9.0 SET-UP TIPS

This segment of the manual deals with setting up your helicopter in preparation for flight. The set-up includes both mechanical and electronic adjustments to the model.

There are two prevailing schools of thought regarding model helicopter set-up. One sets up a helicopter primarily oriented for upright flight. The other sets up the helicopter for symmetrical flight - this simply means the model is as liable to hover inverted as upright. This flight regimen is also known as extreme aerobatics, or 3D flight.

If you are a beginner, you will have an easier time of learning to fly with a set-up oriented toward upright flight because there is a greater range of pitch to throttle/collective (T/C) stick motion. The T/C stick travels between low and high pitch and hover occur with the T/C stick in the middle of the full range (the model's usually upright).

Extreme performance pilots, on the other hand, demand a set-up which is fully symmerical, i.e. one in which 0^{o} pitch occurs in the middle of the T/C stick range (instead of hover) and full T/C (max) pitch occurs at *both* ends of the T/C stick range (in both the positive and negative pitch directions). Upright hover thus occurs at 3/4 T/C stick and inverted hover at 1/4 T/C stick. This flight regimen is more difficult for the beginner to manage as the range between mid-stick (0^{o}) and maximum (+) pitch is compressed by half. Of course, we assume beginners won't be trying any inverted maneuvers - on purpose that is!

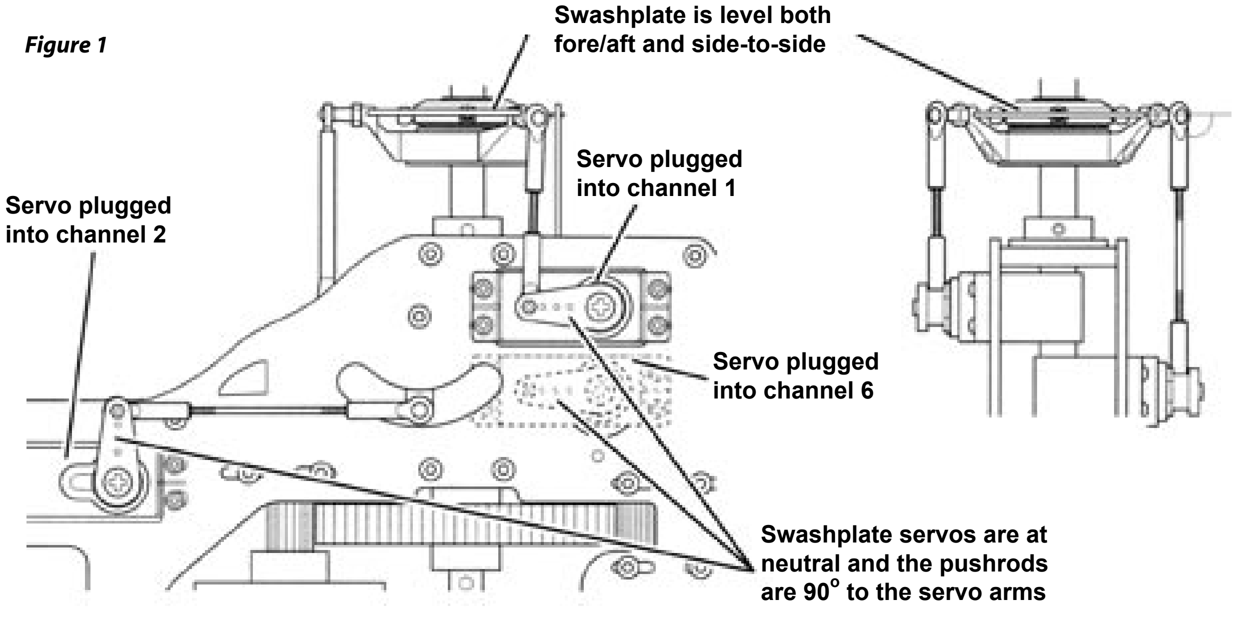
For the ***Tiger 50***, the steps are first a symmetrical mechanical set-up followed by any adjustments for the lighter duty needs of the upright regimen (accomplished in the radio). It doesn't get easier than this!

CYCLIC & COLLECTIVE - MECHANICAL SET-UP: Mechanically it's more important to have CCPM linkages at their respective neutral position in a model set up for symmetrical flight. You can later adjust your model for a predominantly upright flight regimen simply by using the radio system. The converse - setting up mechanically for upright flight and using the radio system to adjust for a symmetrical set-up isn't a sound practice.

The ***Tiger 50*** helicopter is designed for a full-on switchless-inverted symmetrical set-up from the beginning - there are no compromises for the more rigorous 3D duty! By the way, there's still a switch to throw during flight, but the switch referenced doesn't mean the same thing. The term switchless inverted is a holdover from days when flipping a switch actually reversed the controls!

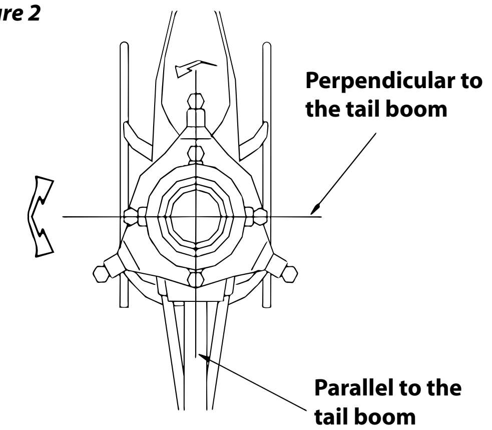
The steps are the same for all models, regardless of intended duty - be it extreme performance, or sport. Building the linkages per sections 7.1 and 7.2 means all the mechanical linkages will be at the neutral position when the control sticks are in their neutral position. All that is left is to ensure that each servo arm is at its respective neutral positions - 90^{o} to the pushrod. (Figure 1)

Figure 1



Look down on the swashplate from above and it is apparent the ***Tiger 50*** uses a 120° eCCPM system as there are three servos (spaced at 120°) controlling the outer ring of the swashplate. The inner ring, however, is spaced at 90° per usual convention. (Figure 2)

