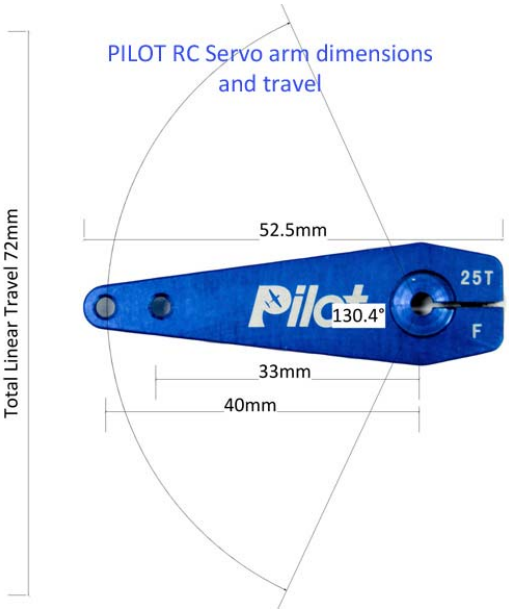
TEST REPORT – PILOT RC New 27Kg and 38Kg Servos

Back in November 2013, I purchased a selection of PILOT RC's first batch of servos for trial testing, both the 27kg and 38Kg. These were the first production prototype models and it's where this report starts.

On first impression I was impressed with the build quality, aesthetically, very high standard. Fitting the servo arm was difficult, the fit was too tight! I tried using the centre screw to pull the arm on, then had second thoughts as I could see a sheared screw about to happen – *Suggestion 1: improve arm fit on servo drive shaft.*



To enable me to test the servo in a plane I extended the centre slot in the arm to open the jaws allowing an easy fit to servo. Here are the dimensions of the final version of the servo arm.

All hooked up to my Futaba 8J and their R2008SB first impression was "WOW" how fast, unbelievable, centre positioning very accurate, delicate movement with applying max negative expo was jumpy, particularly noticeable using the extreme throw position on the rudder for maximum movement – *Suggestion 2: review positioning potentiometer quality or programming of movement.*

Now not wishing to dramatise these two points out of proportion I felt PILOT RC has the making of some top quality servos if they take into account and act on comments received from the various trials that were ongoing and make some small changes. I sent feedback to Tony and he advised that he had similar reports and was taking corrective action, at that time he advised the servos were being re-programmed and software change to make them smoother, the servo arm issue I would find out later the action Tony took.

Tony informed me that a new batch should be ready when I visit the factory and I returned the prototypes in advance. He mentioned he had similar comments from other sources.

In conclusion on the prototype a little more background information for those interested.

Initial testing at PILOT RC facility put the servos through a rigorous testing regime – Minimum of 140,000 operations at 50% max load using the PILOT RC Servo arm pulling from the max throw position, which extends some 31.8cm from servo spindle centre.

Tony was concerned over the excessive wear on one gear found after testing. This was originally made from 7075 AL. He immediately had this re-manufactured with a hard compound metal and told me to replace the gears after sending a full replacement pack. That's dedication of the first order. Well done Tony!

(Something I must add about Tony Tan, which was apparent through correspondence and confirmed in my mind after we met. He is a man of integrity and sincerity, he strives to make his product the best he can, and he does this by listening to the people who count, "you", the customer.

Ok before I have you all in tears and sending Tony bunches of flowers we move on.

December 2014 is the planned launch of the tried and tested PILOT RC 27kg and 38kg servos to complement their existing 20kg servo, so as we eagerly await this announcement. What can we expect in way of performance? Here are the respective specifications at hand to date.

