REVIEW

WORDS: **JON TANNER** PICTURES: **JON TANNER AND DENIS STRETTON**

CTX-5FBL

A FASCINATING CO-AX FROM SOVEREIGN TECHNOLOGY

Some readers may remember Sovereign Technology from a review I did of their first R/C co-ax model way back in January 2010… That was the 'Helibaby RTF', which was a large electric co-ax for outdoor flying, but what made it so different was that it used two collective pitch rotor heads, both with flybars providing Bell/Hiller control.

The Helibaby flew surprisingly well, although I did find that weather conditions affected the way it flew, not just the wind (which it handled well) but it seemed air temperature affected the damping and possibly the flexibility of the plastic moulded rotor blades. In other words it was always flyable but felt different from day to day.

Some five years later, when flybars and Bell/Hiller mixing are things of the past, we have the CTX-5FBL, with its two 3 blade flybarless rotor heads!

The CTX-5FBL

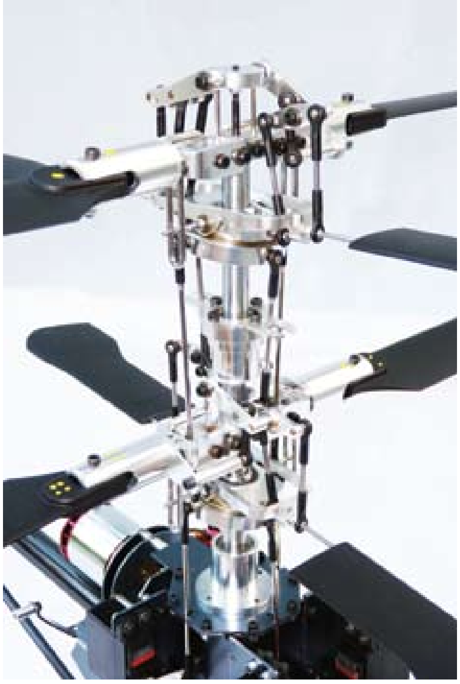
Co-ax models are in the main seen as small indoor models, which are easy to fly and so are good entry-level models capable of teaching newcomers the basics of flying an R/C model helicopter. The CTX-5FBL is a far cry from those, it has two 3-blade FBL collective pitch rotor heads that are beautifully machined with six 390 mm long rotor blades, giving a 932 mm rotor diameter. Each rotor head has its own swashplate that rises and falls providing collective pitch and both tilt together providing cyclic control.

The rotor heads contra rotate and are driven by a single motor via a gearbox and so rotate at the same constant rpm. This means the torque reaction from each disc cancels out and differential collective pitch is used to provide yaw control (fixed pitch models vary the rotor speeds to achieve yaw control).

A 'spider' assembly above the upper rotor head has levers transferring the pitch control from the swashplate to the blade grips. Thus if the spider moves up or down it changes the collective pitch of the upper rotor head creating more, or less, torque reaction than the lower rotor head and hence the model will yaw left or right. The tail servo controls the position of this spider and hence the model heading.

A side effect of this differential collective pitch is that the overall collective pitch changes slightly with yaw, so as yaw is applied the model will rise or drop slightly depending on the yaw rotation. An easy 'fix' to this is to program a rudder to collective mix in the transmitter, although in practice I haven't found it necessary…

The model arrives as a kit, although quite a few sub-assemblies have been done for you at the factory in Taiwan. You will need your radio gear with 4 mini servos, a 3-axis gyro, a suitable



Five years ago I reviewed this Helibaby RTF with Bell/Hiller rotor heads

1360 – 1550 kV motor and an 80 – 100 Amp ESC suitable for 6S LiPo power. Depending on your choice of ESC, a BEC unit/Rx battery may also be needed. The 6 rotor blades are supplied in the kit.

Upper Head Assembly

A 25-page instruction manual is supplied with English and Chinese text; the first few pages cover safety and general guidance/advice with the construction being purely pictorial and parts listings.