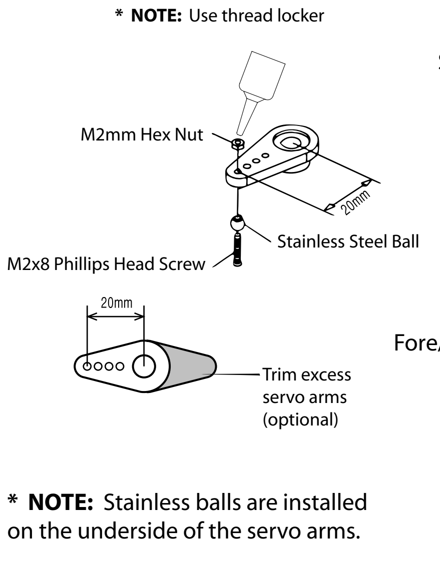
Figure 2

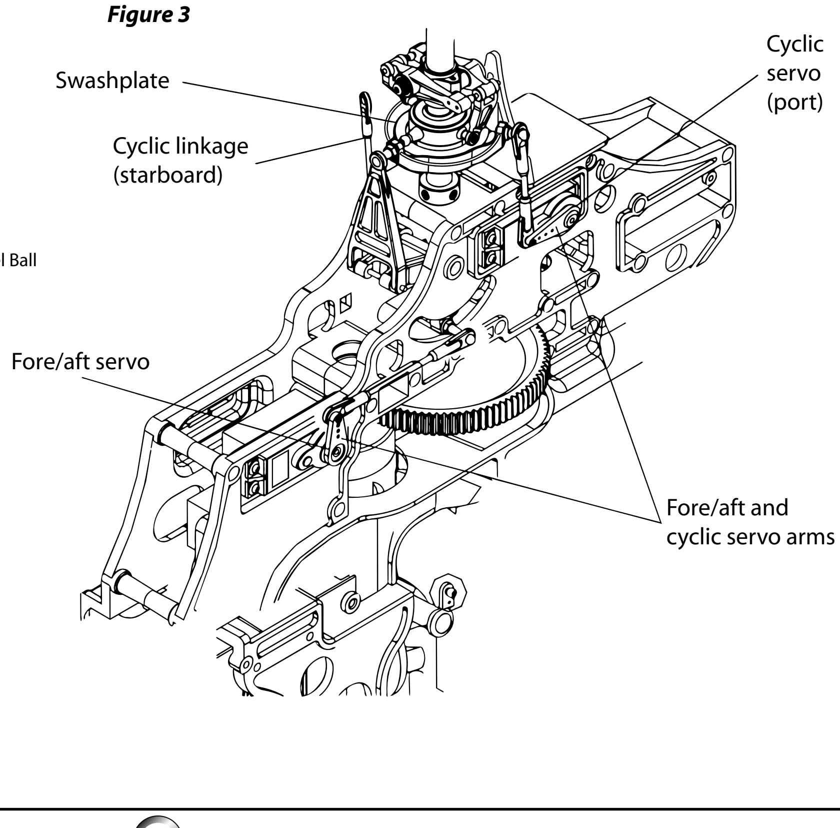


While mechanical methods, or even 4-servo CCPM are very practical methods of inputting controls to the swashplate system (fore/aft cyclic, side-to-side cyclic, plus collective), greater overall system precision and reliability results from the use of 3-servo CCPM. That's largely because mechanical systems have much greater slop, or play in the system - which increases with wear. However, servo failure is more likely than mechanical failure. Thus, inherent in the design of the ***Tiger 50*** is the elegantly very simple to understand concept of reducing the number of parts in the model to increase reliability (fewer things which can possibly fail). As it turns out, this holds true for the electronics as well - hence, it's easy enough to see where failure of a system with 3 servos is 33% less likely than one with 4.

Mechanical set-up is very important insofar as ensuring the linkages form 90° angles to the servo arms at neutral. Equally important is the idea of mechanical leverage. An even application of leverage to the bearings of the servo occurs when the ball links are installed on the inside face of the three CCPM servo arms at a distance of 20mm from center. (Figure 3)

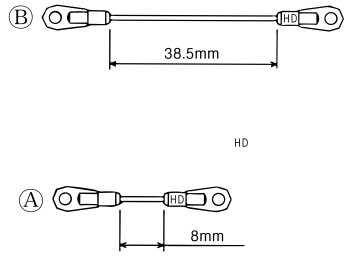
Figure 3

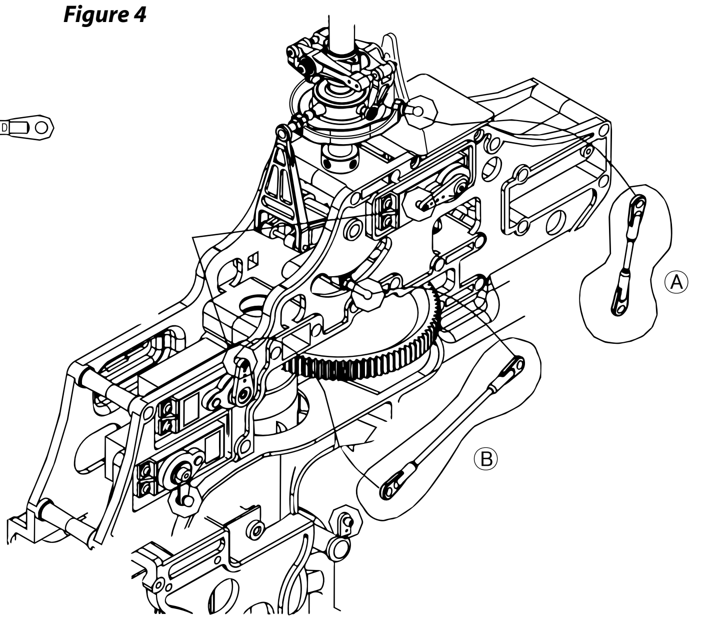




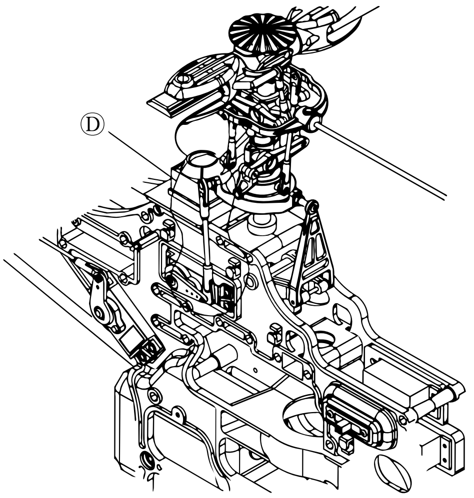
Verify pushrod lengths for the three CCPM servos. Also verify the HD-mark on each of the plastic ball links *face the screw-head side* of the ball. (Figure 4)

Figure 4

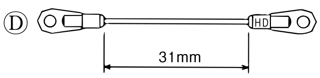




> * **NOTE:** Ensure the pushrods (linkages) for the fore/aft servo, both side-to-side cyclic servos, as well as the T/R (tailrotor) pushrod are 90° to the servo arms when at their neutral positions.



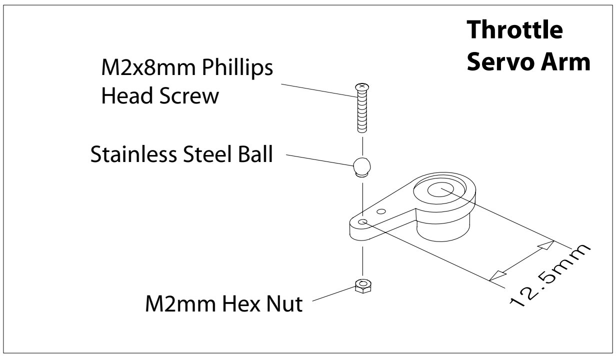
> * **NOTE:** HD ball-links are *uni-directional*. This means the side of the link that has HD on it must always face the side of the ball which has the screw head.

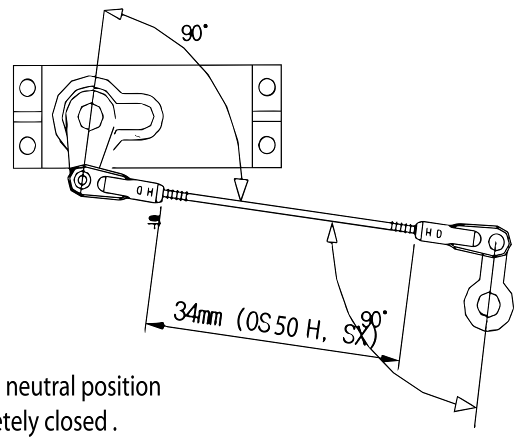


THROTTLE - MECHANICAL SET-UP:

Mechanically setting up the throttle is next. The pushrod length shown for neutral position is approximately the hover throttle opening also, but this dimension is really taken to be mid-point between WOT and idle (not fully closed). This means you set it up with this length, but plan to adjust it after the helicopter has been flown - but *before* making really precise electronic adjustments to the throttle curves. (Figure 5)

