

# CSM SL-560 GYRO TEST REPORT BY 3-D PILOT RUSS DEAKIN

## MY INVOLVEMENT IN THE PROJECT...

My personal involvement in this project started back in July 2002. I was asked if I was interested in flying the gyro and briefly report on my findings. A couple of weeks later, I did fly what was the first version of the SL 560 and was impressed with several aspects of the gyro. The tail lock was superb, pirouette consistency was good and the unit did not show any neutral drift characteristics. I did however find the pirouette stop-controls and some handling issues were in need of attention. So as requested, I verbally reported these findings and thought little more of this for some time.

A month or so later, I was once again asked if I minded testing a later version of the SL 560. However, my personal circumstances had changed as I had made a positive decision to 'give up the day job' as a cabling technician. So I offered my services to CSM on a 'freelance basis' and as such was able to give full flight-testing support in an enhanced 'research and development' role.

The later version of the SL 560 was a vast improvement and felt like a totally different gyro in comparison. I could however still find small sections of the overall handling that I felt required further enhancement. So I reported every finding in the fullest of detail and over a prolonged period of testing and developing, the performance of the SL 560 was enhanced until it was superb in every possible aspect of flight.

## THE PRODUCT...

**From the outside;** the CSM SL 560 looks very similar to the previous 540 gyro. It comes in the same style of protective case, making it look like a similar compact one-piece unit. It has the same series of led-lights to indicate that the gyro is powered, whether the sensing is reversed and if the 'super servo' option is activated. There is a very similar 'quick set-up routine' to get you in the air in minimum time and even the same sticky pads are used! However, this is where all similarities to all previous CSM gyros end! The internal components of the SL 560 are 100% new and the following information supplied by CSM Ltd highlights the level of technology involved!

**The Sensor;** is a second-generation Tokin piezo unit that is specifically manufactured to a high-specification dictated by CSM. The Token sensor was retained over the 'silicon' type of sensor because prolonged tests revealed the sensor gave a higher overall performance. The only real concern with the piezo sensor was the drift characteristics and CSM were looking for a vast improvement over earlier sensors. However, prolonged tests concluded that no more than 1.5 deg/sec of drift from turn-on to the first 3 minutes of operation could occur.

To further reduce the possibility of drift, the SL 560-sensor signal processing code has specific features built in to counteract drift and the gyro is programmed to remove any drift that may take place when the model is stationary. So, by the time you have started your model and began

flying, the amount of drift that could be experienced is less than 1 deg/sec. Of interest is that this is around the same level of accuracy as transmitter stick centring. In simplistic terms, this equates to a 400% improvement over earlier sensors and in practice these levels of drift remain undetectable by the pilot.

The one area where the Tokin sensor out-performed all other types of sensor was in dynamic tests. The rotation range of the Tokin sensor is capable of going all the way up to 1000 deg/sec. So at a rotation rate of 2 revolutions per second, the gyro is still under full control of the sensor and can dramatically smooth out high-speed rotations. The response rate was also found to be far superior and whereas some sensors used in model helicopter gyros operate at just 10Hz, the Tokin sensor achieved a response speed of 100Hz.

The last reason was one of battery consumption. The Tokin sensor operates at just 3-V and this allows the power supply circuitry to be much simpler. In turn this gave a general improvement in sensor battery consumption of 90% over some other sensors.

**The processor;** is completely new and is capable of handling an incredible 4-million instructions per second. This processor also has built in 'pulse handling hardware' that allows input pulses to be read and output pulses generated at 250ns resolution, which is 4 times faster than current PCM technology. In achieving this, the core processor is freed up from mundane tasks, so it can spend much more of its time on the calculations. The A-D converter is 32 x over-sampled with D.N.I. and this gives an effective 15-bit resolution that is also a dramatic improvement over its predecessor. The result of the above to the user, is that the SL560 gyro is now dramatically smarter and much more accurate than any of it's predecessor's!