The assembly is divided into five steps, each beginning by showing the finished assembly step. There are then sub-sections that also start with a picture of that completed sub-section, so you start by using the subsequent sub-section to end up with the first…

First is the 'Main Shaft Combination'. The main shaft carries the upper rotor head and is an 8 mm o.d. hollow shaft that reduces to 7.2 mm in the middle section to provide clearance for the 10 mm lower shaft that fits round it and rotates in the opposite direction. The main shaft is long at some 280 mm and what with it being hollow for the spider pushrod, plus the outside reduction, it must be an engineering challenge to produce it perfectly straight.

And now I am reviewing this CTX-5FBL

We received an early production sample with the CTX-5 box sleeve showing the FB version

Well packaged

Quite a few assembled sub-assemblies are included

Other parts including the cute canopy

Three pairs of blades supplied, the boom is 'cosmetic' and you can see the 'spider' assembly at the bottom

Main shaft with a collar secured using tapped holes in the shaft; note the reduction in diameter giving clearance for the lower shaft that runs over it

In addition three sets of tapped holes are provided in the shaft to secure other parts to it, so when I checked the one in the review kit I wasn't surprised that it needed a slight 'tweak' for it to run true.

Assembly starts with a mast collar being screwed to the main shaft and the swashplate pushrod guide/bearing holder sitting above it. A spacer tube goes below the collar with another bearing holder, which is screwed to the upper one and so locks the assembly in place around the collar. The upper swashplate is supplied assembled, as are the control links, which at first seem too long but are correct as they connect to the spider later on in the build sequence.

Lower swashplate has the same size upper and lower sections so both swashplates tilt the same amount

The secured collar is between those two bearing holders that are thus fixed in position

There are two of these hard dampers, one either side of the securing screw that acts as a flapping fulcrum point

Lower shaft assembly with its 53 tooth main gear

The rotor head is supplied assembled, so I undid a screw to take a peek

Swashplate driver that clamps to the shaft before the securing screws are fully tightened

The two rotor heads also arrive pre-built, but I did want to have a look at the design so I removed one of the blade grip axles. The axles are secured to the rotor hub with M3 screws and there are hard rubber dampers either side of the screw, which acts as a pivot for the flap damping. The resulting damping is hard. The blade grips have the usual two radial bearings and a thrust race between to fully support them. The machining of these parts is really excellent.

A swashplate driver is loosely screwed to the underside of the rotor hub and it's worth noting that this also clamps to the main shaft, so the clamping screw should be tightened before the other screws are fully tightened.

Underside of the lower hub showing the screws holding it to the cone shaped bearing holder

The swashplate driver covers a fixing screw

You can just see the 8 mm bearing that carries the main shaft

Bearing block with 10 mm bearing on the lower shaft and 8 mm bearing waiting for the main shaft

The hex shaped bearing block locates into the side frames so it can't rotate

Lower rotor head showing the bearing blocks that carry the 8 mm mainshaft and 10 mm lower shaft

The mixer arms on the yaw spider are ball raced and the guide pins slide into the rotor hub

Upper rotor head with the plastic guide and the holes for the spider guide pins

Lower bearing block supports the main shaft, as well as the yaw pitch assembly

With these sub-assemblies done, the swashplate is slid onto the main shaft followed by the rotor head, which is secured to the shaft with three short M3 screws and once done, the swashplate driver, can be finally secured.

Lower Head Assembly

The lower 10 mm o.d. shaft is much shorter and has an inner diameter of 8.5 mm so the main shaft can run inside it. The lower swashplate is different from the upper in that the rotating discs are stacked on each other so that the control balls are the same distance from the centre. This is because as well as controlling the lower blade grips, the upper disc transfers collective and cyclic movement to the upper swashplate; thus the two swashplates tilt the same amount remaining parallel to each other.

The lower rotor head is similar to the upper, but fits to the 10 mm shaft and it rotates counter clockwise, while the top rotates clockwise. A swashplate driver fits under the hub, again leave loose as you'll need to remove it later because three screws secure the rotor hub to the bearing holder fitted to the main shaft – I found out the hard way…

The manual continues by screwing one of the 53 tooth gears to the lower shaft hub and at the front of this section, it shows the completed lower shaft combination of rotor head, swashplate, bearing block and main gear, but as I say, I later had to undo some of this.

First job when combining the assemblies is to screw the lower rotor hub to the cup shaped bearing holder using three screws – a pin locates the parts in the correct orientation. The lower swashplate driver can then be attached and tightened to the 10 mm lower shaft. The gear can now be attached to the main shaft (if not already done…).