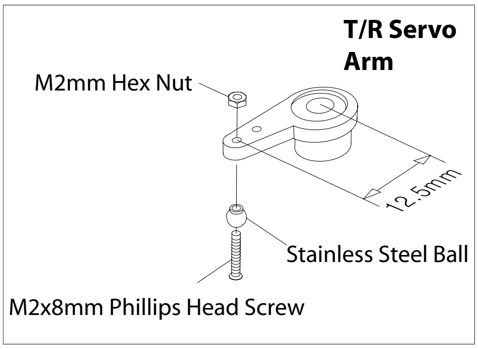
Figure 5





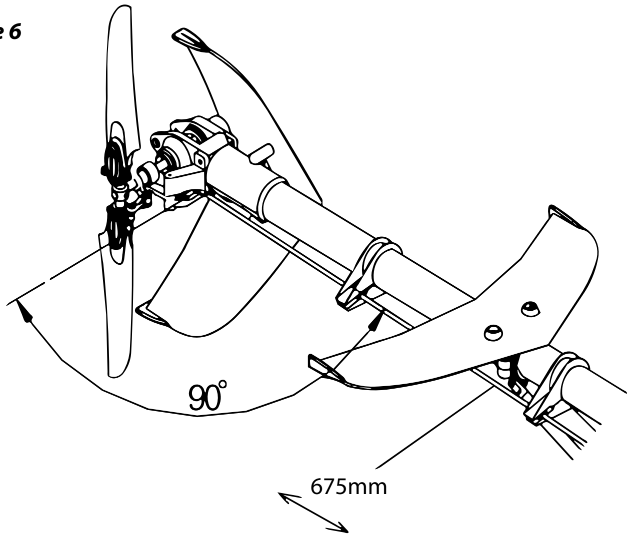
* **NOTE:** Dimensions given for OS Max 50 SX-H at middle of travel - this is neutral position for linkage. This is between WOT and idle - not between WOT and completely closed .

TAIL ROTOR - MECHANICAL SET-UP:
Mechanically setting up the tail rotor (T/R) is next. The pushrod length shown for the neutral position is for hovering. Again, this is the point at which both tail rotor control arm and tail rotor servo arm make a 90° to the tail boom. We keep harping about this because otherwise instead of symmetrical throw in the linkage, there is differential throw. This means different motion (more to one side than the other) on each side of neutral - it makes flight and adjustments less predictable. Again, as with the throttle linkage, this given length is a starting point - you may need to make slight adjustments after flying the helicopter model. Also, if you are using a heading-hold or heading-lock gyroscope, this dimension is quite likely accurate enough as is and will not need further adjustment. (Figure 6)



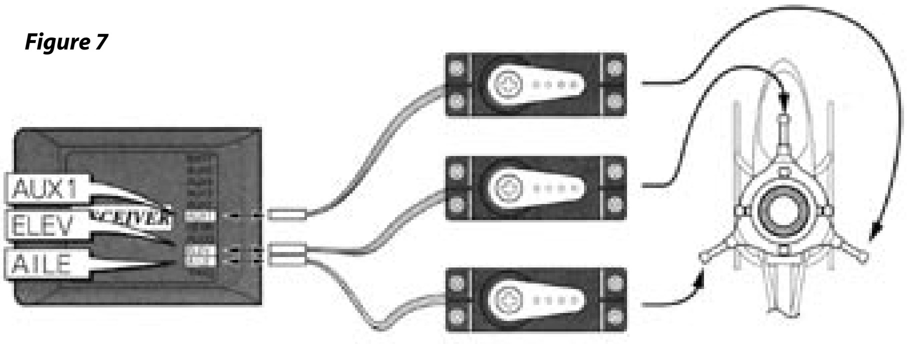
* **NOTE:** Dimensions given are for hover as the neutral position for linkage. This is not with T/R blades at flat or 0° pitch, it's at hover pitch.

Figure 6



ELECTRONIC SET-UP: Introduction
While we like to think the sequence is to always perform an electronic set-up *after* mechanical set-up, in fact, the processes interact to a certain degree. For example, in order to perform the mechanical set-up we need for the servos to be plugged into their respective channels *and* for each servo to be centered, or in its neutral position. We are aided in this process somewhat because we know how long to build each pushrod (for the theoretical center). However, reality intrudes as despite the best efforts of world class engineers and manufacturing processes, the practical effect of the end user installing servos from different manufacturers (and even accessory servo arm manufacturers) means in effect we're really giving you a really close point from which to start making slight tuning adjust-ments. The more precisely the neutral position for each servo is set, the closer the initial set up will be to the final set-up. In any case, the mechanical and electronic set-up we suggest will be close enough to permit successful test flights from which fine tuning can depart. Next, consult with the radio system's manual and verify the three CCPM servos are plugged into the receiver - something like this. (Figure 7)

Figure 7



Do the same for the throttle and tail rotor servos - as well as the gyroscope, the switch harness, and the flight pack battery. Once that's done, ensure you've routed the antenna via the antenna tube (3.1) and protected the avionics from vibration (6.4).

ELECTRONIC SET-UP: Background
We've discussed the two predominant flight set-ups; one oriented for upright flight and other oriented to symmetrical flight. We've also touched on the concept of pitch and throttle curves. Let's elaborate on all this a bit.

As it turns out, the pure symmetrical set-up is fictional since helicopters initiate and end flight with the engine at idle and the rotor blades stopped. Thus, the symmetrical set-ups shares similarity to the upright oriented set-up in what's called the Normal Flight Condition, or Normal Mode. However, first let's review how a helicopter flies before we proceed.

For a helicopter to fly it depends on the lift generated by the rotating main blades. These blades are tilted at an angle, just like a fan or a propeller has an angle and hence, as they spin, they move air. Introduce a positive angle into the blades (leading edge higher than the trailing edge) and they produce lift because they push the air downward while simultaneously *lifting* the helicopter off the ground. The more angle, the faster the helicopter is lifted. But in practice, the practical amount of angle is limited by two things, the horsepower available to spin the main rotor and the angle at which the blades will stall, or stop producing more lift than drag. More on this later.

Similarly, if you introduce a negative angle (or negative pitch as it's more commonly referred to) into the rotor system, the helicopter will push the air upwards forcing the model onto its landing gear. From this simple fact derives the idea that negative pitch combined with a model whose orientation is upside-down and we have the basis for inverted flight. As it turns out, the helicopter doesn't care whether it's right side-up or upside-down!

Examine the airfoil of the main blades and you'll see a strong resemblance to the airfoil of a wing. That's because it is a wing! In fact, it's really not uncommon to refer to helicopters as rotary wing aircraft vs. airplanes known as fixed wing aircraft.

Control of the helicopter is established through the introduction of additional angles of pitch (both positive and negative) within the overall gross angles we mentioned earlier. Let's look at an example.

Suppose a helicopter uses 5.5^{o} of pitch to hover (the converse holds true as it would use about the same, or -5.5^{o} i.e. *negative* pitch to establish a hover inverted and thus, the convention is introduced of indicating when pitch is negative, otherwise, it's assumed to be positive). Anyway, from a hover, for the helicopter to move forward, the linkages of the rotor system would introduce a little bit more pitch on one side of the rotor disk and remove a bit of pitch from the other. These result in a tilting of the entire rotating disk forward - which would cause the helicopter itself to also tilt forward and thus, move forward. Coming to a stop would entail the reverse, or the tilting the disk aft.

R/C model helicopters use a combination of Bell and Hiller mixing to provide both direct and indirect control over adding and subtracting the small amounts of pitch involved in controlling the rotor disk. It is beyond the scope of this manual to enter into greater technical depth. Let's return to the idea of blade angles, or pitch, as they relate to stalling the blades.