27kg Rated Servo Model: PW27AH

Speed: 0.119 s / 60° @ 8.4v & 0.136 s / 60° @ 7.4v
Power Supply: 6.0 ~ 8.4vdc
Dimensions: 40 x 37.8 x 20mm
Weight: 76.3g
Torque: 27 kg cm (375 oz.in) @ 8.4v & 23 kg cm (319 oz.in) @ 7.4v

38kg Rated Servo Model: PW38AH

Speed: 0.129s/60° @ 8.4v & 0.147s/60° @ 7.4v
Power Supply: 6.0 ~ 8.4vdc
Dimensions: 40 x 37.8 x 20mm
Weight: 76.3g
Torque: 38 kg.cm (528 oz.in) @ 8.4v & 34 kg.cm (472 oz.in) @ 7.4v

(Designed by PILOT RC - Made in Taiwan)

First some comments from Louis Genade who installed a full complement of the final production servos along with the newly manufactured arms on the PILOT RC YAK 55M with a DLE111cc - The servos used were: 4 x 27kg on wings (2 each wing) and one 38Kg on rudder.

Asked for comments Louis said,

" These PILOT servos are fantastic, they are extremely fast and precise, neutral alignment is very accurate, every return to neutral even from a slow stick movement through to a very fast full swing on the control surface resulted in pin point accuracy".

"I was doubtful of fitting one servo on that big rudder surface, however had no problem performing a knife edge loop and several repetitive yaw manoeuvres, on inspection immediately after rudder servo not even warm. I'm very impressed."

"I fly aggressively and put a model through a strict routine so I

need perfection. The pattern manoeuvres I did like slow rolls and eight point rolls were very accurate. I use double the normal throws and have up to 80^{o} of movement on elevators and 70^{o} on ailerons; (see linkage setup) the speed of travel is second to none. These servos, if priced reasonably will outperform most available."

"WARNING - Do not try to stop one of these with your fingers, a trapped finger between the arm and servo body hurts! Trust me on this!

Practical usage of the final production servo showed no signs of jumpy movement or servo arm issues, all were taken care of. Tony informed me during our visit he changed the manufacturer of servo arms as they were not up to his standards. The fit is now perfect to the servo spindle.

Further, on testing the effectiveness of the locking bolt I was pleasantly surprised to see that the accuracy of the fit of the central screw could not be better, don't make the mistake of trying to remove the central screw without first loosening the side locking screw, it really works. I have not used lock tight on the central screw threads and after several flights there is no sign of loose arms. I did however use a little lock-tight on the side locking screws. It's much easier to remove these when required than trying to undo lock tightened servo are screw, the reason is the good sized hex key bolt that's supplied.

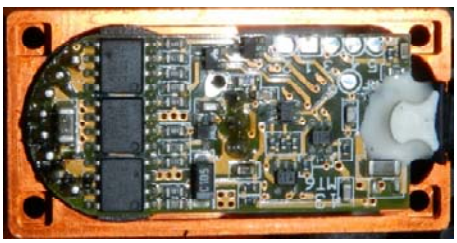
Oh yes! I am informed that the smoothing of servo arm movement was achieved by reprogramming of servo software just as Tony predicted. Also Tony changed the brushless motor for a new higher quality unit that has improved current draw significantly, the results of my current and pull tests will follow.

Note: Each servo comes with a servo arm as shown above. This PILOT RC servo is the only one we know that comes with an aluminium extended arm and 18" wire leads, (that in reality are 20 inches see photo).

Build Quality

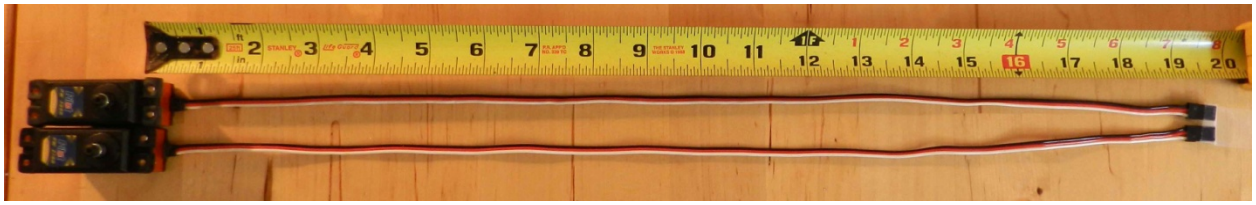
Having stripped down a servo I'm impressed yet again all the quality enhancing features:

- 'O' rings on all case bolt heads
- 'O' rings on case top and bottom joints
- 'O' ring on servo shaft to prevent ingress of dirt and dampness
- PCB circuit board neatly constructed and has overall lacquered coating for corrosion protection



- Gear set is special hardened steel with two ball races on main drive shaft and inset bronze bearings on lay shaft

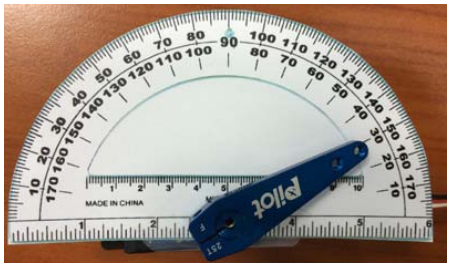
As far as the build goes, absolutely no obvious issues, the very generous 18" wire lead ensures that in most cases your lead will reach the fuselage body without connectors; and to be on the safe side the servos we checked actually have 20" leads.



Performance testing

So, how does the overall performance fair with all this high powered flapping of control surfaces?

Movement throws were checked and found in excess of 68° and 62° either side of neutral, total movement is 130° and with end points set at 140% this provides a massive 72mm linear throw with the PILOT RC arm.



Further test on the electrical performance have determined that the initial problem of erratic movement has been completely corrected, (see video on my FB page) the final production models are smooth and very accurate, (refer to video on my FB page). They centre spot on, no matter what speed in any direction and at any end point setting, they come back to the same spot with literally, pin point accuracy, "*yes you got it*" see video on my FB page.

Practical Bench Testing

To evaluate centre line and smoothness of operations we set the servo on a test stand and extended the servo arm to exaggerate movement to show movement and neutral alignment precision, we can confirm that they returned to the centre spot every time after slow, erratic and fast continuous operations.

Using the servo test feature on the Futaba T8J, a channel was programmed to run the servo through a complete movement. With transmitter front trims set to centre and the software sub-trim set at zero movement was calibrated.

Channel 1 was selected and end points in both directions set at 100%. Whilst in neutral position the arm neutral position was recorded by placing a needle at the tip of the extended pointer. Full travel in each direction was then recorded. End Points were re-set to 140% in both directions and full travel in each direction again recorded.

Having obtained the 100% & 140% set points, the end points were then re-programmed in 10% increments in both directions and results of full travel limits recorded. Each test regardless of end point positioning concluded that the neutral alignment was <0.3mm and that was at the end of an extended arm some 165mm (6.5") long, remarkable accuracy.

Static & Dynamic Load Testing

Not having advanced laboratory instrumentation to complete full load tests on the 27/38Kg servos as would be the case in the factory; "I am informed that servo testing methods are a very closely guarded secret among servo manufactures".

Here is where the manufactures load testing methods enter a mythological state and the secrecy begins on actual rating methods used for servos.

Quality branded servos of lower load ratings, up to 10Kg (my testing shows), do manage to lift a dead load of their specified rate, however, servos of 15 to 20Kg, or more, all fall short of those magical figures quoted in the manufacturers specifications. The question is; how far short?

Tony did advise me that he carried out tests against other brands at his factory; he shared the results which show just how these brands faired under load testing. These are the combined results of other brands verses PILOT.

Branded Servo Comparison Chart						
No.	**Brand**	**Model**	**specs torque (kg.cm)**	**test torque (kg.cm)**	**spec/test achieved**	**Average %**
1	JR	8911	25	14.8	59%	56%
2	HITEC	HS-7990TH	44	29.7	68%	
3	HITEC	HS-7955TG	24	15	63%	
4	JR	MP91TWV	21.7	11.1	51%	
5	JR	DS8921HV	36.5	20.5	56%	
6	SAVOX	SB-2270SG	32	17.5	55%	
7	SAVOX	1256TG	20	9	45%	
8	PILOT	PW-38AH	38	22.9	60%	59%
9	PILOT	PW-20AH	20	11.9	59%	
10	PILOT	PW-27AH	27	15.6	58%	

