TSK Mystar Mystar goes 3D

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joins W3MH from Japan to describe 3D setup for the TSK MyStar series of helicopters

The author doing what he likes most: flying his Mystar 60v2 inverted and waving to his Japanese friends....

Introduction

3D flying has become very popular in the last few years and is no longer a strange flying style for a few crazy pilots. With the new F3C rules even the most traditional and serious competition pilots have had to practice new maneuvers which require skills in controlling a helicopter in backwards and inverted flight. Beside of the necessity, many pilots have realized that 3D flying is a lot of fun and also a new challenge, only limited by the imagination and the fantasy of the pilot. Even for Sunday flyers 3D practice can give new motivation and the confidence to handle the helicopter in all kind of situations.

Most model helicopters can be set up for 3D flying with minor modifications even though they have been designed for "normal" flying. In this article I'm going to describe how to set up the TSK Mystar series for 3D flying.

The main modification is adjustment of the rotor head for symmetrical operation about the mechanical centre, which is set to 0° collective pitch. This modification can be done using regular TSK parts.

Basic principles

The basic idea behind my approach to 3D flying is that the helicopter uses a completely symmetrical setting. This ensures that the helicopter reacts in inverted flight the same way as it does in normal flight. This way the heli will "behave" as we expect it and as we know already from our normal flight experience. Of course some "semi-3D" settings are also possible and for some situations more appropriate (for example for the new F3C rules), but the mechanical adjustments and the "programming" of the transmitter are more complicated. To achieve the goal of having the same flight characteristics in normal and inverted flight it is best to use symmetrical blades. This makes it possible to set the throttle curve and tail rotor mixing parameters (revolution mix, torque compensation) in normal flight and copy the values for the negative collective pitch values. This gives a reasonable setup right from the beginning which will avoid any unexpected reaction of the helicopter in inverted flight. It is difficult to get such blades for all the different sizes of helicopters here in Japan and so far I have been unable to obtain symmetrical blades for the Mystar 46. In this case I use the same blades as for the Mystar 60 (NHP Sport II), but I cut them down in length from 68cm to 60cm and check the balance again *(Ed: Do not attempt this type of modification unless you are sure you know what you are doing)*. Most symmetrical blades do not store the energy so long in the final stage of an autorotation but they usually accelerate very quickly again once the rotor has slowed down in a 3D autorotation maneuver (inverted, rolls, backwards etc.).

After getting familiar with the idea of a symmetrical setup it is easy to understand that for the initial setting of the heli (and the transmitter) the 3D condition is set first. Some transmitters have pre-set values already programmed in for tail rotor mixing, pitch curve or throttle curve, but for setting the servo centers and linkages it is important to

deactivate all of these functions and set all trims in the central position. Check if the throttle trim is set to ATL (so that the trim acts only in the low throttle regime) and set it to it's minimum (engine off). We start with the mechanical set-up for the 3D flight condition followed by the Pitch/Throttle curves and the other mixers (Revolution mix, P>R) for the different flight conditions of 3D, normal flight (start, hovering and low speed flight), autorotation and if required, F3C aerobatics.

The Mystar 30/46/60 series

TSK's Mystar series are well know for their high quality which includes rigid frames, precise linkages, low wear and thus long maintenance intervals - ideal for 3D flying which stresses the materials and structure more than any other flying style. But as with many other popular helicopters the Mystar series was initially designed for a flying style compatible with the "old" F3C rule set. This means that hovering with about 4-5 degrees of pitch was the main operating position of the rotor head and linkages. The extreme values of -4° and +12° were only reached for short periods in some "extreme" maneuvers such as the roll or the autorotation. The loops and turns could be flown in the range of 0 - 9 degrees of pitch.

For 3-D flying the most popular pitch values are plus and minus 5° for hovering (inverted and normal) and plus and minus 10° for quick climbs and acceleration with 0 degrees in the intermediate stages of most 3D maneuvers. Depending on the engine, the blades and one's personal preferences, these values can vary between 4-6 and 8-11 degrees respectively; 5° and 10° are the settings which I use on my Mystar 30, 46 and 60. The center position is now 0 degrees. In this position all pushrods, linkages, mixing arms and servo arms should be horizontal or vertical and/or perpendicular to each other so that any movement to the positive side or negative side of the pitch range is symmetrical.