The main shaft passes through the cup shaped bearing holder, which, as it is secured to the lower head hub, is centred on the lower shaft – thus the shafts are concentric. A lower bearing holder with a 10 mm upper bearing fits over the end of the lower shaft, while an 8 mm bearing carries the main shaft and the second gear is then secured to it. Finally, a lower bearing block carries the bottom of the main shaft.

Yaw Control

I earlier described the yaw control system and you can see the spider unit at the top of the model. Its shaft passes through a plastic guide in the top of the main shaft and exits from another at the bottom. An articulated lever is fitted to the lower bearing block, which has a pivoting bearing holder and the end of the yaw rod is secured in the bearing. Thus the tail servo pulls/pushes the lever and the spider travels up or down changing the collective pitch of the upper blade grips.

Cleanly moulded sideframes

Reduction gearing – the bevel gear doesn't need a fixing screw

I used a 3 mm rod to set the rotor head phasing when fitting the gear reduction unit

Final Assembly

With the mechanical assembly all but finished, it is mounted into the plastic sideframes. The plastic used it quite soft and so seven aluminium cross braces are used with the two main bearing blocks to strengthen the whole assembly. The bearing blocks fit snugly into the frames and the hex shaped bearing block between the gears slips into the corresponding recesses so that it cannot move vertically and the hexagonal section prevents it rotating – clever! Lots of M3 screws hold it together. One point worth highlighting is that the front and rear servo rails are different so fit them correctly!

A 'gear reducer assembly' is provided ready to fit, which has a 16T bevel gear driving the two main gears and the motor drives the 47T spur gear. The bevel gear slides onto the shaft retained with a cross pin. The main gears have to be positioned so that two blade grips are positioned directly above each over and over the tail boom; the bevel gear and its assembly is then fitted and screwed into place. A tip here is to use a 3 mm rod (3 mm flybar) through the blade grips.

You'll need a 1360 to 1450 kV motor to run on a 5S or 6S LiPo pack (3200 mAh is recommended). I chose a Scorpion HK-3226-1400KV, which is aimed at 500 class helicopters producing a constant 1770 watts (2.37 hp) pulling 80 Amps – more than enough! A 12T pinion gear is used and when fitted, the gear mesh was ideal.

The plastic used is quite soft but the hex spacers and bearing blocks produce a solid assembly – note the hexagonal section prevents it rotating

The bevel gear sits slightly outside the main gears, the mesh is correct and if any wear occurs, the pinion could be shimmed to tighten the mesh

Scorpion HK-3226-1400KV motor is ideal

The tail boom is shown as next fitted, it is not functional but helps stabilise the model on the ground and certainly helps orientation. I needed to add a turn of tape on the boom for the fin clamps to do their job, and the boom stay ends need gluing in place.

Electronics and Final Bits

Four mini servos are needed and bearing in mind two swashplates and rotor heads and lots of links, I wanted some powerful ones. I chose Spektrum H5010 digital servos that have metal gears, power/speed is 4.6 kg-cm with 0.11 sec/60º @ 6 V, which will do the job well. A 3-axis gyro is recommended and I chose a Spektrum AR7200BX receiver with its BeastX gyro.

These servos fit perfectly but I first centred them so I could position the arms. Unusually, the roll servo arms are shown as 13 mm, while the elevator arm is longer at 16 mm. This struck me as unusual as the model uses 120º eCCPM swashplate control, which usually requires the three servo arms to be the same length and the Tx/gyro software corrects the mechanical differential. Different length arms could create a small interaction between

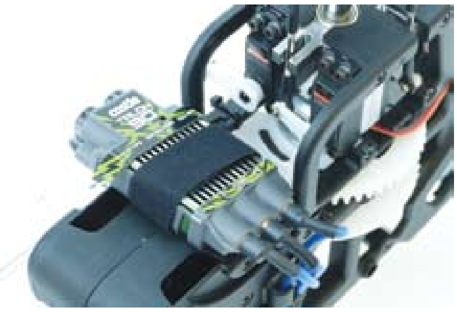
Yaw assembly, you can see the M3 nyloc nuts used to secure the rod in its bearing

