

## **Precision Aerobatics Thrust 10 Brushless motor with RotorKool™ technology**

The development of our new PA Thrust™ motors has followed our traditional design philosophy employed in our aircrafts; which is doing things better. Thrust™ motor is one of the coolest running high performance, high-torque and high efficiency brushless motor ever produced to date. The design incorporates our latest innovation, **RotorKool™** which keeps the stator core material, the low resistance windings, highly permeable stator plates, high quality NMB Japan triple bearings and powerful neodymium magnets at optimum operating temperatures regardless of duration or the number of consecutive flights made\*.

\*provided sufficient airflow is permitted.

### **Motor specs**

Outside Diameter	28mm
Length	31.7mm
Weight (gr/oz)	41.2gr / 1.45oz
Motor Shaft Dia.	3.0mm
Mounting Bolts Dia.	M3
Max efficiency Current A *	6-12A
Peak current A (15 sec)*	16A
Battery pack range **	2~3 LiPo / 6-10 NiCd
Poles	14
KV rpm/V	975
Recommended ESC	PA Quantum 18
Peak Watts	183 watts

*\* Unrestricted airflow and air scoops are mandatory to ensure long service life and long term performance consistency. Extended Continuous Operation without the required cooling provisions may be detrimental to the coils and magnets and will void warranty.*

*\*\* PA 3cells (11.1V) 1000mAh pack is recommended*

### **Propeller selection**

**APC 10x3.8SF** - Excellent overall propeller for 3D, freestyle aerobatics with more thrust than the other propellers. It slows down the plane nicely for hardcore 3D flying (excellent for low rolling harriers) and still provides lots of instant thrust. This is our recommended propeller for the PA Electric Shock.

**APC 10x4.7SF** - This is the higher range propeller for the Thrust 10 and an excellent over all propeller. It allows high speed maneuvers with respective punch. Adequate airflow to cool down the motor and ESC is required as well as a good battery and throttle management.

**APC 9x4.7SF** - Very nice propeller allowing longer flight duration (lower amp drawn) still with good thrust due to the high RPM!

**APC 10x5E** - Good sport aerobatic propeller with higher efficiency. If you are after longer flight duration with good thrust give this propeller a try.

We recommend getting a few different size propellers with your thrust 10 motor. Swapping a propeller is an easy task so you may want to experiment and feel the difference to fit different style of flying. Also in a hot summer day you may want to use a smaller propeller while in a cooler day you can run the motor with a larger propeller.

## **The iPAs Drive Test Methodology:- An Engineered Approach to Testing**

Through hundreds of hours of flight testing our airframe designs, we have established that there is a direct correlation between the airframe and drive system and one affects the other with consequences to the desired aerodynamic performance. We designed our power plants with the airframe that promotes efficient cooling. The idea behind the design was to allow the power plant and airframe to work in harmony in order to achieve optimum performance, that could never be easily achieved with a mix and match approach. Every step of the design from the airframe, motor, speed controller through to the matching power packs have been done in a very careful and measured fashion with the sole propose to achieve the maximum aerodynamic performance without compromising flight time. We call the result **iPAs**, PA **I**ntegrated **P**erformance **A**irframe-**D**rive **S**ystem, allowing any modeler to get it right the first time in the simplest and shortest way; the completely hassle free buy, fix, fly and forget method.

Below we will tell you a bit about the task of testing the gear to confirm the performance results.

While this may sound easy, it is actually a very complex test that should be done carefully. Any variations with the type of ESC set up, ESC brand, type of battery, charging of the battery pack (can even vary between same brand and type of pack), type of chargers, climate (environment temperature) and testing gear will derive different results. Even the duration of the bench run will change the reads due to the battery voltage drop caused by the internal resistance of the battery as well as the age of the battery. All those factors can create A LOT of read variations.

We conducted **multiple** tests (both static and dynamic tests) on each of our motors in different climates/temperature, using different testing equipment, changed ESC and batteries to determine the real performance of the motor. We also had the model flown by multiple test pilots to obtain different individual flying styles.