Figure 1. Left: MS30/46 pitch plate with an additional hole for an arm length of 20mm. TSK Rod ends RE-SS, -S and -L. Seesaw joint MS30/46 and MS 60 original and modified ones (2.5mm shorter) made of rod-ends and rod 2.3mm.

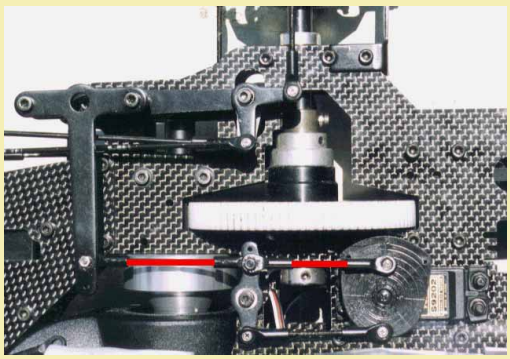

Fig. 2: Straightened linkage (MS46) between servo and Pitch lever by mounting the two ball links in the same hole on opposite sides of the push-pull arm.

Mechanical changes on the rotor heads for the MYSTAR series

MS 30/46

With the mixing arms on the seesaw unit (on the flybar) in the horizontal position the blade holder takes a position which normally gives about 4° of pitch. It is impossible to get a full stroke of -10 to +10 degrees without the mixing arms reaching their mechanical limit.

- An extra hole in the pitch plate of the blade holder (SH3008, Pitch arm) increases the pitch range for a given swashplate movement (Fig. 1). As an additional benefit this also increases the amount of direct control input from the swashplate and the amount of feedback from the flybar (stabilization). This means the heli reacts quicker to elevator and aileron control AND also exhibits more stability in a rough wind!

- When the seesaw mixing arms are in a horizontal position the blades must have a collective pitch angle of 0 degrees. The original seesaw joint (TSK: SH-3016) has to be replaced by a shorter one. Use a standard linkage rod and super short rod ends (TSK: RE-SS, Rod end super short Fig. 1.). The RE-SS rod ends have to be shortened further by 0.5 mm each using a sharp knife. I apply a small amount of Cyano-glue when mounting the first rod end on the linkage so that the rod doesn't turn when mounting the second rod end. The second one doesn't need to be glued.

MS60

- The pitch arm (508-5450) can be set to two different arm lengths. As indicated for MS30/46, use the shorter setting (inner hole) for an increased pitch range, quicker response and higher stability.

- The original Seesaw joints (508-5465) have to be replaced by shorter ones to have 0 degrees pitch on the blades when the mixing arms are in the horizontal position. They are easily made by using a threaded rod and two short rod ends (TSK: RE-S, Rod end short). Shorten one by 2mm or each by 1mm.

Additional Changes

MS30

- The washout unit with the guide pin which moves in a slit in the mainshaft gets some radial play after a few flights. This is not a problem for normal flight conditions where the swash plate is not moved to its limits all the time. To get very precise control during extreme 3D maneuvers the washout unit can be replaced by the MS46 washout unit (413-6600 wash-out assembly) including the guide pin (513-5670) below the rotor head. This combination is only possible with the modified shorter pitch arm.

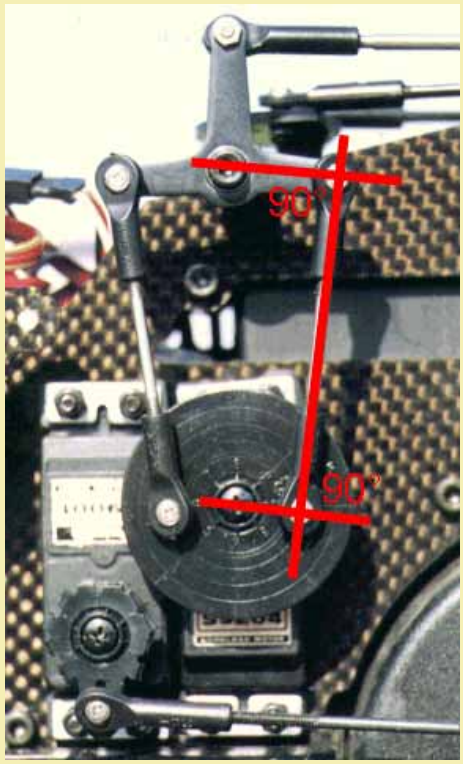

Fig. 3, above. Servo arm (MS60, elevator). The disk is rotated until the lines are parallel to the servo case. Then the holes for the ball links are drilled using the guide lines. Make sure that the linkage and the thought line between the ball link and the servo center form a 90 degree angle.