The bevel gear sits slightly outside the main gears, the mesh is correct and if any wear occurs, the pinion could be shimmed to tighten the mesh

upper pitch to match the lower. The yaw control needs to be checked that it operates in the correct direction; right yaw should give less pitch. The amount of yaw pitch change required is some ±3º or about 8 mm movement of the servo control rod, which gave a good level of control. Don't forget to check the gyro sense is correct too…

An 80 – 100 A ESC is needed and I chose a Castle Creations Talon 90 and it has proven an excellent choice with the Scorpion motor. This ESC has a 9 A continuous BEC (with 20 A peaks), which again is ideal for this and any 500-size model set up. I decided to use the Castle Link to set up the ESC, which is really easy to use and allows you to match the Talon to the chosen motor.

I also elected to use the Governor mode, which I'd had good success with on another model. The manual specifies a rotor rpm of 1700 to 2000 rpm,



Talon 90 was a good choice for this model

Spektrum AR7200BX receiver/BeastX controls the Spektrum H5010 mini servos

Upper rotor head rotates CW and the lower CCW; I marked the blades and grips

so I set three speeds selectable via the flight mode switch, 1700, 1800 and 1900 rpm with the option to increase to the 2000 maximum.

The supplied rotor blades are the same as those on the earlier model. These are moulded from a plastic 'NYGF' material (I believe this is a Nylon Glass Filled plastic that is used in the auto industry), they are symmetrical with a 'BERP' tip and are pretty flexible. The weights of the six blades were between 77 and 79 g each, so I matched the weights as closely as possible for each rotor head. Last of the assembly was to fit the nicely finished and rather cute canopy.

The flight battery slides into a neat slot, which keeps it close to the mainshaft and so optimises the C of G. The space measures 60 x 45 mm and so will accept a wide range of packs. I chose to use the OptiPOWER 6S 4300 mAh 30C packs, which fit well and are more than powerful enough. All up weight with the LiPo is 3150 g.

Flying

First flights were a bit unexpected because a bad wobble developed that was entirely due to me – I'd failed to screw the lower rotor head hub to the bearing block that sits above it! Once that was corrected all was well and I set about fine-tuning the blade tracking, which with some help didn't take long.

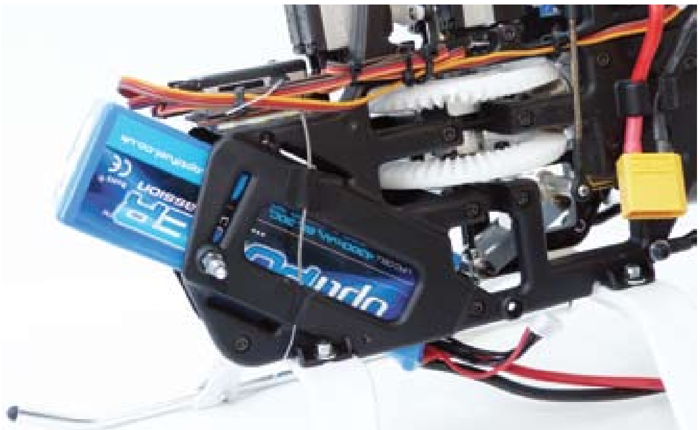
First impressions was of just how smooth this big co-ax is, with so much going on, I expected to see a few wobbles but, but nope, it is super smooth. Visually, it takes quite a bit of getting used to, partly because of the unusual shape – I am used to flying models where only the rotor head is visible above the canopy but here there are two in full view, plus it is quite short, so its appearance in the air is very, very different.

The model is completely controllable and is certainly inherently very stable so I pushed it into gentle circuits, however as speed increased, a slight wobble/shake developed which turned out to be head speed related. I has been flying it the lowest recommended rpm of 1700 rpm, and when I increased it to 1800, the wobble disappeared so I tried 1900 rpm finding that this improved stability and it felt more 'locked in'.

I found the control response to be pretty aggressive and so reduced the dual rates and added some exponential, which smoothed out the flight characteristics. The model tends to self-level, which I think is due to the height of the model and the resulting pronounced pendulum effect. In larger circuits, I found my control inputs had to be held in for the model to keep going; again this is compared to single rotor models. The other adjustment I found necessary was to reduce the rotor head gain on the AR7200BX/BeastX.