We believe that drive system testing should not be purely based on bench testing, because those are clinical test done in controlled environments that are completely different from actual flight conditions. Interactions of external environmental factors such as cooling, prop loading, G-Force etc. can not be accurately simulated on the bench. The real performance data comes from actual flights because this is where it counts the most. Therefore, we have taken the approach to conduct actual live test to acquire our data, i.e. flying the actual aircraft and performing actual 3D maneuvers, like any other experienced modeler would for real. We do not simply fly straight and level circuits and performing simple aerobatic maneuvers during our flight test but we actually fly our aircraft to the maximum limits of their aerodynamic performance envelope.

We strongly recommend going over the graphs below as they are the real dynamic test we've conducted with the motor.

### **Static Bench Test Results: PA Thrust 10 + Quantum 18**

Prop Type	Battery Voltage (V)	Current (A)	RPM	Watts (W)	Static Thrust (oz)	Static Thrust (gr)
APC 10X3.8SF	11.13	16.3	7035	181	33.60	952.5
APC 10X4.7SF	11.10	16.4	6840	182	31.84	902.7
APC 9X4.7SF	11.37	12.3	8325	139	30.88	875.5
APC 10X5E	11.29	13.7	7875	155	29.76	843.7

In 3D flights, thrust and power usually require the immediate power for few seconds to get out of a maneuver. We have based our static tests on this datum. We used 4 different brands of testing gear to verify the results and accuracy of reads. Test results may vary depend on your set up of your ESC, climate, altitude, duration of run etc.

## [Dynamic Flight Testing Results](#)

The dynamic test is real time data acquisition by onboard data loggers installed on the actual aircraft which the gear is designed for. These airplanes are deliberately flown by advanced pilots executing actual advanced maneuvers to simulate the real world performance conditions where these airplanes are expected to be flown.

We have included several graphs to cover as many advanced freestyle and 3D routines as possible especially maneuvers that places the most demand on the drive system. The graphs also show the actual motor cooling performance as it goes through each different maneuver and air speeds.

You may also want to look at all the temperature traces on the graph that indicates a fairly constant operating temperature throughout the flight in relation to the dynamic loads imposed by the propeller. This is where our exclusive Rotorkool™ feature comes into action to keep motor core temperature considerably below the critical temperature limits of the neodymium magnets allowing our Thrust Motors to provide consistent performance far longer than any other motor.

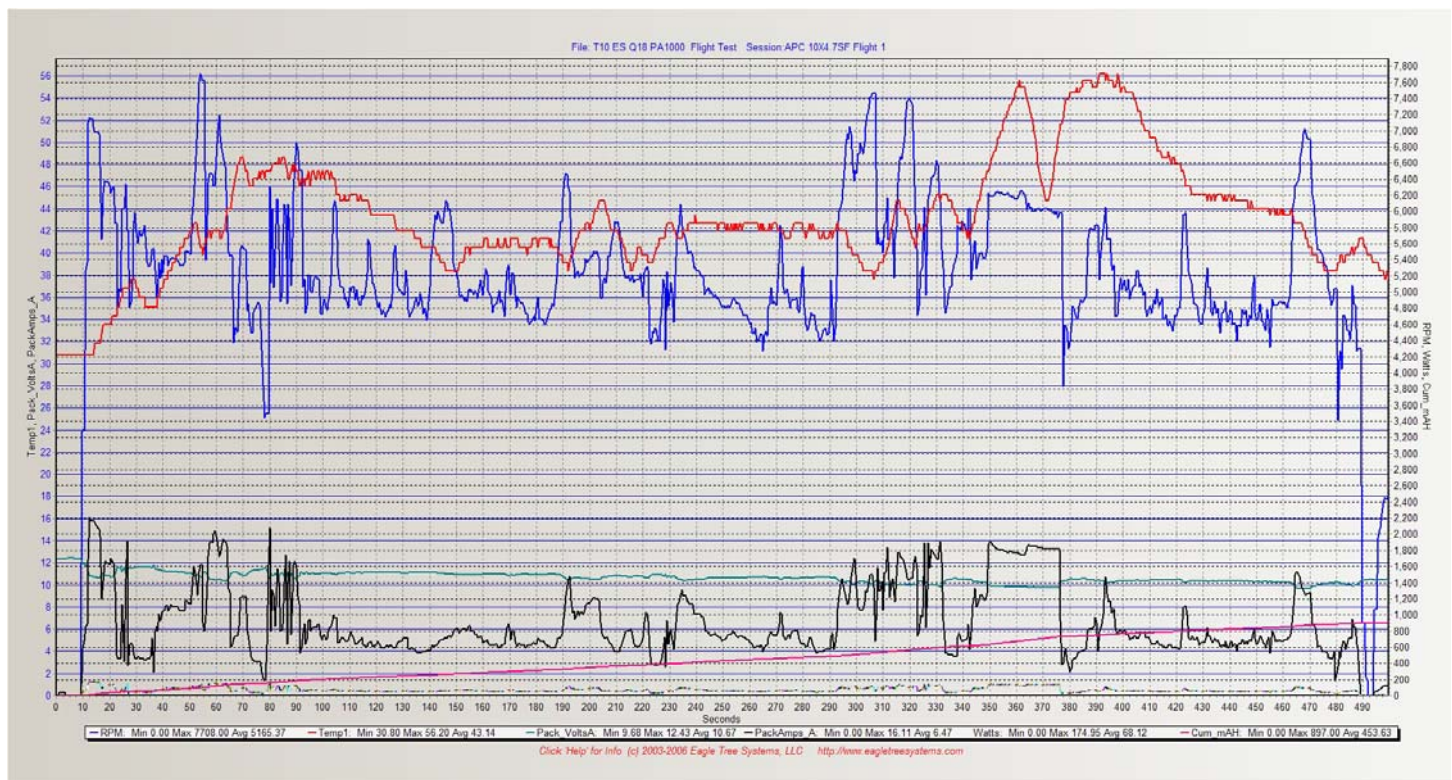
## [iPAs Dynamic Flight Test Results](#)