Fig. 4, right. MS 60: Pitch linkage setting for 3D mid point: Stick in center position: all linkages and arms form 90 degree angles. washout arms and pitch lever (upper arm) are horizontal.

MS46

- If the washout arms of MS46 are replaced with the MS60 washout arms (513-5660) the flybar deflection is increased and allows even quicker maneuvers.

- The linkage between the servo and the pitch lever (TSK 512-5540, N6 CP-Lever set) should be adjusted to achieve a higher degree of linearity. By mounting the ball link from the servo and the ball link to the lever in the same hole of the push-pull arm using a CP-M2-14mm screw and mounting the ball link on the pitch lever in the upper hole the linkage is absolutely horizontal (Fig. 2, previous page) in the middle position of the pitch servo and will give a perfectly symmetrical pitch travel across the range of +/- 10 degrees.

MS60

- The pitch servo linkage can be modified the same way as for the MS46, but because of the different dimensions of the MS60 frame it is necessary to drill a third hole in the pitch lever in between the two existing holes.

Initial mechanical Setup

After the above mentioned changes have been made, the helicopter can be set up for 3D flight very easily. The servo arms supplied with the kit can be used, mounting the ball links on the outer holes (for JR). Futaba servo arms can be modified in the following way:

- Switch both the transmitter and receiver on, center all trims, dials, sliders and sticks perfectly (check this with servo monitor on the transmitter, if available), and make sure that no pre-set mixers are activated (P->R, PHov,ThrHov etc.).

- Center or (better) deactivate the trimmers for hovering pitch or pitch trim! They shift the center of the pitch curve (which should be 0 degrees) and the whole curve (min., center and max.) and make it impossible to get a perfect match between the pitch and throttle curve.

- Now the servo discs (not arms) can be set on the servos in 8 different positions. Choose the position which aligns the auxiliary lines on the discs perfectly parallel and perpendicular to the servo case and thus to the linkage. (Fig. 3)

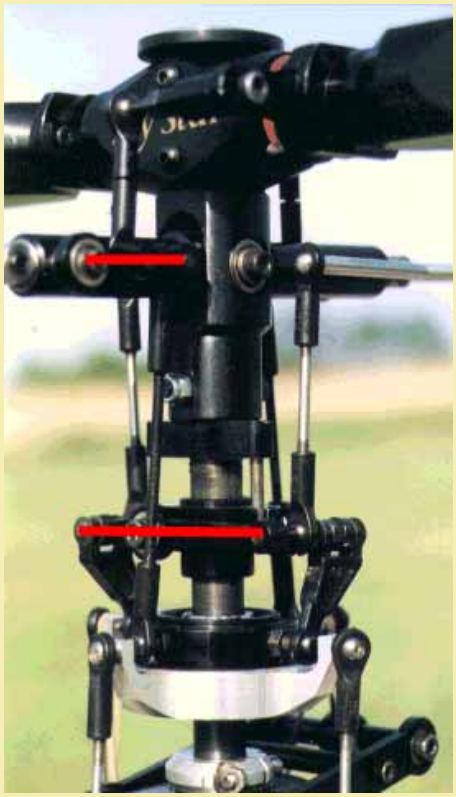

Fig. 5: MyStar 60 Rotor head basic setting: Blades on 0 degree, washout arms and seesaw mixing arms horizontal.

- Now drill the 2mm holes for the ball-links on the 12.5 mm (Pitch and Aileron) or 10 mm radius (elevator) . Use the rings and lines on the disc for positioning. Take care; the location for the holes are not on the straight lines but are slightly displaced away from the linkages so that the angle between the linkage and a line from the servo center to the ball link is 90 degrees.

After setting the linkages between the servo arms and the push-pull arms (elevator and collective pitch), adjust the linkage to the pitch lever so that its arms are vertical and horizontal (Fig. 4, previous page). Now the linkages to the swash-plate are set as indicated in the manual. The linkages between the flybar and the washout unit are set to a length such that the washout arms are horizontal (Fig.5) . Finally the linkage between the swash-plate and the seesaw mixing arm blade holder is set so that the blades have 0 degrees pitch angle and the mixing arms are horizontal (Fig. 6).

Now adjust the tail rotor linkage (servo arm vertical) so that the tail blades are separated by about 1 cm when folded together (Fig. 7, next page). Check that the air thrust is blown against the tail fin, not opposite! This is just about the amount of torque compensation needed in the zero pitch condition to overcome the drag of the blades.