As it turns out, depending on the airfoil, a blade (or a wing for that matter) stalls between 14^{o} and 18^{o} of pitch, or angle of attack (how much higher the leading edge is related to the trailing edge). Because the main rotor may have as much as $10\text{-}11^{o}$ of pitch during maneuvers, and because the addition of control inputs will increase the pitch on one side of the rotor disk by as much as $5\text{-}6^{o}$ (whilst simultaneously reducing the pitch on the other side, of course - but we're only concerned with where the blade stalls), we need to beware the possibility of stalling part of the main-rotor disk (causing an extended loss of symmetry in lift). The reason for touching on this is related to the extreme power of 50-class engines when coupled with the agile airframe of the ***Tiger 50*** helicopter which means if you are not careful, you may find yourself on the wrong side of the limits imposed by physics! In short, be aware of the fact that there *are* limits.

ELECTRONIC SET-UP: Pitch Curves

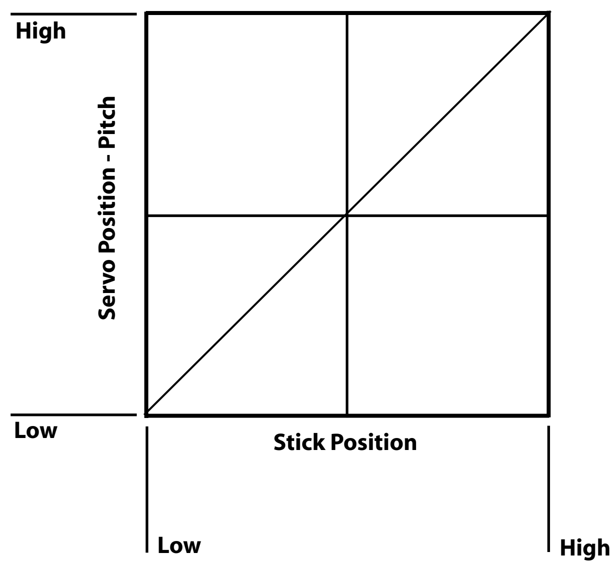
We suspect that in the course of learning about model helicopters you've heard the term pitch curve or throttle curve bandied about. All that's meant by this is the graphical representation of what happens to a control (servo) when a stick on the transmitter is deflected (moved). Let's see if we can shed some light on this. We'll begin with pitch curves since they're easy to visualize and they relate to orientation (upright or symmetrical set-up).

First some terms and definitions - so that we're all on the same page. We start by assuming you are using a Mode 2 setup in your transmitter. This is Throttle/Collective as well as the Tail Rotor on the left-hand control stick and the fore/aft as well as the side-to-side cyclic controls on the right-hand control stick. Holding the transmitter in both hands and moving the T/C stick towards you will decreases throttle and collective pitch while moving it away, or up, increases T/C pitch. T/C servos are linked electronically. Push the tail rotor stick to the left and the nose of the heli goes to the left - and vice versa. The rotation caused by the T/R is about the axis of the main rotor, i.e. the helicopter will spin around in circles.

The right-hand joystick controls cyclic pitch (which is the adding and subtracting of pitch from the collective pitch). Cyclic pitch tilts the rotor disk and causes changes in direction. Side-to-side, or aileron, cyclic causes rotation about the longitudinal axis (the length - or tail boom axis) so the machine will roll. As you would expect, move the joystick to the right and the machine will roll to the right. In a similarly fashion, the fore/aft directions for the joystick (or control stick) causes the machine to roll about the fore/aft axis. Pushing the joystick away from you dips the nose and a pull towards you raises the nose. Continue to hold the control and the helicopter will rotate in place about that axis (when combined with the well timed and skillful application of collective pitch in both positive and negative directions as well as some T/R to hold position). Did you expect this to be easy? It's not - which is why there are more fixed wing pilots than rotating wing pilots! But you *can* master it.

So what does a pitch curve look like? This is what a collective pitch might look like. (Figure 8)

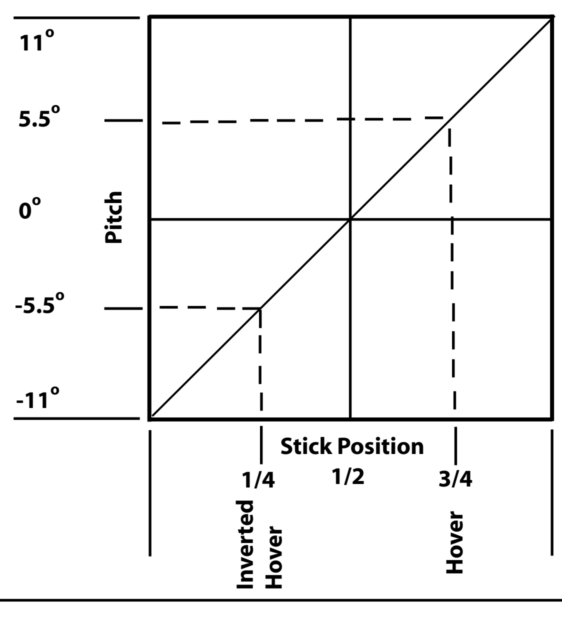
Figure 8



If you're thinking, *That's not a curve, that's a straight line!* You're right as in this case, the pitch curve ***is*** a straight line. It's an example of the pitch curve for a switchless inverted set-up. Let's put some numbers to the curve to see if it helps.

Below, the pitch curve represents the pitch range from 11° to -11° with mid-stick being 0°. This is the pitch curve of a helicopter, which can perform equally well inverted and right side-up. Either extreme of the joystick represents 11° of deviation from 0° and the upright hover occurs around 3/4-stick while the inverted hover occurs at about 1/4-stick, both with 5.5° pitch. (Figure 9)

Figure 9



The shorthand for the pitch curve in Figure 9 would be -11, 0, 11. It would be understood that we meant -11^{o}, 0^{o}, 11^{o} but the degrees could just as easily be left off. The proper name for the curve in Figure 9 would really be:
Switchless Inverted Pitch Curve, Idle Up 1

The *Switchless Inverted* part you already understand to mean a set-up for symmetrical flight, while *Pitch Curve* is now self-explanatory. The *Idle Up 1* part refers to the flight mode used for most aerobatics. Depending on the brand radio you select, these names may be different . . .

Futaba-brand radios may refer to **Idle Up 1**, or **I1** and ***JR***-brand radios may refer to **Flight Mode 1**

. . . but they both mean the very exact same thing!

This brings us to something else. Your radio may, in addition to these flight modes, refer to others like Hold Condition, or Hold Mode, and Normal Condition, or Normal Mode, and even Idle Up 2, or Flight Mode 2. We'll get to these later.

By the way, Futaba uses the Flight Condition while JR uses the word Mode - but we figure they really just do it to confuse us! Don't worry if you hear people referring to Mode this or Mode that but you notice they fly Futaba equipment - it just means they've been hanging around folks who use JR equipment - it's not a sin! Plus, of course, there are other brands too - like Airtronics, Hitec, et al. and each have proprietary terminology you'll need to get the hang of.

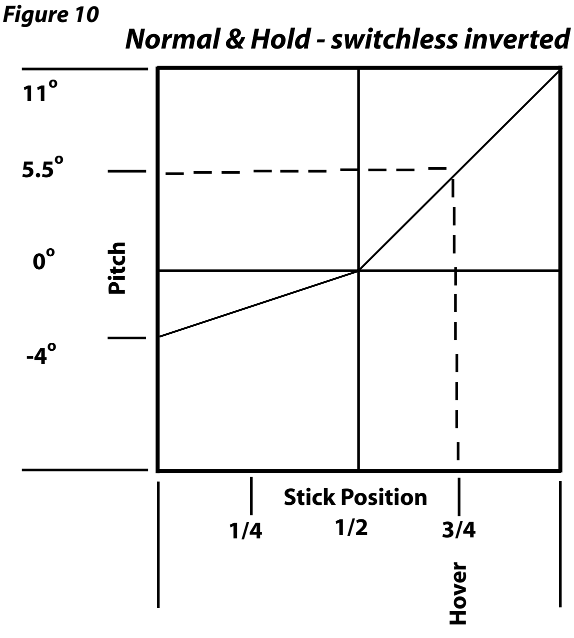
Oh, and in case you're wondering, no we're not going to teach you how to program a *specific* radio to the ***Tiger 50*** in this manual. There are too many radio systems with excellent manuals which explain *exactly* how to set-up a CCPM heli for us to replicate all their work. That, plus the radio models change almost yearly, so anything we put in the manual would soon be obsolete!