PA Thrust 10, PA Quantum 18, PA1000mah (General 3D Maneuvers)

### **Engineering Units**

Current = Amps, Voltage = Volts, Power = Watts, Temperature = Deg C., RPM = RPM, Battery Capacity = mAh.

## [Test Flight 1 \(APC 10X4.7SF\)](#)



### **Graph interpretation & Flight Report:**

Dynamic test was deliberately conducted in a hot summer day with ambient air temperature of 31.2 Deg C (88.16F).

The **red line** shows the motor operating temperature throughout the flight is between 38-48.5 Deg C (100.4-119.3F). The operating temperature rises and drops corresponding to the loads being imposed.

In this flight we conducted a specific test in which the motor has been deliberately held at full throttle for almost 30 seconds (between 340-380sec mark on the graph). The test consisted of the following steps: Very long vertical climb (the plane was almost out of sight) - temperature gradually peak at 56 Deg C (132.8F), throttle was shut at the apex of the climb coming back down in a long inverted spin at about half throttle, gradually increasing to  $\frac{3}{4}$  throttle, to continue applying loads on the motor. Temperature peaks again at 56 Deg C (132.8F) and then gradually falls back to be within operating range in the subsequent maneuvers till the end of the flight.

The red line demonstrates that despite the extremely high air temperature, and the hard over-load imposed on the motor, the RotorKool™ features were effectively managing the motor's temperature.

This is indicative of both the **blue line** (RPM) and **Black line** (Motor current) corresponding to the specific flight maneuvers.

