Big is Beautiful.

This is certainly the case for many model aircraft particularly scale models. The ability of larger models to fly at a more realistic scale speed and to ignore the effects of variations such as low-level turbulence means that modellers have been producing some very impressive large aircraft over recent years. Powering such aircraft has been instrumental in the development of many converted and custom produced spark ignition motors. In terms of the development of electric flight the early years were mainly involved with small to medium sized models with relatively low-powered motors and low battery counts, and although the enormous expansion of the RTF foamies and suitable power systems has saturated the bottom end of the range, we have only recently started to find motors, controllers, and battery systems available for larger models. It is interesting to note that these systems tend to operate with large diameter propellers at moderate RPMs using high cell counts (high voltage) at quite moderate currents and this is an aspect of motor efficiency which I intend to look at in more detail in the future. I was recently loaned a number of units which fit very nicely into this area so I am going to provide you with some detail on these.

Tornado Thumpers.

Not, perhaps, the most obvious of names for a group of brushless out-runner motors, but it may have originated in IC engine parlance where a long stroke, low RPM, high torque engine is often referred to as a "thumper", and these motors are based on a similar design philosophy. There are twelve motors in the range and I have included the manufacturer's specifications in the following table.

Thumper Model	**3536**	**3542**	**3548**	**4240**	**4250**	***5055***	**5065**	**6354**	**6364**	**6374**	**8085**	**80100**
Volts	7-15	7-15	7-15	11-26	11-26	11-30	11-30	14-37	14-37	14-37	22-52	22-67
Kv	1000	1250	900	900	600	580	380	200	230	200	80	130
Max Power kW	0.4	0.54	0.71	0.54	0.72	1.28	1.4	2.4	2.6	2.9	6 0	6.5
Max Eff Am s	30	45	60	45	45	80	80	90	90	90	120	130
O/A Len th mm	55	61	67	60	70	75	85	78	88	98	170	185
Diameter mm	36	35	35	*42.5*	*42.5*	*49*	49	63	63	63	80	80
Wei ht ms	110	140	170	140	210	310	420	480	645	790	1400	1750
Min Pro Size	9x6	11x5	11x5	11x5	12x6	13x8	16x8	16 10	16x10	16x10	20x10	20x10
Shaft Diam mm	4	4	4	5	5	8	8	10	10	10	12	12

Some of the data in this table is amazing, 6 kW of power from an electric flight motor is a figure which is not to be sniffed at. Couple this to a 30 inch propeller and you have a power plant which would probably fly a microlight. John Kliszat of Overtec (who is marketing these motors) sent me a pair to review and as you will see in the photos these were the 4250 and the 5055.

I decided right at the beginning to use LiPo batteries to run the motors but the equivalence between these packs and Nickel Metal Hydride (or NiCd) is now well understood by the majority of electric flyers. John Klizsat provided me with a pair of Xoar wooden electric propellers, the sizes of which were chosen to match the motors to the Tornado Professional 3S LiPos I had been testing in some previous work. He also sent me a range of suitable accessories which you will see in the photographs and which I will cover in a bit more detail later. I started my testing by running basic static thrust tests for both motors from zero to maximum throttle using the two props and a 3S Tornado 2200 mAh 25C LiPo. These results are shown in graphs 2 and 4, but remember that the voltage/current readings are combined into watts to allow for the voltage drop which occurs as the load increases. These two plots indicate a very useful performance but if you check on the manufacturer’s specification above you will see that the motors are being very lightly loaded by this set-up.

My first move to try to get further up the performance profile of the motors was to repeat the two tests using a 4S pack which obviously gave me a 33% increase in input power. These results are available in graphs 3 and 5 and even though the outputs of up to 2 kilograms of static thrust are significant, they are still only a small part of what the specification indicates is available. I decided at this point that I had to work with larger propellers and repeated the testing using the Xoar 13” x 7” on the 4250 and a Menzs18” x 6” on the 5055. This latter test resulted in a static thrust of 3300 gms (7.3 lbs in old money) which was definitely approaching the limit for my test rig; I had to lock the bench castors to prevent the whole thing departing at speed.

