Precision Aerobatics Thrust® 30 Brushless motor with RotorKool® technology

The development of our new PA Thrust® motors has followed our traditional design philosophy employed in our aircraft; 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	37.2mm
Length	37mm
Weight (gr/oz)	105gr / 3.7oz
Motor Shaft Dia.	5.0mm
Mounting Bolts Dia.	M3
Max efficiency Current A *	18-28A
Peak current A (15 sec)*	39A
Battery pack range **	2~4 LiPo / 6-12 NiCd
Poles	14
KV rpm/V	905
Recommended ESC	PA Quantum 45
Peak Watts	470 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) 2200mAh pack is recommended. With 4 cells pack the chosen propeller must fit within the motor's limits (current drawn).*

Prop selection (with PA2200mah 20-40C V2 Packs)

APC 11x5.5E - Excellent lower range prop for the T30 with outstanding efficiency of 84%!! Running cool and smooth with longer flight duration.

VOX 12X6 - Nice propeller with lower flight speed and punch compared to the APC 12x6E but with the advantage of being lighter (meaning faster prop spooling) and a nicer prop sound ;)
Better suited for general sport flying.

APC 12X6E - Excellent overall propeller for freestyle, pattern and basic 3D. Nice balance of thrust with constant flight speed (for tumbling maneuvers). Matches well to the Thrust 30 with excellent efficiency and good flight duration. This is our recommended general prop for the Katana MD and Extra 260 if flight duration is in mind.

VOX 12X7 - Nice overall propeller for aerobatics and pattern flying providing more flight speed for high energy maneuvers with longer flight duration than the APC12x6E due to the higher efficiency. It resembles the performance of the APC12x6E but with better efficiency and 3.8A lower current drawn, plus it has the sleekly wooden appearance ;)

APC 13x4E - If you are a thrust freak and want a 3D beast then give this propeller a shot. With a whopping **95.68oz** thrust no doubts you will impress your club mates!! Please note that this prop is not a good choice for pattern flying due to the low flight speed (low pitch propeller). This prop may be a good choice if you want to practice some low and very slow 3D since it provides the instantaneous thrust (the extra punch to get out of embarrassing situations). The combination of the low pitch and the large diameter acts as an air brake and will allow slow harriers without speeding up but with a penalty of slower throttle response therefore we do not recommend this prop for beginners. It is stable in hovering and TR.

VOX 13x6.5 - This is the highest range prop for the Thrust 30 with the V2 pack and is an excellent overall prop for extreme 3D and freestyle. Allows high speed maneuvers with a lot of punch. Adequate airflow to cool down the motor and ESC is mandatory, as well as **strict** throttle management.

VOX 11X10 - Good propeller for high speed with high efficiency.

We recommend getting a few different size propellers with your thrust 30 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.

A little background

For a number of years, modelers have accepted the notion that in order to attain top notch performance, one has to run outrunner motors to the extreme limit with the risk of overheating. In fact, heat has become inevitable part of contemporary high performance Brushless Motors and nothing much could be done about it.

However heat is one of the main contributors to premature magnet deterioration and bearing failures leading to permanent performance degradation over time or even dangerous and catastrophic destruction due to thrown magnets.

In order to avoid unwanted heat damaging the motor, some modelers have resorted to over sizing their motors. This in turn increases the all up weight and thereby affecting wing loading and flight performance. There seems to be a no win situation and the only way to enjoy this wonderful hobby is to accept the seemingly hopeless compromise.

Motor power has always been quoted in Watts, but heat is Watts too. So, the real question is *"Are all the quoted Watts being used to drive the motor, or is there a significant amount of Watts wasted in heat?* To answer that just touch your motor immediately after flight and if it is hot enough to burn your finger, THAT is where the Watts went as opposed to driving your airplane, therefore, quoted watts are essentially meaningless when evaluating a motor (because it does not indicate the efficiency). The propeller's RPM is the most important performance factor.