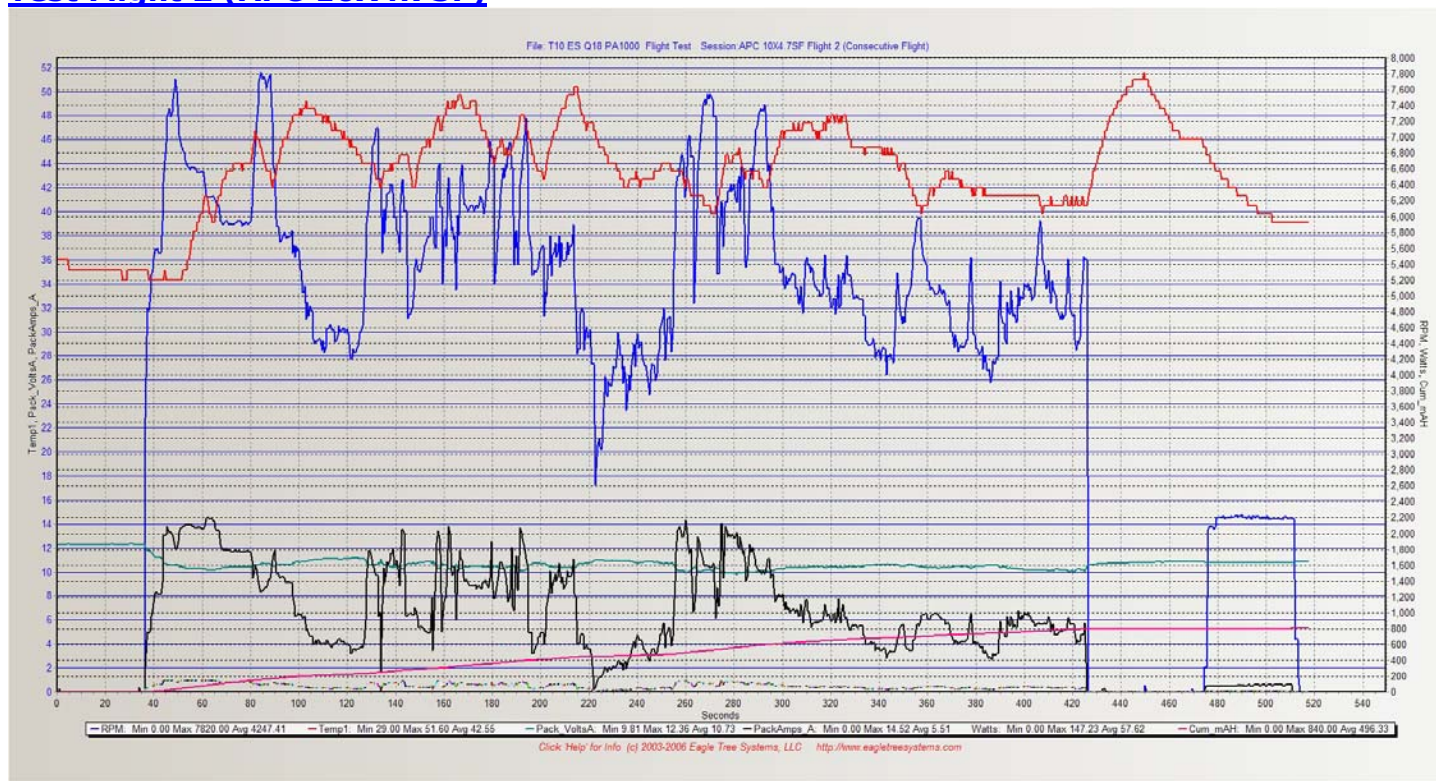
The **green line** shows the performance of the PA 1,000mah 18C-30C pack throughout the flight. The battery voltage never dropped below 9.68V and averaged around 10.67V.

Most lesser quality packs would have exhibit a drop in punch under considerable loads towards the end of the flight, but despite stressing the motor at the hard vertical climb, in the last quarter of the flight, the maximum current drawn was kept below the critical 30C burst rates and maintained performance with no risk of LVC (Low Voltage Cutoff) throughout the flight. The drive drew at a maximum rate of 16.11C from the 1000mAH pack and remained cool after the flight indicating an optimum match of the drive to the pack.

The **pink line** (cumulative mAh) indicates the accumulated battery capacity throughout the flight and consumed approximately 90% of the pack's capacity after an **exceptionally hard 8 minute flight**.

The **orange line** (watts) shows the motor power output throughout the flight peaking at **174.95W** on this propeller. No issues were noted with the Quantum 18 ESC (Electronic Speed Controller) and the throttle response was smooth, direct with no hesitation and remained within the ESC's design temperatures in-spite of the abuse. Throttle response was instantaneous with surplus reserves for punch-out during torque rolls and hover-recovery right up to the end of the flight.

## Test Flight 2 (APC 10X4.7SF)



### Graph interpretation & Flight Report:

Dynamic test was deliberately conducted in a hot summer day with ambient air temperature of 31.2 Deg C (88.16F).