I also realised at this point that I was beginning to produce an awful lot of graphs (its some kind of character weakness for anoraks like me) so decided to simplify things slightly. I plotted graph 1, a set of calibration curves for the three props so that you can switch from prop RPM to static thrust (and vice versa) easily, and then re-plotted some of the earlier curves without using RPM as a variable. I also included a series of results for 2S batteries for a reason which I will cover in a moment, but the 4 graphs, 6, 7, 8, and 9 now cover a broad spread of the performance envelope of these two motors. I think these results are quite impressive, and remember that these are only a pair of motors from the centre of the full range.

Volts versus Amps.

There is a theoretical link between the power input to an electric motor (usually measured in watts) and the output in terms of shaft torque, and this is normally expressed in terms of the efficiency of the motor. With brushed motors the efficiency curve is usually fairly peaky, i.e. the highest efficiency occurs over a relatively narrow band of RPM and falls away quickly above and below this area. The electro-mechanical differences with brushless motors is normally considered to lead to a much flatter curve and this results in more versatile application since they can be operated some way from the optimum area without excessive reduction in efficiency.

One of the more complex aspects of this relationship is the relative importance of voltage and current. We can input the same power by using high voltage with low current or by using high current and low voltage, e.g. 30 amps at 10 volts is the same input power of 300 watts as 10 amps at 30 volts. The same theory indicates that, of these two possibilities, the high voltage approach is the more efficient, and the thought occurred to me, as I was doing this testing, that I had the test results to allow me to check this. If the motor were operating at a higher efficiency (but at the same power input) then the power output should be greater.

Look at graph 9. At an input power of 200 watts the three packs are providing 27 amps/7.4 volts (2S), 17.5 amps/11.4 volts (3S), and 12.7 amps/15.8 volts(4S) with the voltage decreasing as the number of series cells increases. The thrust comparisons are, however, the reverse of what theory would lead us to expect. The 2S pack is giving greater thrust than the 3S which is also greater that the 4S. The differences are not enormous but the pattern is consistent and is repeated in graphs 6, 7, and 8.

I know that this is where the reader expects the writer to produce a brilliant explanation, but I am stumped. I will need to look at the theory more closely and maybe come up with a logical explanation. If I am unable to do so, then I may well adopt a pragmatic approach and not mention this again. To paraphrase an old teacher training guideline," in the absence of a logical explanation, ring the bell for the end of class".

Accessorization.

Now there's a good word for the crossword fan, but in this case I am using it to emphasize the need for manufacturers to provide a suitable range of extras which enable their products to be utilised effectively. This is, unfortunately, not always the case for electric flight components, but I have been impressed by the range of accessories available for the Tornado Thumpers, particularly since the larger units are well outside of a "typical" description. I have already mentioned the Xoar propellers and Overtec were also able to supply me with an adapter for the 8mm motor shaft (I see little chance of this distorting in any accidental impact), an appropriate controller/programmer, a mount extension frame, and a reverse format mounting package. The photographs are largely self-explanatory but I should add that the quality of the finish on these is admirable. Suitable alternatives may well be available elsewhere, but I was pleased by the way the various Tornado components assembled to provide an exceptionally smooth running combination.

Contacts.

OverTec, Jesmond Dene Trading Estate, Forton, Nr Lancaster, Lancs PR3 0AT
Tel 01524 793328 website **www.overlander.co.uk**

Photographs.