Instead, our goal is to give you a grounding in both how and why certain flight modes exist, combined with some pitch values - which will get your helicopter close to a final set-up - close enough to fly and just make minor trim changes.

As you may suspect, this section was created for folks to whom this is all new. Experienced pilots will just glance at the pitch values we suggest and be on their way without a further glance at this manual!

Since we've discussed the switchless inverted pitch curve Idle Up 1 set-up, let's discuss the Normal Pitch Curve for the same set-up. The Normal Pitch Curve is the one used to start the chopper, carry it to the flight line, and take-off as well as for recovery of the model at the end of a flight. Flying around is done in Idle Up 1 - understand? The goal is for this curve to exactly match the Idle Up 1 curve from mid-stick on up because you don't want the heli to jump up or down when you engage the switch due to a difference in pitch curve profiles. Thus, the top end pitch will be the same; the hover pitch will also be the same (and will still occur at 3/4 stick - exactly as it does for idle Up 1). Similarly, mid-stick will continue to be 0^{o} of pitch. The differences in the pitch curve will only be apparent in the run up to hover. The end result will be a smooth transition between the Normal Mode and the Idle Up 1 flight mode, which can be accomplished from hover pitch on up. At the bottom of the pitch range, there will be about -4^{o} of pitch to enable easy landings even in a stiff breeze (Figure 10)

Figure 10



By the way, if it's not clear, you measure pitch at the blades with a pitch gage while ensuring the flybar is absolutely level. Your hobby dealer will have pitch gages available. With a switchless inverted set-up, there's not often a need for a Idle Up 2 Flight Condition. Some expert pilots who use the condition often mimic Idle Up 1 so as to not have problems if they inadvertently toggle the switch past the Idle Up 1 position. Other expert pilots will have almost the exact same curve loaded but with slight changes to suit perhaps greater wind. We're treading on the territory of professionals. If you don't know *why* you would want an Idle Up 2 (in additional to an Idle Up 1), you likely don't need to worry about it.

This brings us to the Hold Condition. We recommend the Hold Condition pitch curve should look identical to the Normal Curve. The Hold Condition is used for practicing autorotation landings - simulated engine out landings.

The end result is you will have the ability to switch between flight modes, be it Normal, Idle Up 1, (or 2), and Hold without the helicopter doing anything strange. What's more, you can always find the unloaded point on the rotor disk (0^o) because it's mid-stick for every single flight condition. This is a tremendous advantage in flight management and will permit the easiest way to master aerobatic flight with the ***Tiger 50***.

At this point you may be wondering how do you decide what the top end pitch will be? This is determined by the power of the engine. Some engines being stronger than others can pull 11^o of pitch with no problem, others can only pull (without sagging) 10.5^o of pitch, etc. It depends on the engine. However, while we can directly *measure* the pitch of the main rotor, we don't have an easy way to measure power output. The easy answer to this is max pitch corresponds to max throttle opening. Usually. The top-level aerobatic pilots however keep a little in reserve at top end pitch so they can add *more* power to make up for the cyclic demands of pitch and power during maneuvers - but that's beyond the scope of this manual. We'll get into all this a bit later when we discuss Throttle Curves.

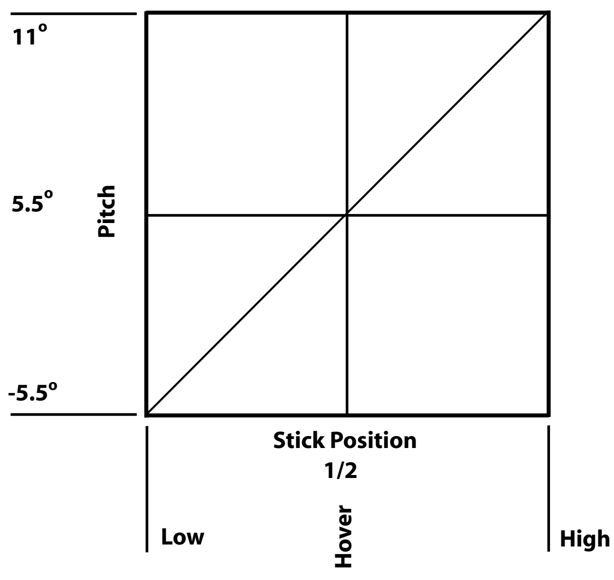
We've pretty well covered the pitch curves for an experienced pilot who wants to perform any 3D maneuvers within their repertoire.

Upright Orientation: Normal Pitch Curve
Next we'll discuss the minor changes made to the pitch curves for the pilot who is not really interested in extreme aerobatic flight. First up is the Normal Pitch Curve (for upright oriented flight). As you'll see, the curve really doesn't look very different at all, but the values are quite a bit different as the hover point now occurs at mid-stick. In fact, this is a much better set-up for hovering as the sensitivity of the T/C stick is reduced by half! Top end pitch is not changed either. Bottom end pitch is changed to the negative value of the hover pitch. In this case, it's -5.5^o (though some pilots may not like the bottom end pitch quite so steep, it does allow greater precision and control for spot landings by adding the ability to drop quite steeply by adding loads of negative pitch).

By the way, have we mentioned just how easy it is to make the changes to the curves? It's done simply by changing the ATV (total amount of servo throw) for each of the three CCPM servos. Of course this is done with the pitch gage installed on the blade so you can interactively make adjustments. It's quite easy and takes only a few minutes to program into the transmitter! (Figure 11)

Figure 11

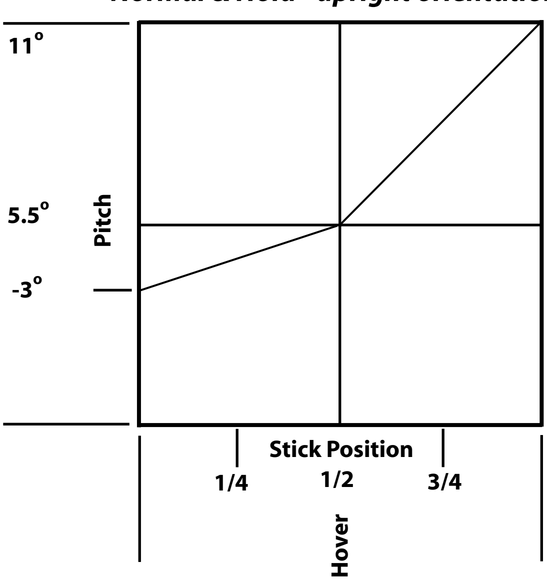
Normal & Hold - upright orientation



You may have noticed the T/C stick is no longer symmetrical for the Normal Curve in an upright oriented system because there's 11^{o} of pitch between low pitch and hover and only 5.5^{o} of pitch between hover and high pitch. Earlier we mentioned many pilots don't like the low end of the pitch range setup so sensitive. This is very easy to adjust with the transmitter by decreasing the low-end ATV values of the three CCPM servos.