This graph shows a consecutive flight immediately after Test Flight # 1 with no break in between.

The **red line** shows the initial motor temperature at 36 Deg C (96.8F), after the completion of Test Flight 1, then started to cool down to 34 Deg C (93.2F) in spite of the take off (into a vertical climb on full throttle). The motor operating temperature throughout the flight remained between 40-49 Deg C (104-120.2F) rising and dropping corresponding to the loads being imposed. This particular flight was **deliberately flown with several full throttle vertical up-lines** followed by KE spins to stress the drive system and the temperature oscillations remained within a narrow band between 42-49 Deg C (107.6-120.2F), which is only about 10.8 to 17.8 Deg C above the hot ambient air temperature.

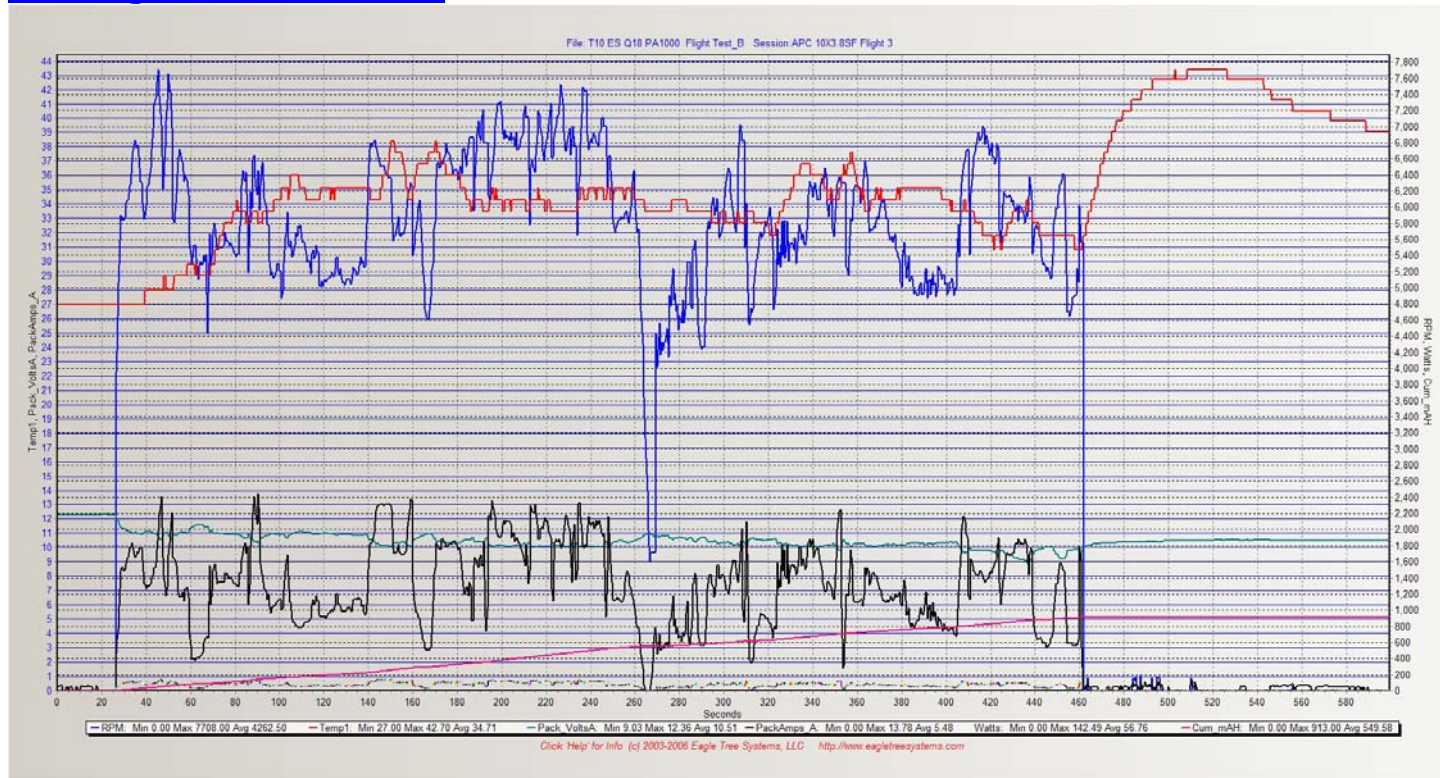
This datum demonstrates how effective the RotorKool design is. At the end of this flight (430sec mark on the graph) the motor was deliberately allowed to stop without cooling for 60sec to deliberately allow the trapped residual heat in the motor to raise the temperature to about 51.8 Deg C (125.2F). this shows the effects of trapped residual heat associated with immediate motor shutdowns. The motor was then allowed to run for 30 sec at about 15% throttle to cool itself down. The temperature trace shows the temperature steadily dropping from 51.8 to 39.5 Deg C (125.2 to 103.1F) during the 30 sec cool-down period, again demonstrating how effective the cooling capability of RotorKool is.