QEFI67-1 **The Tornado Thumper 4250 and 5055 motors from Overtec.**

QEFI67-2 **The Tornado Gold Opto 80 Amp ESC and EPRG-1 programming card.**

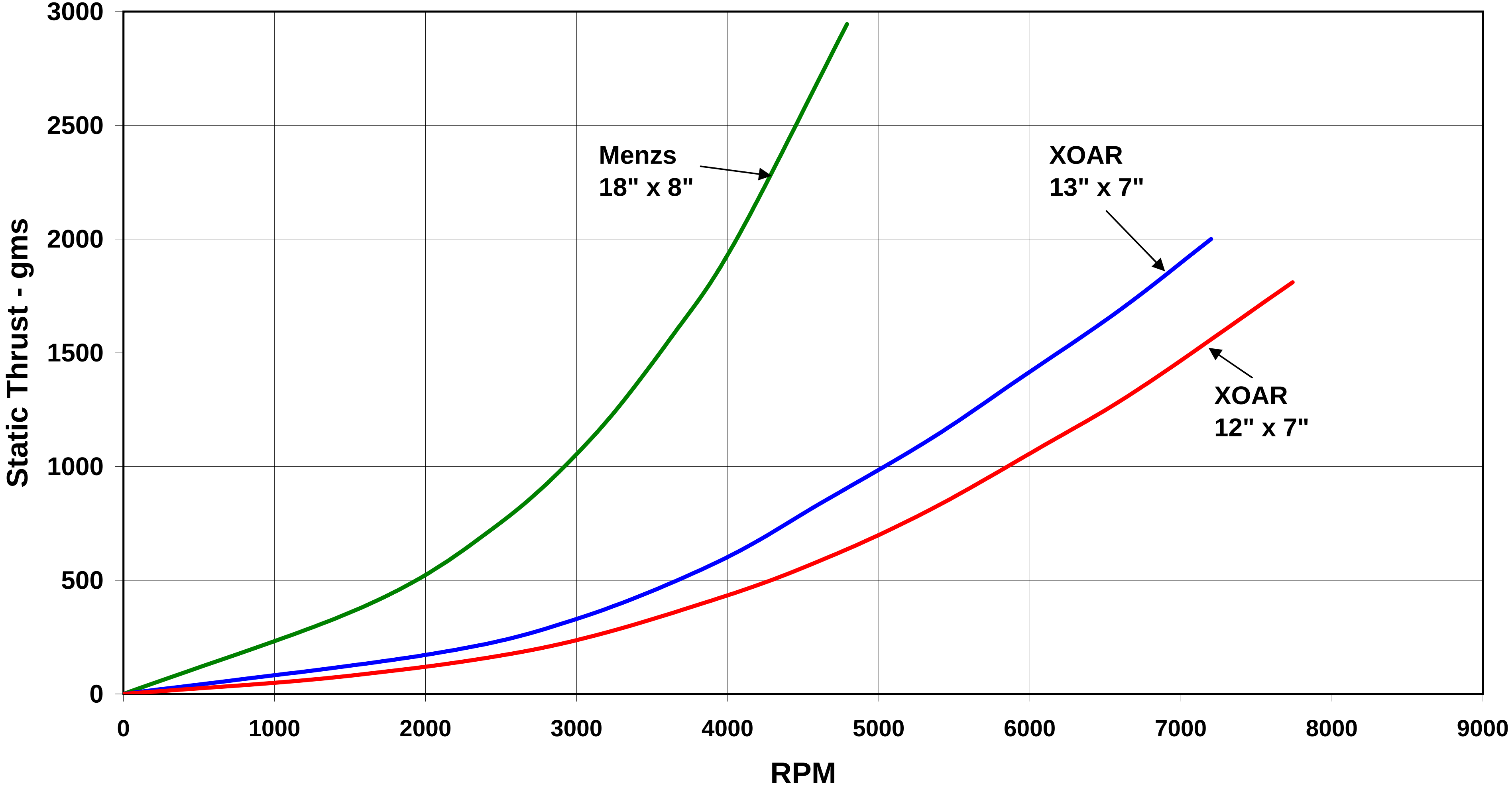
QEFI67-3 **The Xoar 12" x 7" and 13" x 7" electric wood propellers from Overtec.**