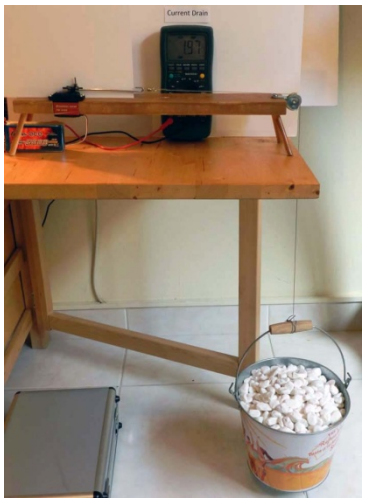
We set up a spring balance with direct linkage to each servo and independently initiated a pull test to determine the stalling load. The results obtained on my tests are shown below.

PILOT RC Servo Comparison Chart based on Terry's RC Testing						
No.	**Brand**	**Model**	**specs torque (kg.cm)**	**test torque (kg.cm)**	**spec/test achieved**	**Average %**
1	PILOT	PW-38AH	38	23	60.53%	63.59%
2	PILOT	PW-27AH	27	18	66.67%	

The purpose of showing the average is having an assurance of what can be expected in a model when a combination of one brand of servos is used.

Remember the comment about the gears

Not satisfied we wanted to load the servos to a determined amount, in this case 10Kg to find their electrical characteristics, so, leaving the real load testing methods to the secret agents and all their millions of dollars worth of equipment, we moved on to what all RC modellers like, 'Practical Testing' and 'how does the PW27AH/PW38AH effect my battery life?



Current drain is the answer!

Using three criteria's we logged results for the following tests

1. Current draw no load
2. Current draw static load (10Kg)
3. Current draw over 50 operations at 10Kg

My load test, the set up is shown in the photos, comprised of using a very technical but accurate system, called "a bucket of stones" duly calibrated on another technical appliance, "a bathroom weighing scales." *"Well let's be practical."*

At this point after picking up the bucket to hang on my test rig, a thought came to mind, "what would happen if I hung this on my elevator or aileron?" The preceding thought was, "what are the real loads on the models we fly?" Anyway just a thought!

"While I'm in a nostalgic mode I was reflecting on the gear issue as I had not tested this part yet, and pondered on how to test them?"

As mentioned, PILOT RC rectified a gear wear concern by manufacturing a new gear with a harder compound steel. The 'to be launched', version will have a tried and tested gear train. I did test the gears also! I took the professional approach and loaded the arm to 30Kg on both models, left it hanging there

for about 15 minutes, waiting for a failure; nothing happened and I accepted they were strong enough. Delighted with the result I reported back to Tony with the news. He replied.

"I already tested gears, took big hammer and hit the arm very hard, also did not break, only took me 15 seconds, no time to waste".

I'm still laughing, an old Chinese proverb. **Confucius say**... "***A good nail does not fear the hammer"***. In this case nor does a PILOT servo!

Back to business:

The tables below show results based on criteria used.

Notes:

1 Tests 1 and 2 were allowed to stand for 15 minutes so temperature and associated current stabilized

2 Temperature thermocouple was positioned on servo case next to motor

PW27RH - PILOT RC Servo						
Test#	**Criteria**	**Weight used Kg**	**Current Draw in mA and Amp**	**T1 °C (start)**	**T2 °C (stop)**	**Remarks**
1	**No Load** (servo and system turned on but no weight/load connected to arm	0	46.3 mA	26	27	One servo & receiver, mA readings taken after 15 minutes
2	**Static Load** (Servo arm is connected to load, no movement)	10	0.90 Amp	27	38	One servo & receiver, Amp readings taken after 15 minutes
3	Dynamic Load with 50 operations	10	1.75 Amp	38	59	Rapid operation 50 full movements and 25 slow operations