Below is another Normal Pitch curve - one that many pilots may find more comfortable. However, be aware that in high winds, it may be harder to get the helicopter back down because you'll find a need for more and more negative pitch as the wind speed increases. In fact, in a stiff breeze, a helicopter with only 0^{o} of pitch, seemingly doesn't want to come down! (Figure 12)

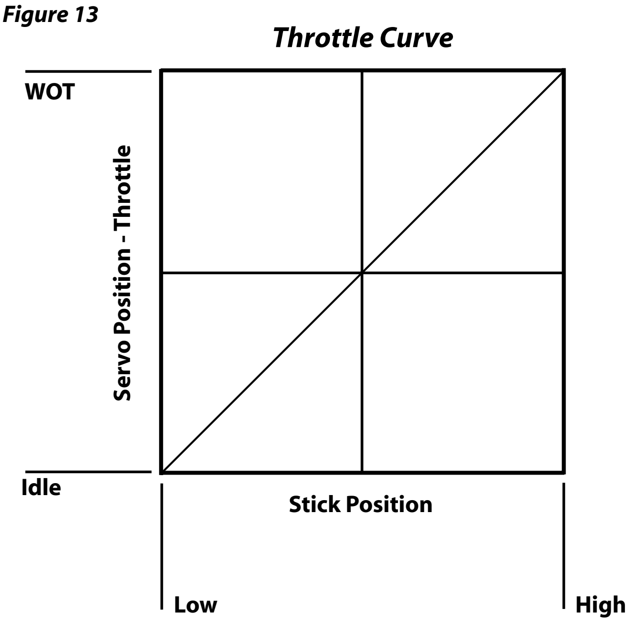
Figure 12



For an upright, or sport, orientation, there's also a need for an Idle Up 1 Pitch Curve because while the helicopter spends most of its time upright, it doesn't spend *all* its entire time upright. This heli will occasionally perform both loops and rolls during which it will be briefly inverted. What does the Idle Up 1 Pitch Curve look like for a machine with a sport orientation? Exactly like the one above! The difference isn't in the pitch curves but in the throttle curves. Why? Because it's critical to always maintain rotor speed, most especially when the helicopter is in the inverted portions of the maneuvers. This leads up to discussing throttle curves.

ELECTRONIC SET-UP: Throttle Curves
As with pitch curves, throttle curves are just the graphical representation of servo position as it relates to stick position. In this case, the stick is the T-part of T/C, or throttle. High stick corresponds to high pitch. The throttle curve for a Normal pitch curve might look like the one below. Notice, how the throttle is closed at low stick and wide open (WOT) at high stick and somewhere in the middle for mid-stick, or hover. (Figure 13)

Figure 13



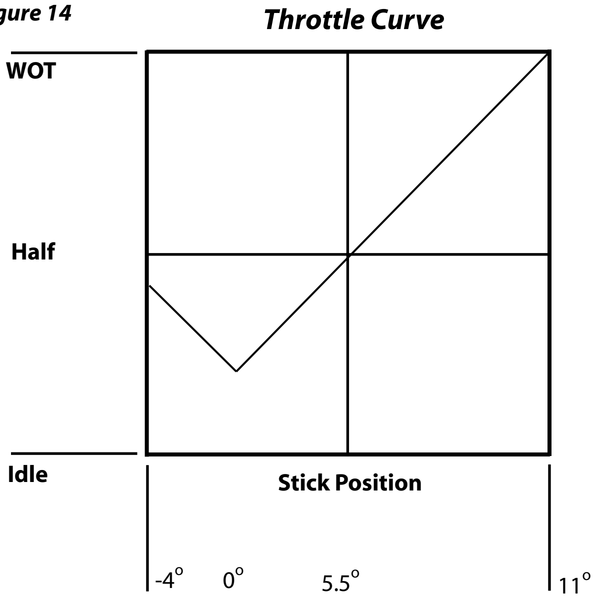
The whole idea of throttle curves is for the throttle to add or subtract power to the main rotor system (by opening or closing the throttle) so as to maintain the RPMs of the main rotor constant. Seems simple enough as increasing main blade pitch means you increase the load, which would slow down the main rotor blades unless we also increased the throttle. Similarly, reducing the load on the main rotor system by reducing the pitch would lessen the load on the engine which is compensated for by closing the throttle the appropriate amount - understand? Hence, the reason why we refer to the throttle collective stick as the T/C stick is because the throttle and the collective pitch move at the same time, or are linked. Usually.

Usually? Yes, the usual relationship means high pitch and high throttle while low pitch is linked to low throttle. But there are times when this isn't the case - during Idle Up and Hold.

Throttle Curves: Idle Up and Hold Conditions
While the throttle and the collective pitch servos move at the same time, or are linked, for Normal pitch curves, as soon as a helicopter is inverted, the pitch servo moves in the opposite (negative) direction. If the system closed the throttle it would mean disaster, as the rotor speed would decay! Similarly, to practice autorotation, the pilots wishes to disconnect the throttle from the collective stick, in effect setting the engine at idle while permitting the pilot to perform the autorotation maneuver as if the engine had died. Then, if the maneuver isn't coming along well, the pilot flips the hold switch back, the engine roars back to life from idle, and the helicopter can enter normal flight again. Both of these are conditions where the linking of throttle and collective in their usual relationship isn't desired. They are accomplished by throwing a switch.

In the case of Idle Up, the pilot flips the Idle Up switch (which may actually have three positions, Off, Idle Up 1, and Idle Up 2). Engaging this switch tells the radio system to convert both the Normal Pitch curve (when Idle Up switch is Off) to the Idle Up 1 Pitch and the Idle Up 1 throttle curves. The purpose is to keep the rotor speed constant. The actual amount of throttle required is subject to experimentation. If you don't know how to fly inverted, get an experienced pilot to help you - or you'll be in big trouble! Below is what an Idle Up 1 throttle curve might look like for an upright oriented helicopter. (Figure 14)

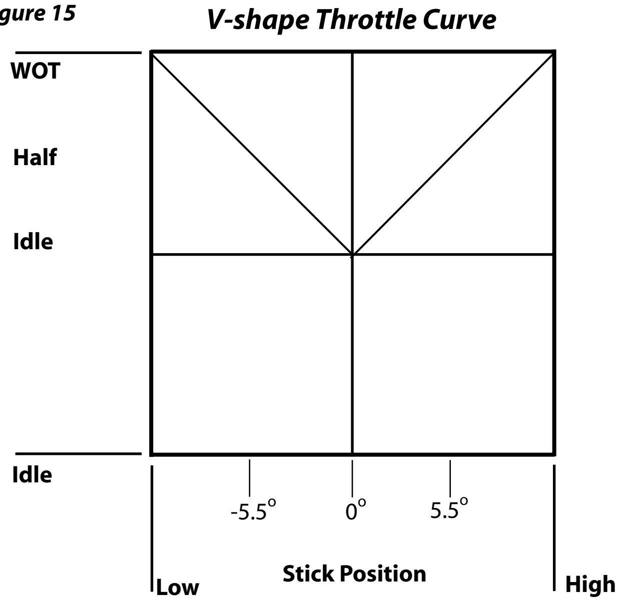
Figure 14



What's immediately apparent is the throttle closes until it hits 0° pitch at which point as the pitch goes negative, the throttle opens up again (some) in an effort to keep the main rotor blade speed constant.