Now the CTX – 5FBL was flying predictably and I was getting used to its characteristics, so it was time to fly it around in bigger circuits and simply get more stick time. Flying it higher is quite mesmerising as the contra rotating discs have a strobe effect that is particually noticeable when looking up at it, hopefully the accompanying photo shows this odd effect. Flight times are impressive with an easy 8 minutes.

How's that!



OptiPOWER 6S 4300 mAh 30C packs are ideal

Early take-off

Seeing two rotor heads and swashplates above the canopy takes a little getting used to

Pushing into forward flight shows the pendulum effect – you can see the upper rotor head leading

The strobe effect is mesmerising…

… and can give confusing visual messages!

Summing Up

The engineering in this model really is top class and it is so refreshing to see a model that is so different. I'm amazed by how smooth it is and as the gears run in it can only get better. Higher rpm suits it better, its flying characteristics are different to single rotor models, much of which I feel is due to its height and resulting 'pendulum effect'.

The CTX-5FBL is completely controllable, but you do need to get used to it, particularly in circuit flying as it likes to hover and so needs pushing into forward flight. Tail response is more conventional in response, however don't expect hard stops, and as mentioned there is an interaction with height – I may try adding a yaw to collective mix. All my flying to date has been with the servo arm lengths as stated in the manual, and I will try lengthening the roll arms to match the elevator arm (as per the gyro instructions), which may lead to increased gyro gain.

So, how do I sum up this intriguing model? A coaxial collective pitch helicopter is mechanically challenging and Sovereign has met this challenge with style and practicality. The design is clever, producing a 'clean' and functional arrangement. Theoretically, both rotor heads should have the same phase angle but this is mechanically challenging producing acutely angled pushrods and other conflicts.

Sovereign has elected to keep all the pushrods vertical and in practice with a 3-axis head gyro, there doesn't seem to be any side effect – the model follows the stick inputs!

So, if you are looking for something very different, this could fit the bill… I will be taking the model to some of the usual UK fly-ins, so come along and have a look. Now all it needs is a scale fuselage!

Response

I mentioned in the review that I intended to ask Sovereign Technology why the elevator servo was shown to have a longer arm than on the roll servos. The response was that the model design limited the roll arm length and in practice the small difference is 'managed' by the gyro and so doesn't impact on the flying.

Update

While writing this, I received the following Press Release, so later this year I hope to be able to add a KA-32 or KA-52 Alligator fuselage!

East Coast Scale Helicopters LLC

The new Sovereign technology coaxial helicopter, the CTX -5FBL, will be available from the US distributor East Coast Scale Helicopters. See the full review of this model in this issue of Model Helicopter World.

We were so impressed with the stability and smoothness of this machine and as it has a very scale rotor system and flies so nicely, we will be making some scale fuselages to complement it. Initially planned are the KA-32 and the KA-52 Alligator and they should be available some time later this year.

East Coast Scale Helicopters LLC, 741 Lincoln St, Franklin, MA 02038. USA. Tel: +508 520 1867 Email: vario@comcast.net www.Eastcoastvario.com

MHW

Spec

PRODUCT: CTX -5FBL
MARKETPLACE: It's unique…
MANUFACTURER: Sovereign Technology Co., Ltd., Taiwan, R.O.C. /www.tech-sov.com Email: cindy@tech-sov.com
US DEALER: East Coast Scale Helicopters, LLC
741 Lincoln Street, Franklin, MA 02038 USA
www.eastcoastvario.com
Email: vario@comcast.net
Tel: 001-508-520-1867 or 001-508-918-3845
MAIN ROTOR DIAMETER: 932 mm
OVERALL LENGTH: 750 mm
ALL-UP WEIGHT (INCL. BLADES AND BATTERY): 3150 g
CONTROL REQUIREMENTS: 5 channel heli radio and 3-axis gyro system
POWER REQUIREMENT: ESC and 6S 3200 mAh LiPo
RRP: US $599

We Used

JR DSX 12 with Spektrum AR7200BX Rx/BeastX gyro, 4 Spektrum H5010 digital servos for the 120º eCCPM and tail control, Scorpion HK-3226-1400KV motor with Castle Creations Talon 90 ESC powered by OptiPOWER 6S 4300 mAh 30C