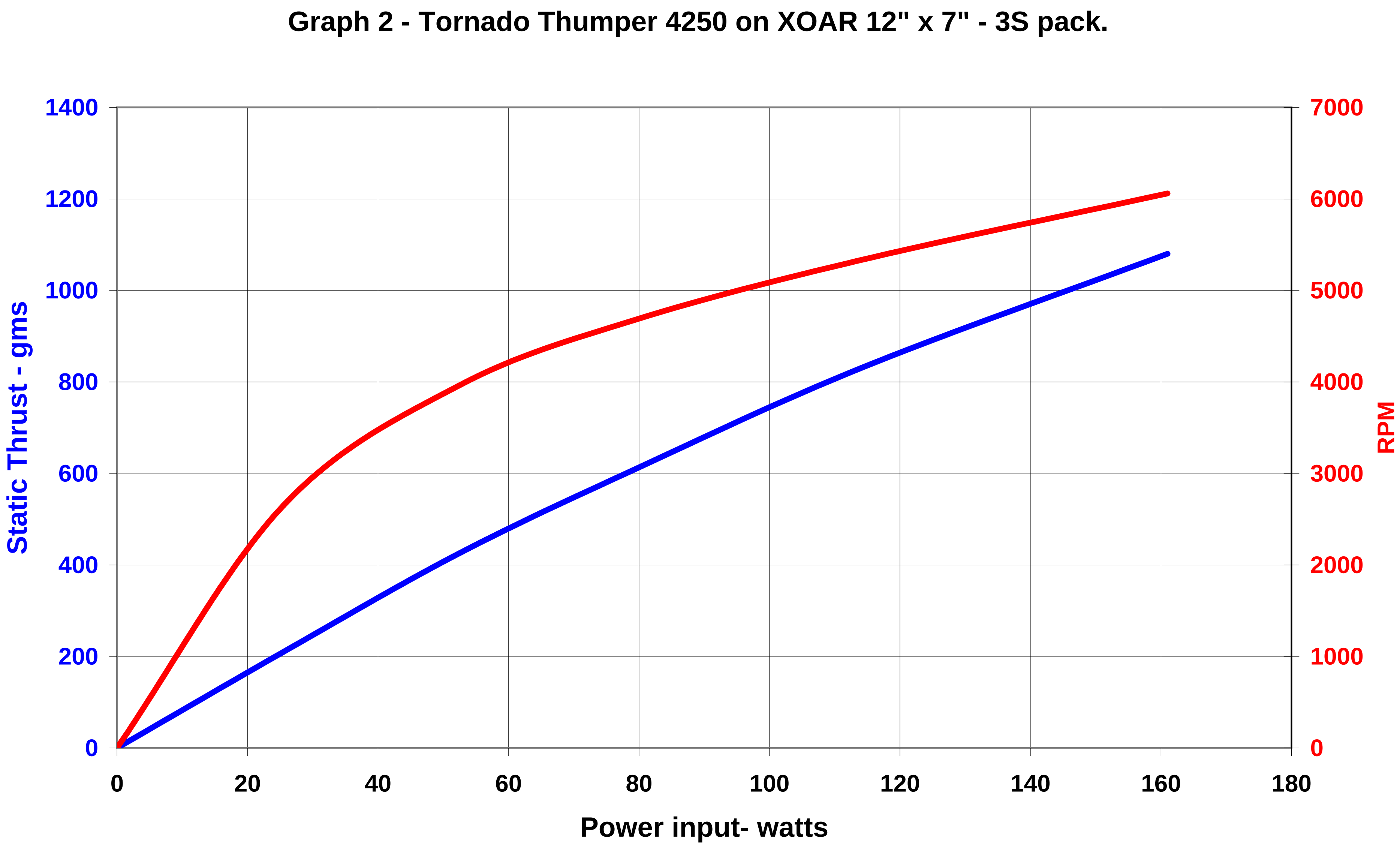
QEFI67-4 **Tornado Collet Style Prop Adapters for 8mm and 10mm motor shafts.**

QEFI67-5 **The Tornado Thumper 5055 fitted with the Tornado Mount Extension Frame.**