PW38RH - PILOT RC Servo						
Test#	**Criteria**	**Weight used Kg**	**Current Draw in mA and Amp**	**T1 °C (start)**	**T2 °C (stop)**	**Remarks**
1	**No Load** (servo and system turned on but no weight/load connected to arm	0	40.8 mA	26	28	One servo & receiver, mA readings taken after 15 minutes
2	**Static Load** (Servo arm is connected to load, no movement)	10	0.22 Amp	28	32	One servo & receiver, Amp readings taken after 15 minutes
3	Dynamic Load with 50 operations	10	1.10 Amp	32	36	Rapid operation 50 full movements and 25 slow operations

Interestingly it can be seen that the higher rated PW38RH ran cooler at lower currents than the PW27RH exactly as expected as we did not pro-rate the weight based on a percentage of the servos output specification.

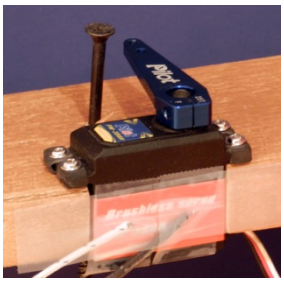
As a follow up to this report we will run the above tests again on both servos with prorated loadings based on specification, thus, 27Kg Servo X 27% = Load 7.29Kg and 38Kg Servo X 27% = 10.26Kg*. (Just a coincidence it worked out to 27%, it's based on my bucket size)*

In addition to the above we carried out

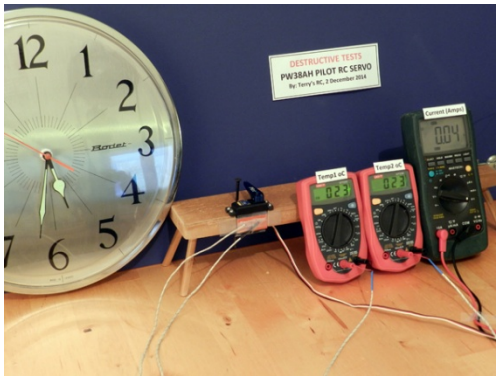
- Servo neutral alignment tests, using an extended point arm of 165mm to highlight misalignment deviations
- Servo neutral alignment tests with Tx end points adjustments set at 100%, 140%, and from 10% up to 100% in 10% steps.
- Slow operation tests to see smoothness of movement at low speed
- Extended operation for 20 minutes using a spring balance giving approx. 9.5Kg loading

Destructive Testing

Remembering my trapped finger incident and the fact it did not jamb the servo arm, I thought; what would happen if it did get jammed?



I fixed the 38Kg servo on the test stand and installed a jamming post "technical term for big screw," about 20 degrees to one side of the neutral position. I reluctantly decided to destroy one of my servos.



Thinking back at the hammer test, I thought I now have one that Tony did not do and we shall see how long his servo lasts!

The set up was simple, two temperature meters and a current meter. The thermocouples were taped on the casing one at either end. Notice the small clock positioned on the left to time the event.

What transpired was an eye opener. Notice the ambient temperature of 23°C and the idle current of 0.04Amp or 40mA. Rather than give you a blow by blow account, look at the chart!

PILOT RC 38Kg Servo Destructive Test Results				
Time	**T1°C**	**T2°C**	**Amps**	**Remarks**
17.38	23	23	0.04	System turned on arm not engaged
17.38	23	23	2.25	System arm engaged on post
17.41	55	50	2.25	(checked servo operation working perfectly)
17.42	56	51	2.23	
17.43	73	68	2.15	
17.45	85	83	1.58	Protection circuit kicks in between 85 to 90 degrees
17.50	91	89	1.24	(checked servo operation working perfectly)
18.00	94	92	1.23	
18.05	90	86	1.23	
18.10	92	90	1.25	
18.20	92	88	1.32	(checked servo operation working perfectly)
18.29	94	92	1.33	
18.33	94	91	1.28	
18.36	94	91	1.28	
18.39	93	91	1.28	(checked servo operation working perfectly)
18.41	93	90	1.28	
18.42	92	90	0.04	Servo arm disengaged & system turned off
18.55	24	25	0	System recovery took 13 minutes

I gave up after one hour. I could not destruct the servo. Again I sent Tony a message with the results and said I have just spent an hour and a half doing a destructive test but the servo is still working.