After setting the throttle servo so that it moves to maximum without bending the linkage, check that the carburetor is fully open and almost closed respectively in the end positions of the pitch stick (ensure that the barrel is fully closed with the trim set to the lower maximum, engine off position).

Now the mechanical setup is finished and the helicopter is in a completely symmetrical setting with a total pitch range of about -11 to +11 degrees, a center position of 0 degrees pitch and a small amount of initial torque compensation on the tail rotor. All further adjustment will be done using the functions on the transmitter.

Fig. 6: MyStar 60 3D mode collective Pitch Settings
Above: Maximum pitch +10°
Right: Stick Center Position: 0°
Below: Minimum pitch -10°

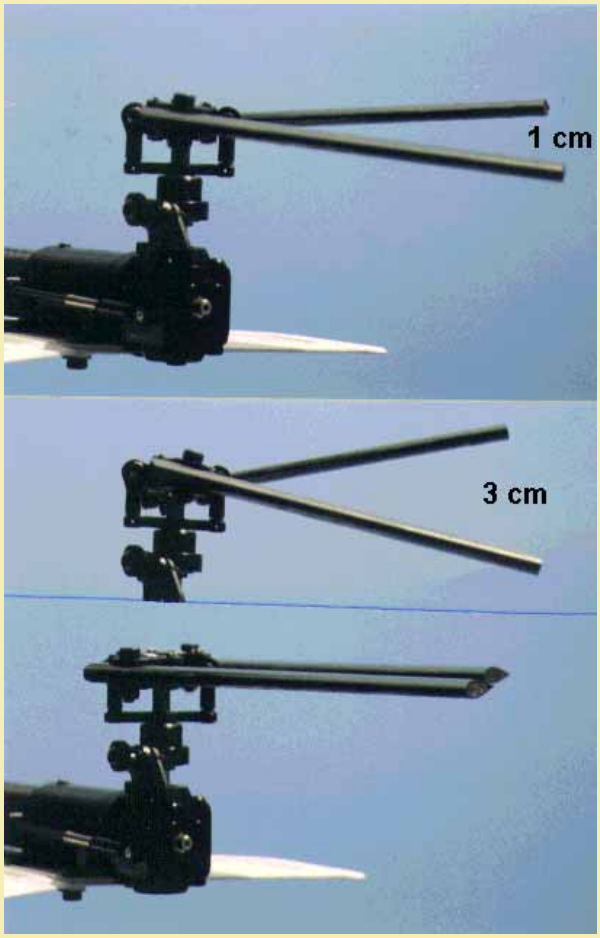

Fig. 7. Tail rotor mixing, blades folded together

***Top** - Initial setting, stick centered, servo arm vertical, blade tips separated by about 1 cm.*

3D mode: Center Position.

***Middle** - 3 cm separation*

Normal mode: Maximum pitch

3D mode: Maximum/Minimum pitch

***Bottom** - 0° separation.*

Autorotation: All pitch values

Normal mode: Minimum pitch

Flight Conditions

3D

This flight condition will be set first on the transmitter. Select the switch to activate this condition (usually Idle-up 1 or Idle-up 2). Then activate this flight condition and set the following parameters:

- Pitch curve: set Pitch max./min. to 90% (-10 to +10 degree). Depending on the engine/muffler/fuel used this might need some adjustments after the first flights. Fig. 8.

- Set the throttle curve to a U-shape (or double-V shape on simpler transmitters) as indicated in Fig.8 using the point edit function on the transmitter. Copy the values symmetrically for the + and - range. A throttle setting in the center (0 degree pitch) below 50% is reasonable for most engines. The U-shape fits the engine characteristics better than a simple V-shape. You can activate and use the throttle-”hover” trimmer to adjust the throttle setting for the area around the 0 degree pitch during flight for fine adjustment (depending on the needle valve setting and weather conditions).