We at PA understood that without effectively eliminating heat, all the good motor attributes already available in our motors and as well as others, contributes very little to the motor's overall performance in service because heat building up under load means loss of efficiency and eventually leads to detrimental effects in the electro-magnetic properties of the motor. These effects cause significant deterioration of power, thrust and eventually flight times.

We set a target to make a high performance, extreme thrust motor, which is light, runs cool and efficient for maximum flight time, is made of highest grade materials and features precision engineering and machining.

This led to rethinking the design of current brushless outrunners, their strengths and limitations and thus led to the development of a completely new line of PA Thrust® motors.

About the design

Some of the common brushless outrunner manufacturers have gone as far as incorporating high temperature magnets and exotic adhesives to circumvent the effects of the heat problem. There are myriad of crude and inefficient cooling techniques ranging from a multitude of holes, to fins, to bolt-on fans and impellers.
Unlike those, the new PA Thrust® cooling design took a complete departure in the current thinking by engineering a High Velocity Force Cool Ventilation (HVFCV) into the rotor end bell **as well as** taking full advantage of thermodynamic properties of the stock material itself. HVFCV is achieved through a set of solid metal turbine impeller blades painstakingly **CNC milled** as an integral part of the rotor end bell assembly, which not only provides the positive force cool ventilation by drawing fresh cool air through the stator and magnets, but also doubles up as a heat pump to first draw excess heat from the rotor assembly itself and then act as a heat exchanger by expelling it through the air stream contacting the solid metal turbine blades as it spins at high velocity. Micro ridges, intentionally CNC cut into the rotor, further multiples the end bell's surface area and serve as radiators to further boost thermal dissipation achieving unparallel cooling and henceforth having the ability to swing larger propellers than other conventional outrunner motors of similar class while remaining considerably cooler and more efficient.

There is more to the "Cool" look of the CNC exterior casing than meets the eye, and looks can be deceiving. Under the hood, is where serious engineering comes into play. With only the highest quality materials and components used in the manufacture, the new PA Thrust® motors are manufactured with the tightest tolerance making it possible to maintain the smallest air gap between the stator and shaped neodymium magnets, significantly boosting torque and thrust. The relatively silent and vibration-free operation of the motor is a testament to the tight tolerance manufacturing regime we have adopted specifically to harness the maximum power produced by the motor (within the limits of today's technology) for the sole purpose of swinging the prop. This allows the motor to swing propellers of at least one size larger than any contemporary motors in its class while running cool with maximum efficiency.

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-Drive **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.

What iPAs means to you, the modeler? iPAs provides a pre-matched, optimum gear setup derived from hundreds of hours of flight testing that would make your PA model perform as advertised out of the box. This also means you will no longer need to try and figure out by experiments what gear best matches the airframe and the desired flight performance.

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 (dynamic) test to acquire our data, i.e. flying the actual aircraft and performing actual 3D maneuvers, like any other experienced modeler would. 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 since they are the real dynamic test we've conducted with the motor.

iPAs Static Bench Testing Results

PA Thrust 30, PA Quantum 45, 11.1V PA2200mah **20-40C V2**

Prop	Battery Voltage (V)	Current (A)	RPM	Watts (W)	Static Thrust (oz)	Static Thrust (gr)
APC 11x5.5E	11.51	25.7	8970	296	56.48	1,601.20
VOX 12x6	11.37	33.1	8295	376	64.64	1,832.54
VOX 12x7	11.28	33.2	8190	375	63.04	1,787.18
APC 12x6E	11.19	34.8	8040	390	64.32	1,823.47
APC 13x4E	11.28	31.0	8355	350	95.68	2,712.53
VOX 13x6.5	11.15	39.9	7620	445	75.04	2,127.38
VOX T30-X	11.17	39.1	7680	437	67.36	1,909.66
VOX 11x10	11.10	39.8	7530	442	32.00	1,066.00

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.