He replied.

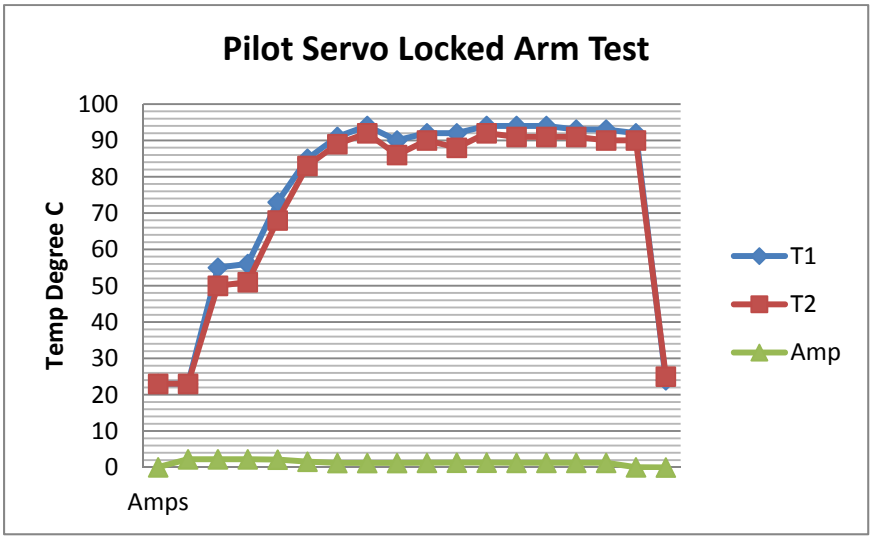
"I already done all those tests, why you waste more time you should have asked me."

He went on to say. *"My servos have built in current protection circuitry so in event of total jamb servo will not burn out and more importantly nor should your plane (but I don't guarantee your plane is as good as my servo)."*

He added. *"The servo will work up to 100°C and at 85-90°C the circuit is designed to reduce torque by 10% to a maximum of 50% and save the servo. Temperature should not go higher than 100°C under normal operating jammed condition. When servo cools down full torque is restored automatically.*

What can I say, except, again well done again PILOT for the innovation. They say a picture paints a1000 words, you dissect the results!

Time, Temperature Current Graph



It's clear that the protection circuitry works. The rapid increase was controlled at 85-90 degrees as predicted and through current/torque regulation the servo temperature was maintained in operational limits.

This gets full marks in my book.

Conclusion:

- This report started out with our observations on the prototype servos and highlighted two points both of which were rectified.
- The arm fit on servo is excellent
- The lock screws are very effective
- From my experience no loosening of the arm bolts

- The extended servo leads of 18” are in fact are 20” unique on any servo I know of
- The build quality is excellent
- Servo seals are effective
- Casing is aluminium and heat dissipation is effective
- PILOT RC comparison to other brands does understate performance which we found superior
- Our flight tests proved excellent control
- Neutral alignment tests exceeded expectations, pin-point accuracy
- End point settings maintained accuracy
- The slow operation test verified the smoothness of movement throughout the travel range.
- The extended operation “experiment” I shall call it, was very successful (now I can see why with the built in protection circuitry)

As for the electrical findings in the tables, it’s time for your feedback during use. I have it on good authority from Tony that the new brushless motor performs to perfection, it did for me!

Finally, as for my intended destructive test, it proves this servo has got to be a winner; it will protect your models and your investment in a hobby that’s by no means cheap, what more can you ask for. As for the price, we wait to see.

How does Terry’s RC rate this servo?

5-star rating "Excellent." - 4-star rating "Above Average." 3-star rating "Average." 2-star rating "Below Average."

Build Quality	
Flight Performance	
Innovation	
Test results	
Endurance under load	
Price	To be announced

Expected LAUNCH DATE – December 2014 or January 2015.