote Receiver Extension Wire 60 & 90cm (2pcs/set)", but you should be able to buy them at any hobby shop that sells JR or Spektrum. (RCDiscuss – monkeyhanger, Aug 9, 2010)

RC Boats & Special Configurations

Recently I was asked to help setup the Fly-Sky T6 radio to work in the RC Boat hobby. The first request was for controlling a sail boat. The next was for setting up the switches to control devices.

Following are the settings for Don's sail boat.

The servo that will be controlled by the right stick for Left and Right directions should be plugged into channel 1.

Keep in mind that only channels 1 and 2 are used. The Heli-90 type takes out the mixing.

Channel 2 is for the left stick (up & down), Channel 1 is on the right stick (Left & Right)

1. Set Mode to Model 1
2. Plug the servo that will control forward and backward into **channel 2**
3. Plug the servo that will control left and right into **channel 1**
4. Set the "Pitch cuv" [Pitch Curve] NOR to:

    1. EP0 = 0
    2. EP1 = 25
    3. EP3 = 50
    4. EP4 = 75
    5. EP5 = 100

1. EndPoint settings should be the default of 100% for everything.
2. Reverse, you are only concerned with channels 1 and 2. If a servo does not move in the direction you need, reverse that servo using this editor.
3. SubTrim adjusts the centering for each servo, again, you only need to adjust channels 1 and 2 to trim up those servos.
4. DR settings should be the default of 100% for everything.
5. Type setting to Heli-90
6. Thro Cuv does not come into play unless you also have a motor on your sail boat. In that case, none of this will work.
7. Swash AFR settings should be the default of 100 for everything.
8. Mix, there are three mixes, each with a switch selection. Set all switch selections to OFF.

Don ended up getting a servo extender because the servos only travel 60 degrees end to end. Don needed closer to 140 degrees. He order one from ServoCity
http://www.servocity.com/html/180o_servo_stretcher.html

The next boat setup request comes from "Bud".

Mr. Shaw,

I reviewed your T6 Program write up and it is great. Unfortunately I am only using the basic ACRO set up for RC scale boats so can't take advantage of all the great tips. I have posed my question to a number of different sources and have not come up with an answer. Hate to bother you but just possibly you might have the answer.

I purchased the Digital Radio software and it seems to work perfectly. The one issue I have, and can't find it anywhere, is how to link the SW A & SW B to channels 5 & 6. Also, but not as important, is there a way to link VR A & B to anything? Lots of new terminology here which doesn't seem to lead me to the answer.

We are using these new radios (HK-T6A V2) in RC Scale boats and they look like they will really work out great. No fancy stuff like with the heli version but everything we need. Please visit our website at www.waveblasters.org. Lots of great boats in our club.

Following are the settings to allow Bud to use Switch A and B to either control a servo, or turn on/off some device.

Lets say you want SWA to control Channel 6, and SWB to control CH5. With the TYPE set to ACRO, and Switch A & B set to NULL and VR A & B set to null, you can go into the MIX settings. Set MIX 1 source=VR A, Des=CH6, Up Rate to 100% , down rate has no purpose, Switch set to SW A.

Now watch your program graph, and switch A towards you (On position). Adjust VR A to give you the throw you want from that servo. When you toggle SW A On and Off, then CH6 will go from zero input to the adjustment you preset into VR A. This setup allows you to control CH 6 with the VR A dial when the switch A is on.

You can do the same setup for MIX 2 using VR B, CH5, and SW B.

The reverse setting determines which direction the servo will move with the VR dials. It only gives you 30 degrees of servo arm travel. If you need more, then you can get a Servo Extender or if your servos are capable, you can get a servo programmer to set the new limits.

Bud's Response to the settings – IT WORKED

These settings work well for the RC scale boating crowd. It gives you four proportional channels (Mode 2 or Mode 3) and two on/off channels for controlling smoke, sound, lights, horns, winches, etc. Folks don't need much more than that. I have a 6 channel system on a Creole Queen paddle wheel which has throttle, steering, bow thrusters, deck lights, nav lights, smoke and a sound system playing New Orleans jazz. You can see it on YouTube - www.youtube.com/watch?v=eOinjdEJukA&feature=player_embedded if you are interested.

Special Thanks

I would like to thank the numerous RC Helicopter pilots selected to proof read and contribute ideas for

this manual. Most of them hang out on the RC Discuss forum www.rcdiscuss.com.

A special thanks go out to GregoryT for all of his hard work in diligently going through all of the revisions and helping word-smith it to bring clarity for new hobbyist.

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The latest version of this documentation can be found at:

http://RabbitSVC.com/t6ConfigurationManual.pdf