Throughout the development of the SL 560, CSM have been very conscious of the high workloads current gyros impose on tail rotor servos. Thus they were anxious to minimise servo movements without affecting hold and stop performance. This has been achieved by using 'dynamically adjusting digital filtering'. This feature greatly reduces the workload on the servo and CSM believe this will result in increased servo life. So with the above feature and the frugal battery consumption of the sensor, dramatically increased battery duration is experienced.

Of real interest to me is that the frame-rate of the SL 560 is presently limited by the servo frame rate. In simplistic terms, this means that with current servo technology, the SL 560 processor is running at just a fraction of its full potential! However, as servo technology develops, CSM have ensured that the gyro can be infinitely re-programmed to suit. Thus, once you have purchased an SL 560 and new technology becomes available; your existing gyro can be re-programmed for just a small handling charge!

## **SETTING UP THE SL-560**

Setting up the SL 560 is extremely easy and takes about ten times longer to write about the process... than actually do it! The only TX requirement is that you use a switched auxiliary channel to control the 'gyro gain' and give control over 'normal' and 'heading lock' gyro modes. Once mounted in the chosen model and connected up as advised you turn on the transmitter, ensure the rudder trim is at neutral and then turn on the receiver. At this point, you can check the rudder stick is operating in the right sense and the linkage is adjusted to give around 8-degrees of pitch at centre stick in 'normal' sensing mode. You then turn the receiver off, wait a while and

then turn it back on again, before toggling the TX auxiliary gain switch to activate the 'quick set-up' feature.

The 'quick set-up' begins with a choice of sensing direction and by moving the transmitter rudder stick from left to right, you will see the orange reverse light come on and off. Once a direction of sensing is chosen, you simply toggle the gain switch once and the servo will move back and forth to indicate your decision has been stored in the gyro's memory. Next in line is the 'super-servo' option and this is to simply tell the gyro what type of servo you are using. The choice is between a 'standard servo' or a 'super servo' that is designed for tail rotor operation. Once chosen, toggle the gain switch and the servo will move back and forth to indicate your decision is stored. The last and final part of the 'quick set-up' covers the actual servo throw and this is adjusted by moving the Transmitter rudder stick back and forth slowly until the desired full throw of linkage travel is achieved with no mechanical binding! Then toggle the gain switch and the servo will move back and forth again to indicate the setting is stored. From here, the opposite direction of tail rotor throw is adjusted in exactly the same way. Once adjusted, a final toggle of the gain switch and the servo will move back and forth several times to indicate the settings are stored and the 'quick set up' is complete. Turning the gyro off, waiting a few seconds and turning back on again will then re-start the gyro with its new settings. From here, adjust the transmitter gain to about 60% and rudder ATV values to an initial value of about 70% each way and test fly the gyro.

The only basic flight adjustments required are adjustment of the overall gyro gain, activating the 'quick trim' feature and setting the rudder ATV values to give the desired rotation rate for each direction. With the SL 560, I always start with the rudder ATV and this is adjusted by percentage in the TX for both left and right directions. A higher percentage gives a higher rotation rate of the tail and a lower percentage gives a lower rotation rate of the tail. To set the transmitter gyro gain, I hover the model in idle-up and slowly increase the value until the first sign of over-sensitivity is visible (wagging from side to side). I then turn down the gain value by about 6 points, before activating the 'auto-trim' feature by toggling the gain switch several times in flight. This then adjusts the trim value in 'normal' sensing so that the tail remains stationary in this mode and provides valuable information required for the stop controls in 'heading-lock' mode. So even if you don't intend to use the 'normal' gyro-sensing mode, it is important that you perform this 'quick-trim' procedure. To test the in-flight sensitivity of the gyro gain, I fly the model into a relatively long dive followed by a gentle pull out and flick of the rudder stick on the transmitter. If no gyro wag was found, I then increase the gyro gain until a slight momentary wag is experienced and then adjust the gyro gain down in small increments until no wag is induced. The gyro is then fully set-up and fully optimised!