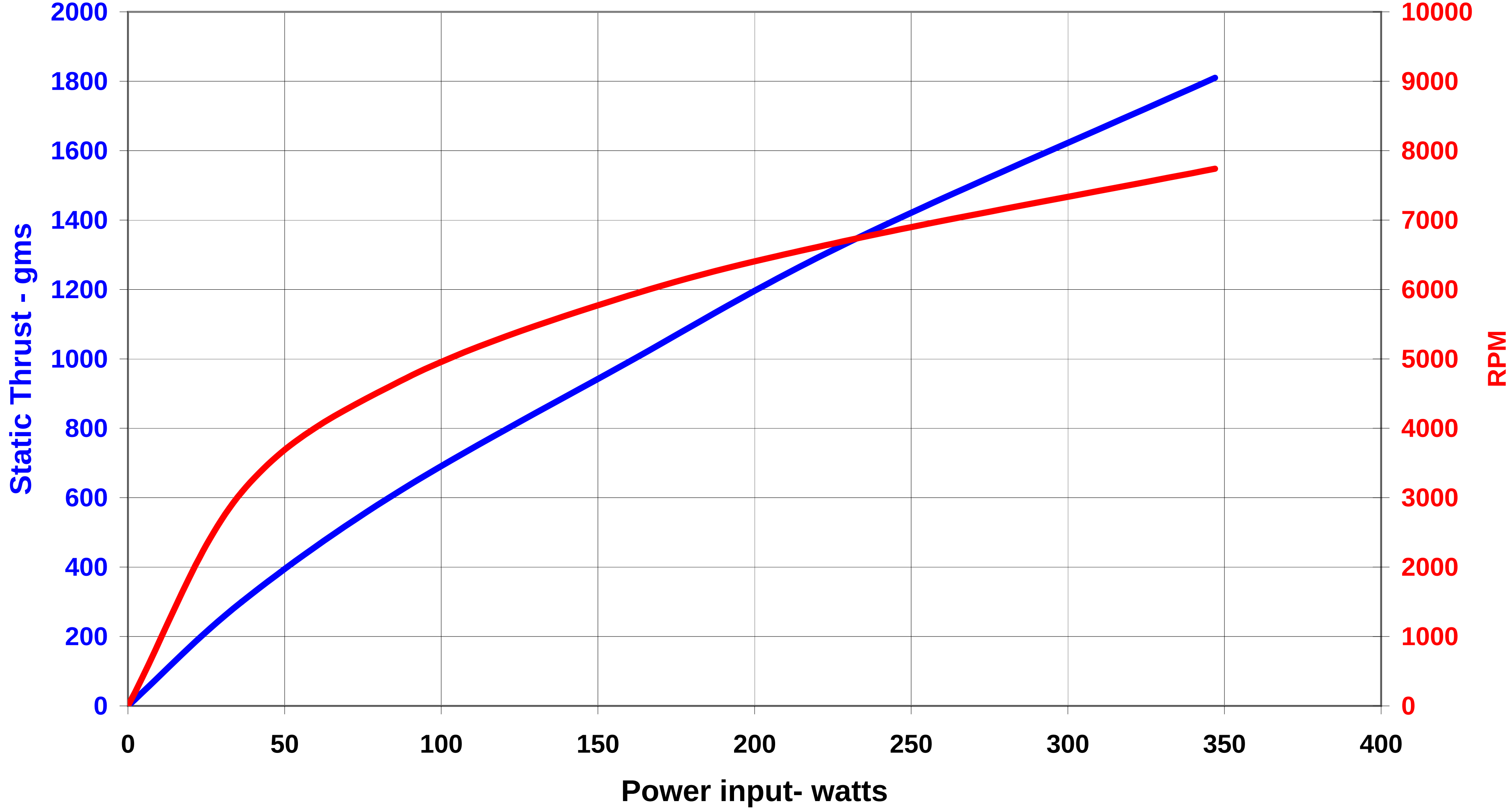
QEFI67-6 **The Tornado Thumper 5055 set up for reverse format operation.**