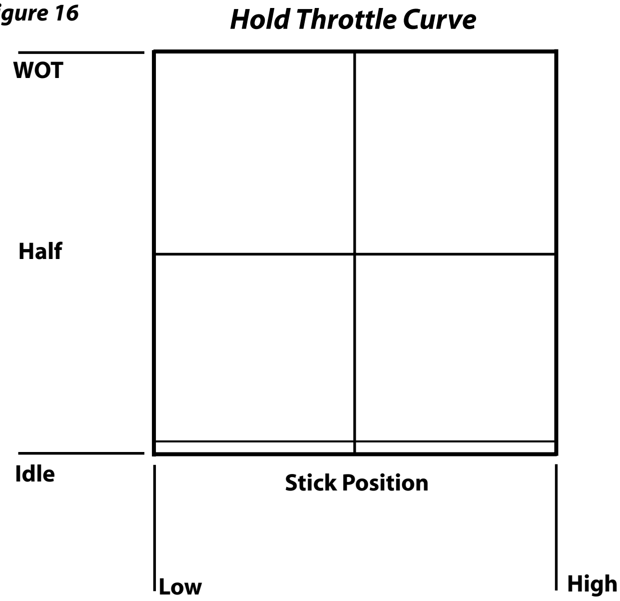
Below is the throttle curve for Idle Up 1 for a full-on extreme performance helicopter. (Figure 15)

Figure 15



This is what's known as a V-shape throttle curve. It follows the Idle Up 1 pitch curve from Figure 9. You'll note, the low-point for the throttle opening corresponds to about 0° pitch. This is close to an idle setting - but it must be adjusted in flight. The throttle for hover pitch is about the same as for the normal curve. The last curve is the one for Hold. Again, this isn't a curve, it's just a straight line that represents a faster (reliable) engine idle. (Figure 16)

Figure 16

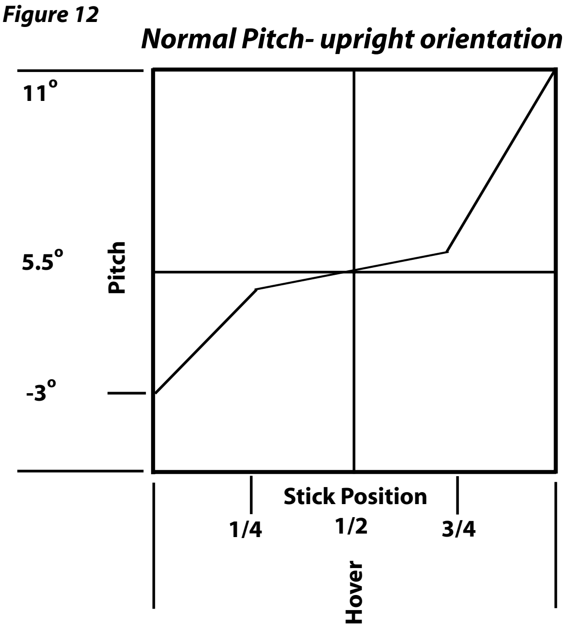


The amount of throttle in the Hold curve is also determined by experiment. Usually the idle setting is a little bit higher than normal, not a lot, just enough to ensure the engine will *not* die during the descent. That's because if you bail from the maneuver (autorotation practice) by flipping the switch back and the engine is dead, then you are committed to completing the autorotation - or crash! Since the reason you usually bail from a practice autorotation is you've screwed it up somehow, you then find yourself in big trouble. Make certain the engine idles reliably.

In practice, these Pitch and Throttle Curves often don't look like the beautiful straight lines we've used for the manual. Often, to keep main rotor speed from decaying, or from going too fast, the pitch throttle points will not be quite as perfect as those we've shown. It's also worth noting that for all of the example curves demonstrated, we've assumed you've had a radio, which can set 5 points for all the curves. These points are, low-stick, 1/4-stick, mid-stick (or 1/2-stick), 3/4-stick, and full-stick.

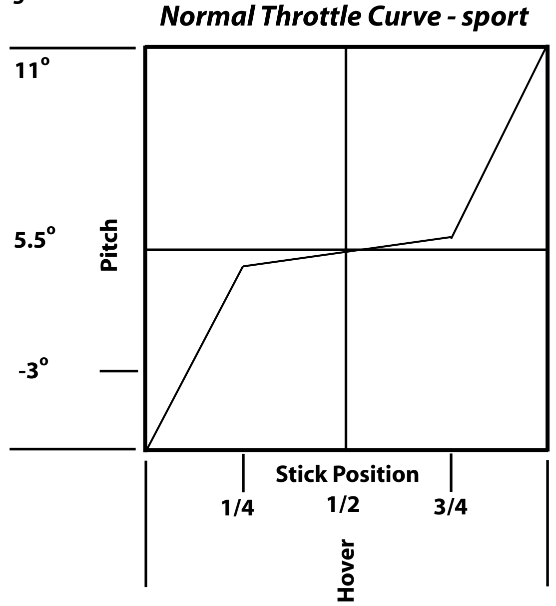
For example, many pilots will have a Normal Pitch curve (upright orientation) which looks more like this. (Figure 17)

Figure 12



The flattened part of the curve is so collective pitch control for the helicopter isn't quite as sensitive. Similarly, the Normal Throttle Curve for an upright oriented helicopter will look more like this. (Figure 18)

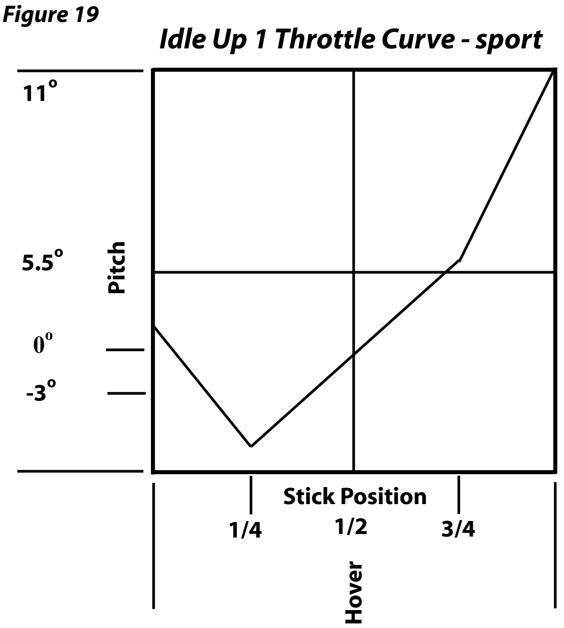
Figure 18



What's happening here is the throttle decreases sharply until the stick is at 3/4-stick then flattens near the hover (mid-stick) position. Again, the curve stays fairly flattish between the 1/4 and 3/4-stick positions which help keeps throttle sensitivity good near hover. From the 1/4-stick position the curve drops steeply again towards an idle setting.

This is what the Idle Up 1 throttle curve might look like for an upright, or sport, oriented helicopter. (Figure 19)

Figure 19



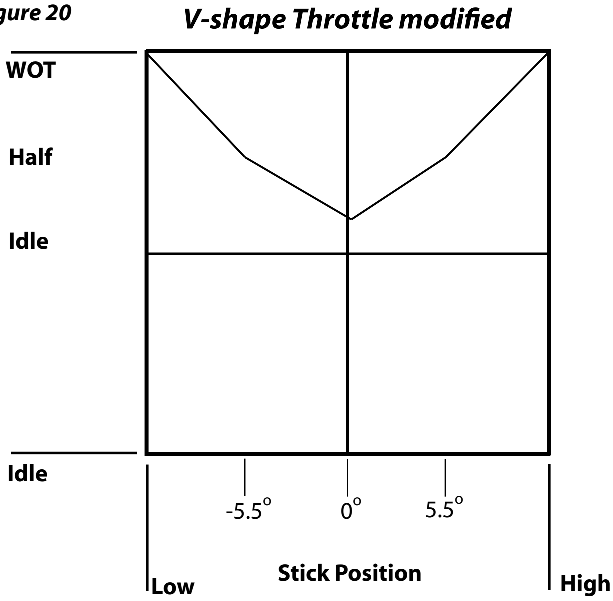
The low point in the curve corresponds to 0°

of pitch and then the curve climbs as the throttle is opened to account for the fact the main rotor blade system is being loaded again as pitch increases from 0^o to -3^o of pitch.