Note :- Actual flight duration is dependent on the individual's flying style and the extent of throttle management used. To make initial flight duration estimates, refer to the dynamic flight testing graphs on the following pages to set the flight duration in accordance to the propeller used. This will be the conservative flight duration estimates whereby the actual flight duration specific to each individual can be then refined by taking note of the remaining battery capacities after the flight session to establish the consistent capacity draw. Due to the relatively flat nature of the discharge curve found on high grade, high performance batteries where it provides consistent performance throughout 90% of the pack's capacity, the drop in power at the last 10-20% of the pack's capacity sometimes goes unnoticed. As such it indirectly encourages the modeler to fly for an extended period and run the risk of encroaching into sudden ESC unexpected LVC (Low Voltage Cutoff). To avoid this, as a rule of thumb, set your flight timer to allow at least 15% spare capacity as a contingency measure to account for weather conditions, inconsistencies in routines and other eventualities you may have not anticipated.

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.

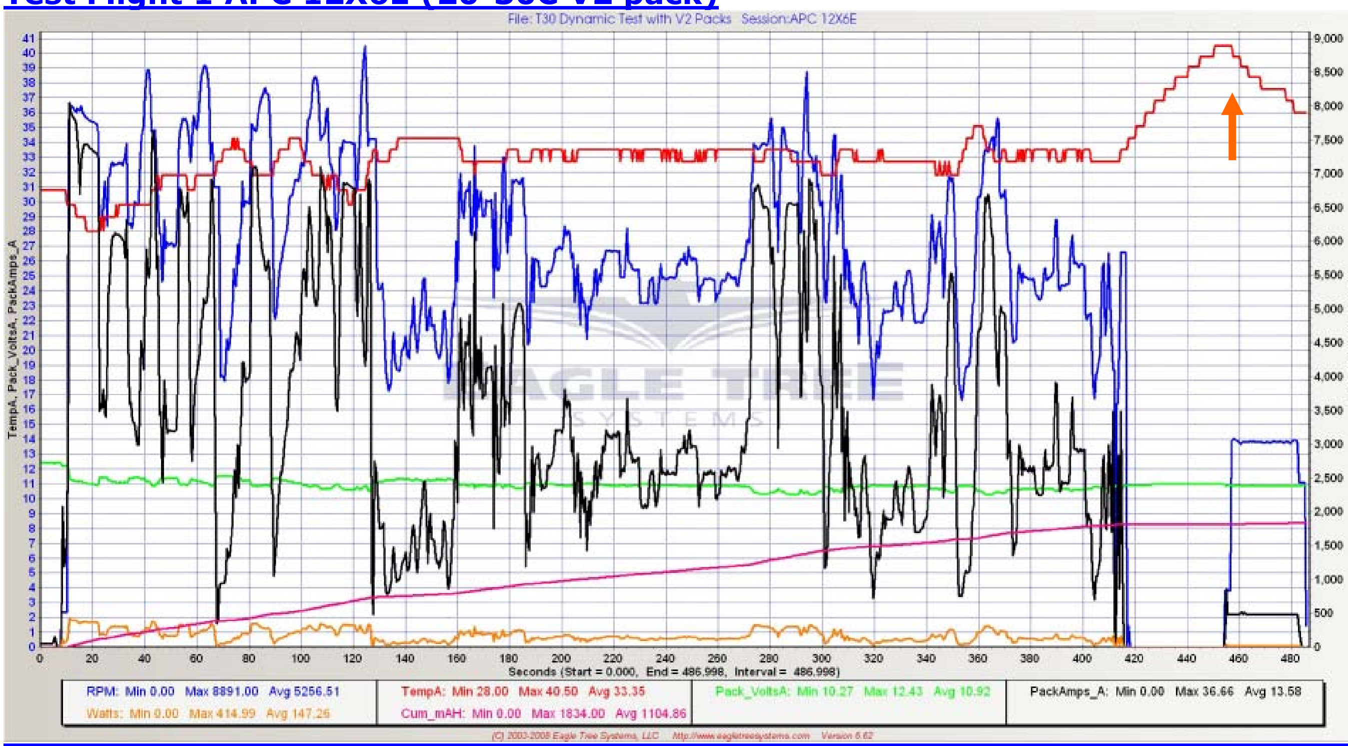
You may also want to look at all the temperature traces on the graph that indicates a fairly constant operating temperature throughout the flight in relation to the dynamic loads imposed by the propeller. This is where our exclusive RotorKool® feature comes into action to keep motor core temperature 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