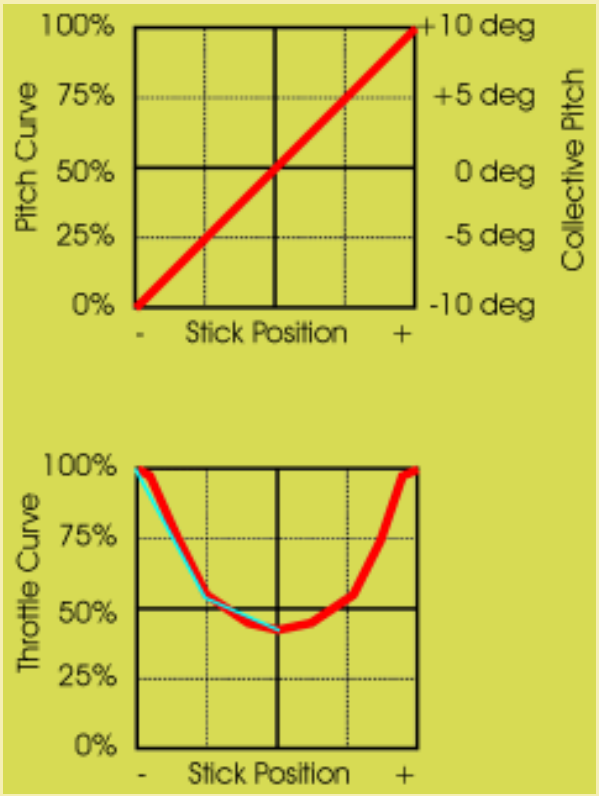

Fig. 8. 3D mode

***Top** - Pitch curve*

***Bottom** - Throttle curve (5-point curve for simple transmitters in light blue)*

- Set the tail rotor mixing to a symmetrical V-shape using the available curves (on high-end transmitters) or mixers (on simpler transmitters). The separation of the folded tail rotor blade tips should go from about 1cm to 3cm from 0 to Max/min Pitch. Fig. 7. Make sure that the tail rotor blades move to the same side for positive and negative main rotor pitch!

This is all you need for 3D-flying. In this flight condition the heli will react in inverted flight in a similar way to normal flight. You can check the adjustment of the throttle curve and the tail rotor mixing in normal flight and copy the values symmetrically to the neg. pitch side and you will find that it will be almost perfect.

Normal flight/start and landing

This will be the flight condition which is used for starting the engine, for hovering maneuvers and for slow speed flight. A low pitch setting of -3 or -4 degrees, a hovering pitch of 5 to 5.5 degrees and a maximum pitch of 10 degrees are reasonable for this flight mode.

- Set the pitch curve to the desired values using the point edit function of the pitch curve on the transmitter. Leave the maximum and minimum values at 90%. The point value readings are about 30% / 73% / 100% for the low end / center / high end (Fig. 9). Check with a pitch gauge on the blades that you actually get the -4 / 5 / +10 degrees and finely adjust the curve points. Activate the pitch hover trim if you like to use it.

- Set the throttle curve to the curve displayed in Fig. 9. The shape strongly depends on the engine/ muffler/fuel combination. In general a center point below 50% is a reasonable starting value. Activate the throttle hover trim function after setting the curve if you like. With this setting the engine stops if the throttle stick trim is set to its lower limit and it is possible to start the engine with the trim in the center position. Before take-off set the trim to its maximum position; this will give you the initial engine and rotor head speed.