The maximum current drawn in this flight was 14.52A with output of **147.23W**. Here the PA 1000mAh pack handled the high discharge rate (14.5C) well and remained cool after flight.

The cumulative battery capacity after the 7 minutes flight depleted the pack by only 50%. The battery voltage throughout the test flight kept fairly constant and high at 10.75V average.

Here again the Quantum 18 ESC performed very well and the throttle response was smooth, direct with no hesitation and remained within the ESC's design temperatures in spite of the abuse. Throttle response was instantaneous with surplus reserves for punch-out during torque rolls and hover-recovery right up to the end of the flight.

### Test Flight 3 APC10X3.8SF



### Graph interpretation & Flight Report:

Dynamic test was conducted in a warm summer day with ambient air temperature of 27 Deg C (80.6F).

The flight began with a 1/2 throttle hand launch take off into a set of vertical climbs and KE spins followed by rolling harriers, inverted and upright harriers and hovers followed by average 3D maneuvers. The average temperature remained constant within 32.8 to 38 Deg C (91-100.4F) rising and dropping responding to the loads being imposed during the 3D maneuvers being executed with a peak current drawn of 13.78A and a max power output of 142.5W.

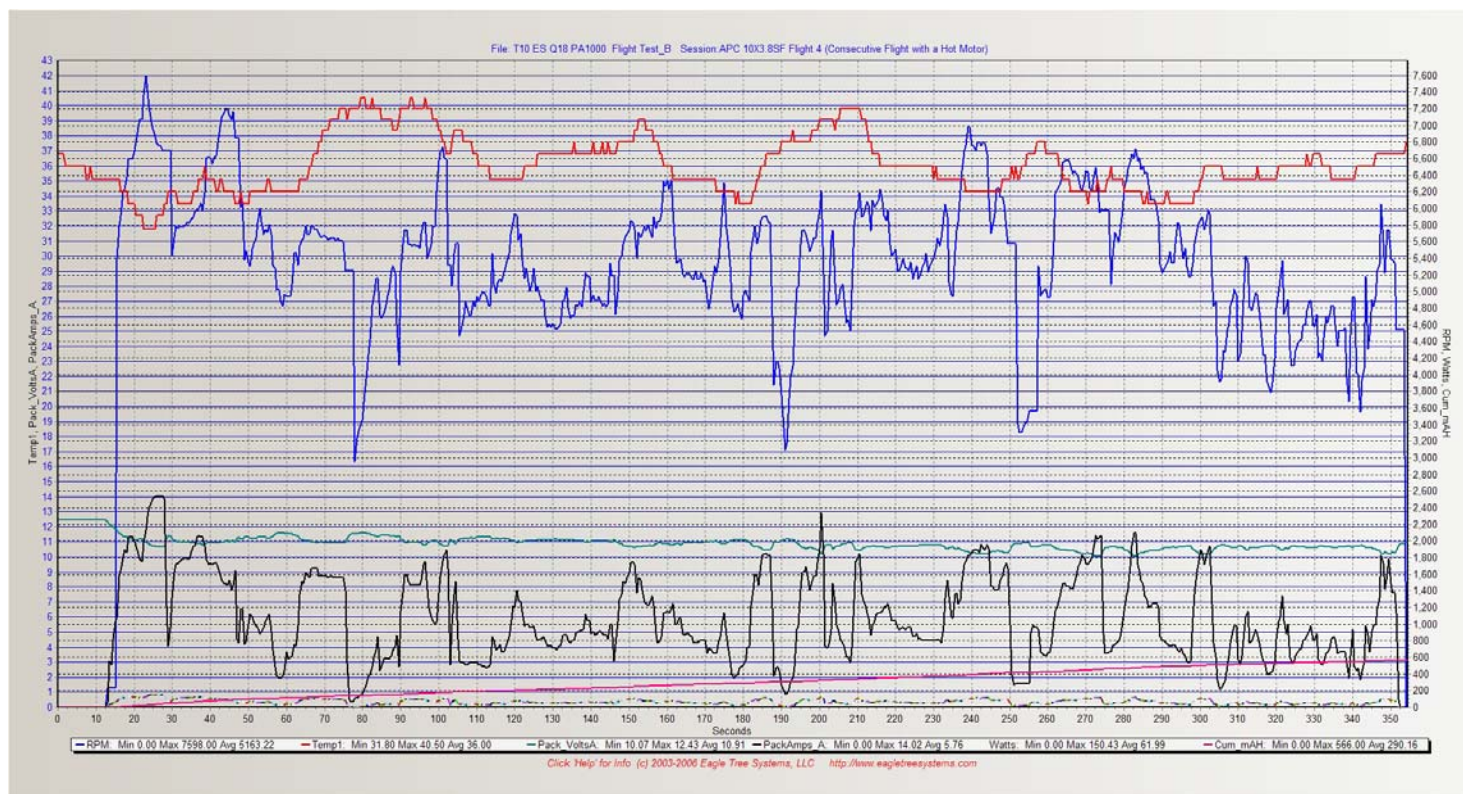
Despite the seemingly lower wattage output with the 10X3.8SF propeller in relation to the 10X4.7SF, the 3D performance was excellent and provided ample thrust with fast response to safely execute slow rolling harriers exceptionally close to the ground.