Gear used: PA Thrust 30, PA Quantum 45, PA 2200mah V2 pack (General Freestyle/3D Maneuvers)

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

Test Flight 1 APC 12X6E (20-30C V2 pack)



Graph interpretation & Flight Report:
Dynamic test was deliberately conducted in a hot summer day with ambient Air temperature of 28 Deg C (82.4F). The intent to conduct this test during the hottest summer period as opposed to during the winter is deliberately aimed to induce the maximum thermal loads on the motor and in order to demonstrate the capabilities and effectiveness of the RotorKool® design. This test flight is a consecutive flight.

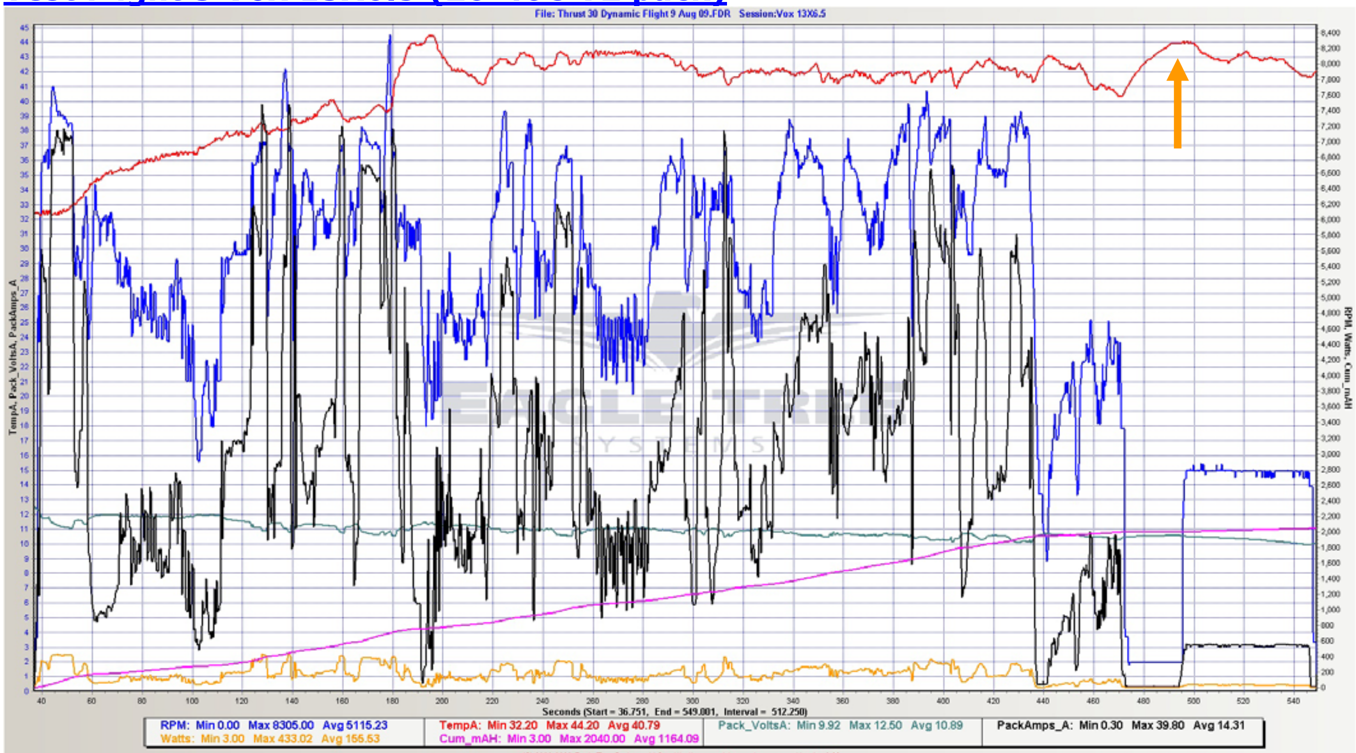
The **red line** shows a very constant motor operating temperature throughout the flight to be in a narrow band between 30–34 Deg C (86.0-93.2F) rising and dropping corresponding to the loads being imposed.
You may note the temperature dropped from 31 to 28 Deg C (87.8-82.4F) after the motor initially started showing the effectiveness of the RotorKool® HVFCV feature even though the throttle was gunned to full power for a vertical climb out after takeoff.
The very constant nature of the temperature trace on this flight shows how well RotorKool® controls the temperature maintaining it within a narrow band. A rise in temperature just before the 420 seconds mark was when the aircraft landed and the motor stopped for 20 seconds and then restarted at idle at the 455seconds mark for 30 seconds to cool down (Refer to the orange arrow in the graph above for the motor temperature drop). That clearly demonstrates the self cooling capabilities and the high efficiency of the motor.