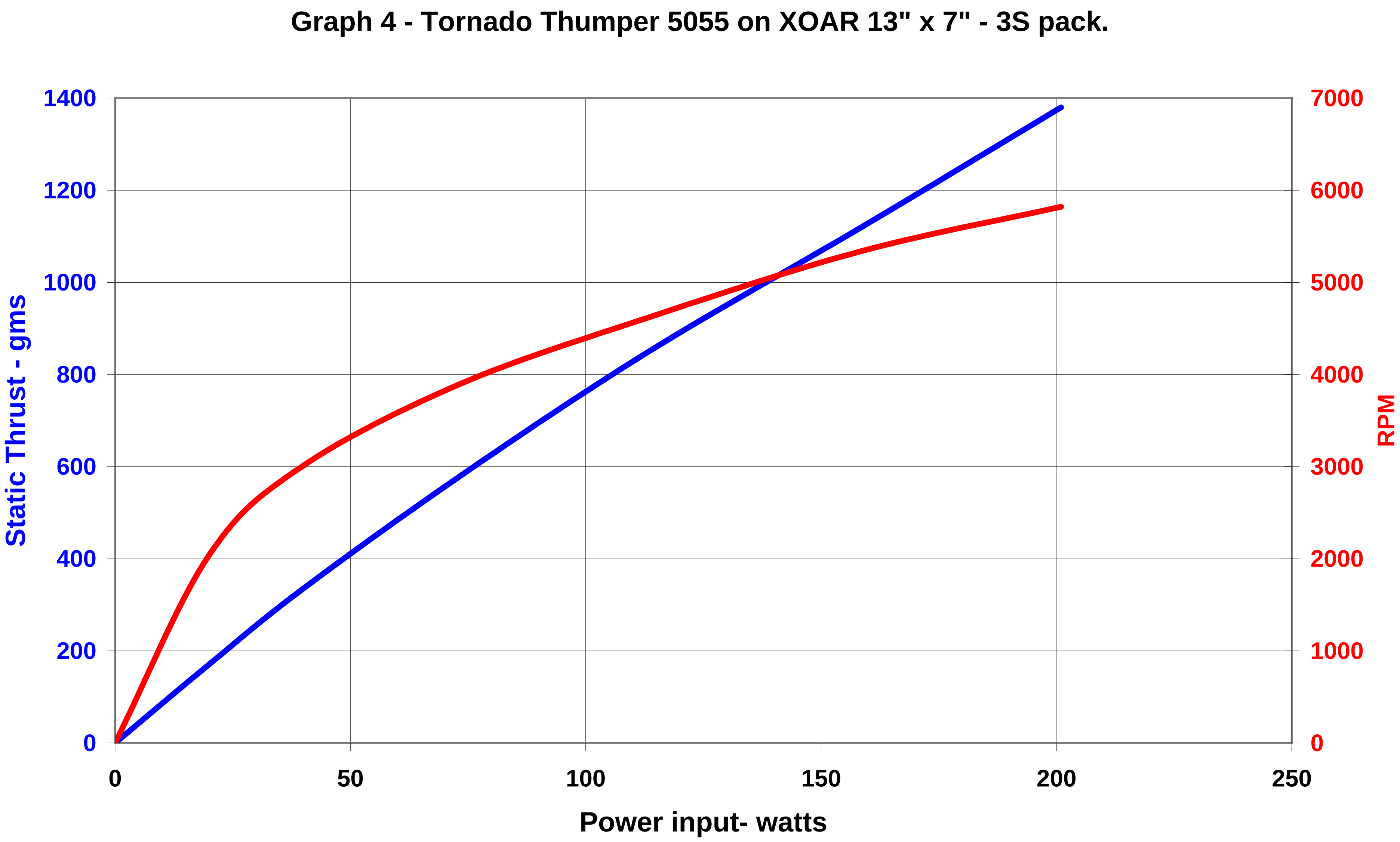
Graph 1 - Propeller Calibration - Electric Wood Propellers.