As the **red line** shows at the end of the flight the **motor was deliberately shutdown without the usual 30 seconds cool down** to demonstrate the effects of trapped residual heat after immediate motor shutdowns. In the case of this test, the residual temperature only peaked to 43.5Deg C due to the considerably lower operating temperature during the flight which then slowly cooled down by natural means.

The **green line** (battery voltage) shows how well the battery was coping throughout the flight. It never dropped below 9.03V and was an LVC-free flight that consumed almost 91.3% of the pack's capacity. Battery remained cool after 7 1/2 minutes flight.

The Quantum 18 ESC performed very well and the throttle response was smooth, direct with no hesitation and remained within the ESC's design temperatures in spite of the abuse. Throttle response was instantaneous with surplus reserves for punch-out during torque rolls and hover-recovery right up to the end of the flight.

## Test Flight 4 APC 10X3.8SF



### Graph interpretation & Flight Report:

Dynamic test was conducted in a warm summer day with ambient air temperature of 27 Deg C (80.6F).

This graph shows a consecutive flight right after Test Flight # 3 (after a short break for a battery change).

The **red line** shows the initial motor temperature starting high at 36.8 Deg C (98.3F) after the completion of Test Flight 3 but even during the full throttle take off the voltage dropped to below 32 deg C (89.6F). The motor operating temperature throughout the fight remained between 32 to 40.5 Deg C (89.6 to 104.9F) rising and dropping corresponding to the loads being imposed.

The peak current drawn in this flight was 14.02A (14C discharge rate). The **green line** (battery voltage) shows how well the battery was coping with the loads imposed by the motor throughout the flight. It never dropped below 10.07V and therefore provided a safe LVC-free flight in this hard 6 minutes flight (**150.43W**). The PA 1000mAh pack remained cool after the flight.

The cumulative battery capacity after the 6.6 minutes flight showed it only drew **57%** of its capacity with the 10X3.8SF popeller!

The Quantum 30 ESC performed very well providing a smooth linear throttle response with no hesitation and remained within the ESC's design temperatures in-spite of the abuse. Throttle response was instantaneous with surplus reserves for punch-out during torque rolls and hover-recovery right up to the end of the flight.