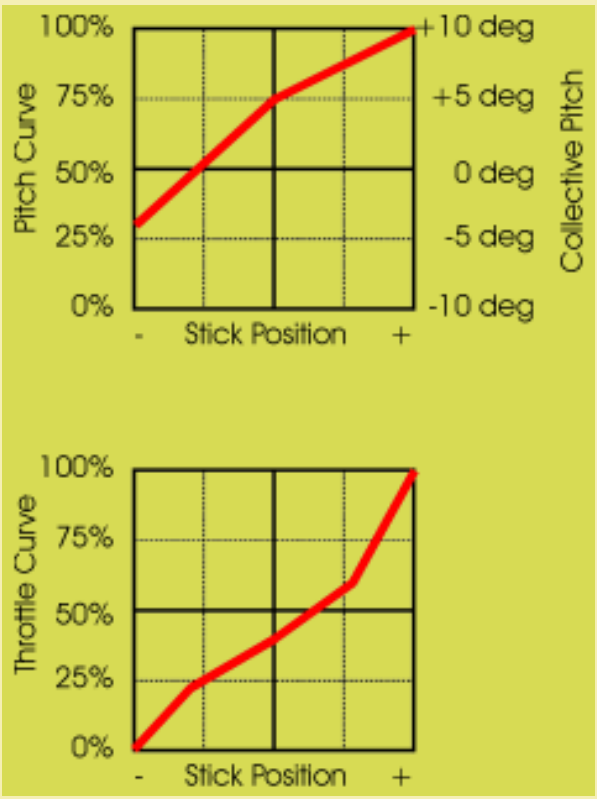

Fig. 9: Normal mode:
***Top** - Pitch curve*
***Bottom** - Throttle curve*

- Use the trim offset function on the rudder function to increase the tail rotor pitch for the hovering position (center stick). Adjust the separation of the folded blades to about 2cm. Activate the P>R function (Revo mix) and set the low pitch (down) value so that the blades just touch each other and the high (up) mixing value to about 3 cm blade tip separation. According to my experience these values are excellent starting values for all sizes of heli, they are almost independent of the tail rotor diameter but they depend on the gear ratio of the main/tail gear (a higher gear ratio gives a higher efficiency of the tail rotor and thus smaller mixing values are needed).

Autorotation (Hold)

The setting of the hold (autorotation) mode strongly depends on what kind of autorotation you want to do: 3D-autorotation with inverted flight or ordinary autorotations with upright flight only.

3D Autorotations

- Copy the whole Idle-up 1 (3D) condition. Increase the maximum and minimum pitch values to +/- 110% which should correspond to about -12 / +12 degrees.

- Set the hold switch so that the throttle goes to engine off or idle position.

- Deactivate the P->R (revo) function and use trim offset to adjust the tail rotor blades to zero (no separation of the folded blades).

Normal Autorotation

- Copy the normal condition. Increase max. pitch value to + 110% (+12 degrees). Adjust the lower part of the pitch curve using the point edit function so that you get about -6 degrees.

- Set the hold switch so that the throttle goes to engine off or idle position.

- Deactivate the P->R (Revo) function and use trim offset to adjust the tail rotor blades to zero (no separation of the folded blades).

Switching between the different conditions

Do not activate the 3-D flight condition when hovering close to the ground. The heli will drop suddenly because of the change in the pitch-curve! After starting with the normal condition (hovering) go into a fast climb with near max. pitch and switch to Idle-up 1. This gives a smooth transition between the different modes. Switching back can be done similarly although it is not a big problem to switch back in any upright flight situation.

The autorotation can be activated either from the

normal or 3D condition depending on the settings (3D or normal autorotation)

Further tuning

The standard paddles on MS30/46 are just perfect for nice 3D flying. The paddles on MS60 are designed for F3C rules and suitable for "soft" 3D. For extreme 3D use light weight paddles of about 30 grams.

Final Remarks

Correct setup of the helicopter makes it much easier to start 3D flying. It is complicated enough to control the helicopter in inverted flight and even more difficult in the beginning to judge the correct mixing parameters and curves. The symmetrical setup helps to save time and efforts in the in-flight testing of the settings but it doesn't replace the mental preparation for a new maneuver.

There are two reasons for crashes during 3D-flying practice: mechanical failure and pilot errors. The high quality of the all-metal construction of the Mystar helicopters and a regular check of the linkages reduce the risk of a mechanical failure drastically. Pilot errors can never be avoided completely but a simple and comprehensive setup of the helicopters lets you have more fun and satisfaction with your heli. A happy and highly motivated pilot makes less mistakes. If you practice a new maneuver high above the flying field and think about a save "emergency" exit out of any inverted maneuver BEFORE you start your heli then you will become a successful 3D pilot and discover the new dimension without frustration.

Good luck and have a lot of fun!

Marco Cantoni

Summary

3D mode

Stick	*Pitch*	*Throttle*	*Tail tip separation*
Max	+ 10°	100%	3 cm
Center	0°	45%	1 cm
Min	-10°	100%	3 cm

Normal

Stick	*Pitch*	*Throttle*	*Tail tip separation*
Max	+ 10°	100%	3 cm
Center	+ 5°	45%	2 cm
Min	- 4°	0%	0 cm

3D-Autorotation (Hold)

Stick	*Pitch*	*Throttle*	*Tail tip separation*
Max	+ 12°	0%	0 cm
Center	0°	0%	0 cm
Min	-12°	0%	0 cm

Normal Autorotation (Hold)

Stick	*Pitch*	*Throttle*	*Tail tip separation*
Max	+ 12°	0%	0 cm
Center	+ 4°	0%	0 cm
Min	- 6°	0%	0 cm

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Many thanks to Marco for this excellent article. You can find this same article (in HTML) on Marco's Website as detailed above

W3MH is getting a MyStar 46 soon; watch out for a full review in due course!

Coming Soon

Shoehorning a 46 into the 30 Baron. Due online in a week or so.