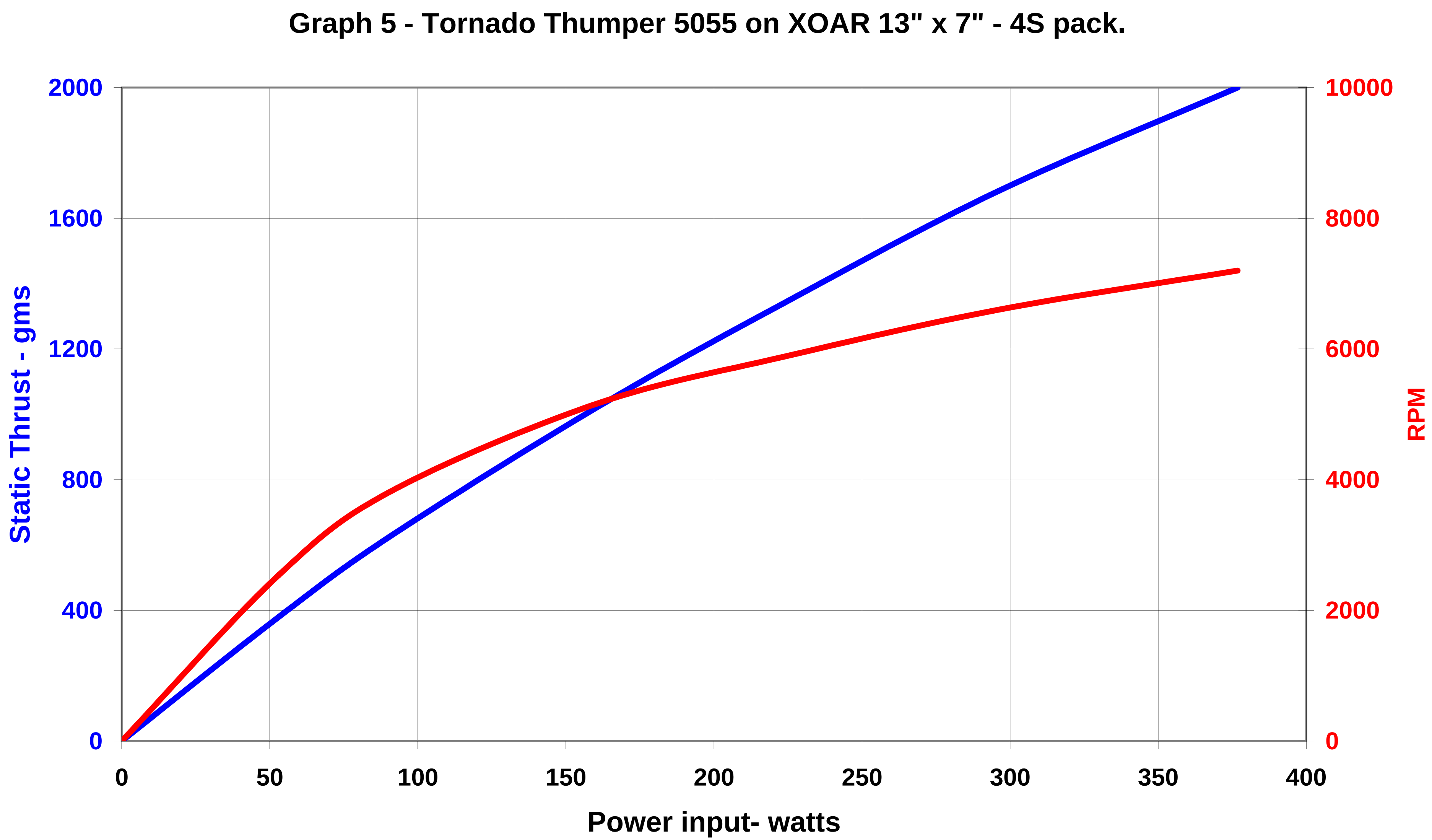



Graph 2 - Tornado Thumper 4250 on XOAR 12" x 7" - 3S pack.
Static Thrust - gms
0
200
400
600
800
1000
1200
1400
RPM
0
1000
2000
3000
4000
5000
6000
7000
0
20
40
60
80
100
120
140
160
180
Power input- watts