## **FLIGHT PERFORMANCE**

When fitted to a well-adjusted model helicopter, the flight performance of the SL 560 is superb. In the hover, the tail sits perfectly still and in many hours of testing in varied conditions; I have not detected any neutral drifting tendencies. Hovering pirouettes provide an amazing level of rotation consistency and halting the pirouette abruptly produces a very clean stop with zero bounce.

The ability of the gyro to hold a given line is extremely efficient and all forms of very fast backward and sideways flight represent no challenge for the SL 560. My general test scenarios

were terminal speed inverted backward circuits, tail first descents, terminal velocity knife-edge descents and many forms of sideways flight. The gyro handles all of these scenarios with ease and in the interest of model life expectancy; I gave up trying to find the limit of the holding power!

Moving into pirouetting manoeuvres, the SL 560 gives a very consistent and totally reliable rotation rate response. In conventional stall turns, the gyro is swift to accelerate into the turn and equally swift to halt the motion when asked. It also halts the motion with no bounce or slight step back that is experienced with some gyros. Turning the scenario into a 540, 720 or full blown Ripper has little effect on either the consistency of the pirouette rate, or the precision and speed at which the gyro can stop the tail motion. My test scenario for Rippers relied on taking the model to a great altitude and allowing it to descend until the speed of the model had become terminal. Indeed, after some 4-500 ft, the tail does show a slight hint of whipping and I would expect the consistency of the rotation rate to deteriorate swiftly at this point... but it does not! With my set-up, the gyro was capable of holding this situation until I decided to exit the manoeuvre and not the other way round! To test this scenario further, I would then perform 'reverse-rippers' to assess the ability to not only halt the motion but physically change the direction of rotation. I also tried slow-rotation rate ripper's and in all aspects of these tests, the SL 560 performs beyond all expectations.

In overall handling tests, the SL 560 performs flawlessly and has a very predictable feel to it. In scenarios like multiple speed and diameter 'pie-dish' manoeuvres that require small changes in tail rotor inputs, the gyro performs exactly as the pilot asks. A small demand equates to a small change and vice-versa. This also carries through to stationary death-dive manoeuvres and any scenario where small critical changes in tail rotor are required to hold the manoeuvre on line.

## **INTERFACE OPTIONS...**

We worked very hard to remove the burden of the pilot needing to make interface adjustments to achieve good results. However, whilst many model helicopters do have good tail rotor geometry, many do not and the gyro does have a limit to its ability to self-adjust. So included with the SL 560 gyro is a PC interface unit with both Windows and DOS versions of the interface program. Overall, the interface is an extremely useful tool for those looking to fine tune the SL 560 to a specific model helicopter or flying style. In addition to this, it is a very helpful diagnostic tool that can be used to confirm a poor mechanical set-up.

If you do choose to interface the SL 560, both the number of functions and the available adjustment-range has been minimised, so you will find the software very easy to negotiate. Within the interface options, the one feature that gives the most noticeable results is the tail rotor 'gain-tracking' feature. Here the 'internal gyro gain' for each direction of tail rotor can be adjusted to enhance both the left and right hand stops independently! Thus if your model helicopter stops from a left pirouette like an express train has just hit it, while the right hand stop is relatively slow, then raising the value of the right hand tracking feature will raise the stop rate of the right hand stop. However, you may find that whilst you like this amazing ability to stop cleanly in each direction, you then find some handling problems in advanced manoeuvres. So if you then experience slight gyro sensitivity in pirouetting loops or fast chaos manoeuvres, it is easily cured by reducing the value of the 'gain-tracking' feature in the opposing direction to the manoeuvre. Thus if you rotate to the right in a pirouetting loop and the gyro is sensitive, simply reduce the gain for the left direction in small increments (or vice-versa) until the sensitivity is removed.