The fly in the ointment is the limitation of having only 5 points on these curves. If you have ever wondered why top pilots use radio systems like flagship 9 and 10-channel systems from the likes of Futaba and JR, the reason is these systems have more capabilities - chief amongst them, more points on the curves.

Now let's look at the Idle Up 1 throttle curve for a switchless inverted, or extreme performance, helicopter. (Figure 20)

Figure 20



This throttle curve looks much like the V-shape throttle curve from Figure 15, but the main difference is the shallowing out of the curve between hover-throttle and 0^o pitch. Also note the throttle doesn't go fully to idle during 0^o pitch as the pilot is not going to spend much time with the main rotor unloaded at this point. Instead, this is actually simply a transition point on the way to re-loading the rotor disk as pitch goes negative.

In setting up the throttle curves, you must bear in mind that while we can measure the pitch we set up into the main rotor disk (using a pitch gage), we cannot however, measure the power settings. Hence, the first thing you set after establishing the neutral point for all the linkages (and ensuring the control and servo arms make perfect 90^o angles as they meet) is the desired pitch for 0^o-pitch, hover-pitch, and full-pitch stick positions. These, of course, are low-stick, 1/2-stick, and full-stick for a extreme performance oriented helicopter. Then, once each of these stick positions are set, leave the settings alone.

Since we cannot measure power using calipers, a ruler, or any gage we will establish the proper throttle position via flight-testing - empirically! For most pilots, max pitch is the simplest to set because the carburetor is at WOT (wide open throttle) position. Remember, depending on the capabilities of your radio system, you may actually use 95% power at max pitch and keep 5% in reserve for maneuvers (throttle ATV needs be at 100% - physical WOT). If the engine will not pull the max pitch you established, then the solution is to reduce the pitch curve at that point. If the rotor speed is too high at max pitch, and you already have all the extra throttle (5%) you want in your pocket for maneuvers, then increase the main blade pitch at high stick using pitch ATV.

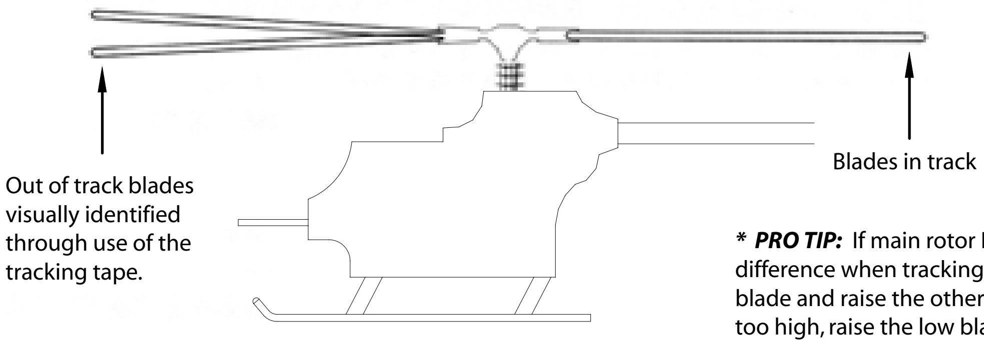
For the Normal mode, you will use the engine's good-idle speed as the setting for low-stick. Hover power is initially a straight line between the two other positions and is dialed in when actually hovering the machine. If when hovering the rotor speed is too low, then increase the mid-stick position throttle curve. Conversely, if the rotor RPMs are too high, reduce engine power at mid-stick. At this point, as we mentioned earlier, it is important to again verify the hover throttle position has the linkage at 90^o to the pushrod. At all costs we desire to keep differential throw to a minimum - with throttle this will promote a linear delivery of the power. All adjustments to the rotor speed are done with throttle curves.

ELECTRONIC SET-UP: Gyroscope

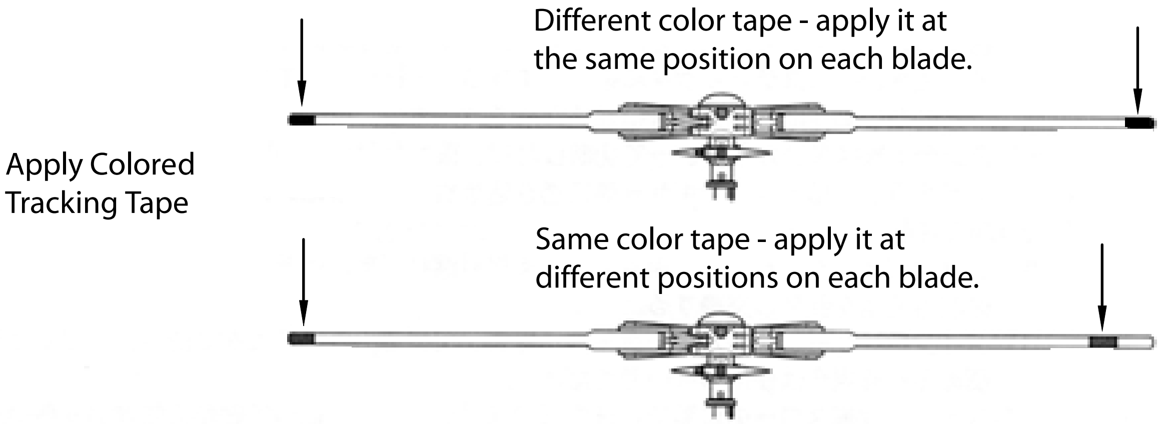
As a rule, piezo crystal gyroscopes have replaced old-technology mechanical spinning gyros. These usually feature heading-hold. When in this mode, turn off the Revolution mix in the radio (all flight modes using heading-hold will have REVO turned off). That's completes initial set-up - now it's time to go to the field!

FIELD SET-UP: Blade Tracking

You've completed an initial set-up on the workbench; now it's time to make some fine adjustments. The first thing to do is remove the canopy because this will permit easy access to the linkages. This will have a negligible effect on trimming the model, but the prudent modeler may add about 6 oz. of weight to the radio platform to compensate. If the helicopter does not drift too much, proceed to blade tracking before trimming the model. If the machine is in need of so much trim that tracking the blades will be difficult, then perform some trimming first. Hopefully the machine is accurately built and very little, if any, trim will be needed. The procedure is to lift the machine into a low hover (skids a few inches off the ground) and verify the blade tracking. It's great to have an experienced helicopter pilot's help at this stage. Apply tracking tape and verify the blades are in track.



* ***PRO TIP:*** If main rotor RPM is fine, split the difference when tracking the blades; lower one blade and raise the other - but if the rotor RPM is too high, raise the low blade to match the high blade and vice versa if the RPMs are too low.



FIELD SET-UP: Trimming & Linkage Adjustment

After tracking the blades, remove the tracking tape, it's time to make trim adjustments. Lift the helicopter into a high hover (skids at eye level) so that ground effect doesn't affect the model. If the model holds position fairly well, or only needs 1 or 2 clicks, you're done. If more than this is needed, make mechanical linkage adjustments to compensate, re-center the trims on the transmitter, and try again. Verify the neutral position for both the throttle and T/R linkages are correct in the hover.

FIELD SET-UP: Dynamic Blade Balance

Remove balance-weight and re-install canopy. Lift model in high hover. If there are some small vibrations, try to dynamically balance the main rotor. Pick a blade and add a wrap or two of tracking tape at the CG of the blade. Lift into a hover and if it's worse, remove the tape and try adding it to the other blade. If it's better but not perfect, add a bit more. This is a trial and error process, which most pilots don't bother with, but time spent here will deliver a much smoother performing helicopter.

10.3 SET-UP NOTES