The cumulative battery capacity (**pink line**) after the 7 minute flight drew 1836mah providing reliability to flight duration estimates to avoid unwanted LVC (Low Voltage Cutoff) issues.

The battery voltage (**green line**) also shows a very constant voltage throughout the flight and never fell below 10.27V and provided consistent flight performance with absolutely no compromises having to be made on the maneuvers from start to end.

The peak watts (**orange line**) drawn on this test flight is **414.99W** with a maximum peak current of **36.66A** (**black line**). No issues were noted on the Quantum 45 and the throttle response was smooth and linear with consistent performance in all maneuvers.

Test Flight 3 Vox 13X6.5 (20-40C V2 pack)



Graph interpretation & Flight Report:

Dynamic test was deliberately conducted in a hot summer day with ambient Air temperature of 32.5 Deg C (90.5F). The intent to conduct this test during the hottest summer period as opposed to during the winter is deliberately aimed to induce the maximum thermal loads on the motor and in order to demonstrate the capabilities and effectiveness of the Rotorkool® design as well as the cooling efficiency of the Quantum 45 and the tested airframe.

The **red line (Temp A)** shows the fairly constant motor operating temperature band throughout 60% of the flight to be between 41–43.5 Deg C (105.8-110.3F) rising and dropping within a narrow 2.5 Deg C (4.5F) range corresponding to the loads being imposed.
The very constant nature of the temperature trace on this flight shows how well Rotorkool® controls the temperature maintaining it within a narrow band. A rise in temperature just after the 475 seconds mark was when the aircraft landed and the motor stopped for 20 seconds and then restarted at idle at the 495 seconds mark for 50 seconds to cool down. Note that the rise in temperature halted and then dropped the moment the motor restarted (Refer to the orange arrow in the graph above and note the **red line**). That clearly demonstrates the self cooling capabilities and the high efficiency of the motor.

The cumulative battery capacity (**pink line**) after the 8 minutes flight indicates that 2,041mah was consumed.

The battery voltage **(green line)** also shows a fairly constant voltage throughout the entire flight and never fell below 9.9V therefore provided very consistent flight performance with absolutely no compromises on the maneuvers from start to end.

The peak watts (**orange line**) drawn in this test flight was **433.02W** with a maximum peak current of **39.8A** (**black line**).

No issues were noted on the Quantum 45 ESC and the throttle response was smooth and linear. The performance was consistent with lots of energy. There was absolutely no feel of any constraints in the maneuvers the test model is capable of performing.