The only other function that will produce very noticeable results is the percentage of 'acceleration gain'. Here a smaller value will produce even faster stop rates, but as a by-product the gyro will see rough transmitter stick handling as pilot demands. You will also find that whilst excessively low values produce an amazing stop rate, this will generate a slight bounce to the stop. In opposition, excessively large values will eliminate any possibility of bounce and mask any rough stick handling, but when the tail is asked to stop abruptly, the potential stop rate will be much lower. So the final values are a compromise of all ideals. Thus adjustments within the interface are best made in small increments from the optimised stock settings.

## **FINAL CONCLUSION:**

No one can deny that superb tail rotor performance is only achieved when all mechanical and electronic aspects are adjusted correctly. However, the SL 560 is an extremely flexible unit that features a large amount of automated self-adjustment! I am extremely impressed with the general handling, out-right performance and lack of drift. Another major benefit is that I can now have six safe flights from one lightweight 1700 MAH receiver battery, which is a dramatic improvement over all other high-performance gyros I have tested.

Overall, the SL 560 represents a huge positive step forward in gyro technology and is capable of competing at the very top-end of the gyro market. I am also impressed with the ability to upgrade the gyro as and when new servo technology becomes available. Of more surprise, is that even with all of the above performance, it is priced competitively enough to bring high-quality gyro performance within the realms of every model helicopter pilot. So because of all these facts and the superb after-sales services offered by CSM, I have no doubts that the SL 560 is going to be an extremely sought after device!

## **FREQUENTLY ASKED QUESTIONS...**

***Q-Were the test gyros different in specification to production gyros?***

**A-Yes** the specification of the sensors was actually lower than the sensors now being used in production units!

***Q-Did you use stock servos for testing?***

**A-Yes** all servos were 'off the shelf' stock items... or in most cases 'well-used' items!

***Q-What servos have you tested the SL 560 with and what gave the best results?***

**A-I** have tested the SL 560 with Futaba 9253, JR 2700G and JR 8700G. Of great surprise to me was that I found it quite hard to tell the difference between any of the above servos when used with the SL 560!

***Q-Will I get good performance with a standard low-spec economy servo?***

A-No... good performance of the SL 560 is reliant on a fast servo designed for tail rotor use! But the gyro will function correctly and work 100% reliably!

***Q-What length of servo arm works the best?***

A-With all of the servos tested, a long servo arm in the region of 18-20 mm provided the best overall results for 3-D flying. For less demanding flight, a smaller arm of around 14-16 mm could be used to enable a large raise in TX gyro gain and make the gyro feel extremely enhanced in hovering scenarios.

***Q-Will you publish 'interfacing' results for specific models?***

A-Yes if I use the SL 560 gyro in a new type of model and find any beneficial settings, I will pass on the information to CSM for publishing on the web-site.

***Q-Did you enjoy the development work and was you're working relationship with CSM good?***

A-Yes I have thoroughly enjoyed assisting with the development of the SL 560 and my working relationship with CSM was superb. To be able to test, assess, give defined feedback and then see accurate changes implemented by CSM was a very satisfying feeling! Testing the Gyro has certainly helped to stretch my flying abilities and I would be seriously disappointed if I have failed to stretch CSM's design and development abilities!

***Q-Would you fly the CSM SL 560 gyro if you had not been involved with the gyros development?***

A-I provided an agreed service that clearly indicated 'no restrictions' on my personal choice of gyro. However, due to the high performance, low cost and incredibly quick turn round on repairs, I have chosen to continue using the SL 560 gyro in all my model helicopters.

***Q-Do you feel there is any further scope for gyro improvements?***

A-Indeed, I do feel that there is always scope to improve gyro technology and CSM do operate a policy of continual self-appraisal and development.

***Q-Are you going to be involved with future CSM developments?***

A-Yes, I have agreed terms for future work with CSM and I will be involved with future research and development work.