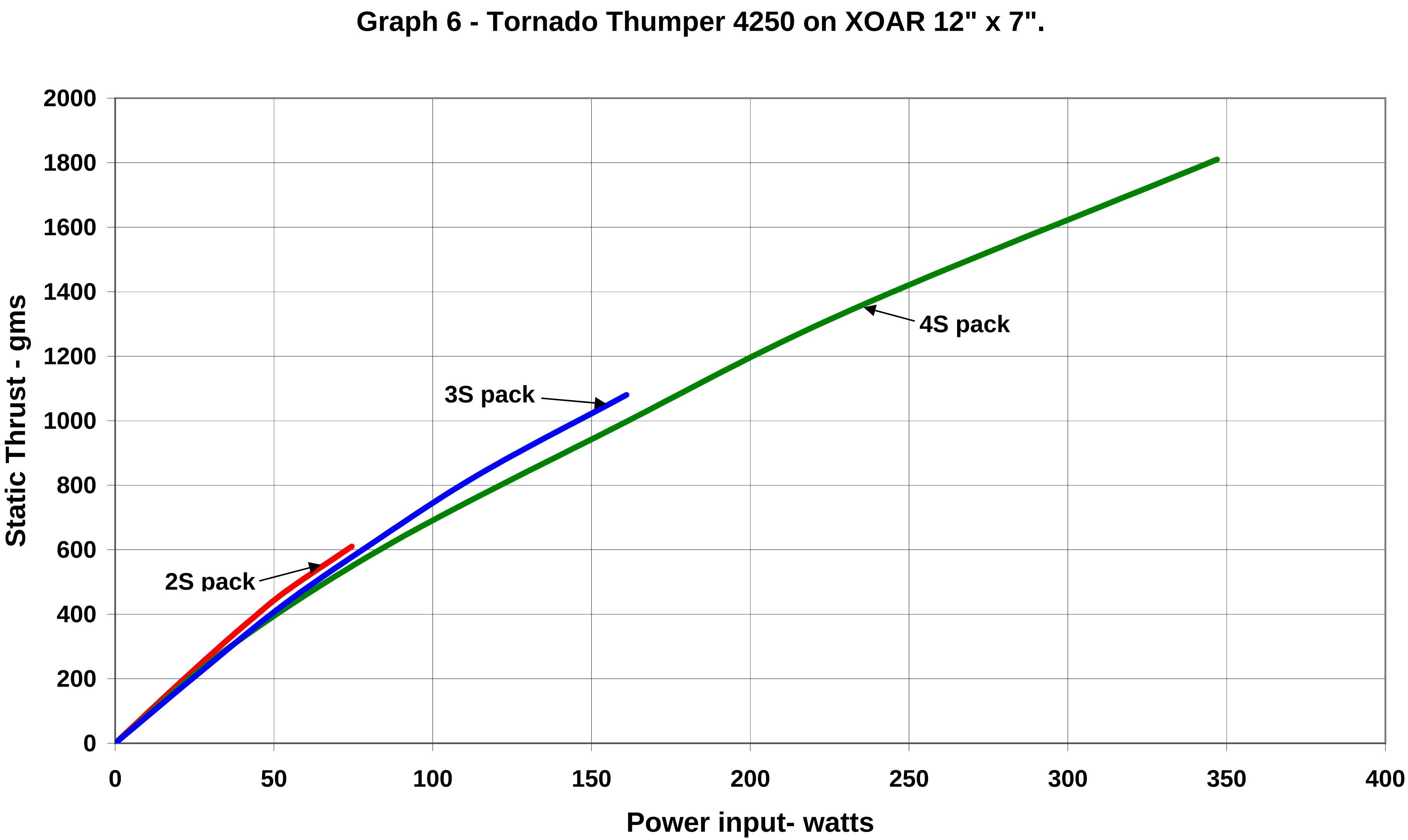
Graph 3 - Tornado Thumper 4250 on XOAR 12" x 7" - 4S pack.



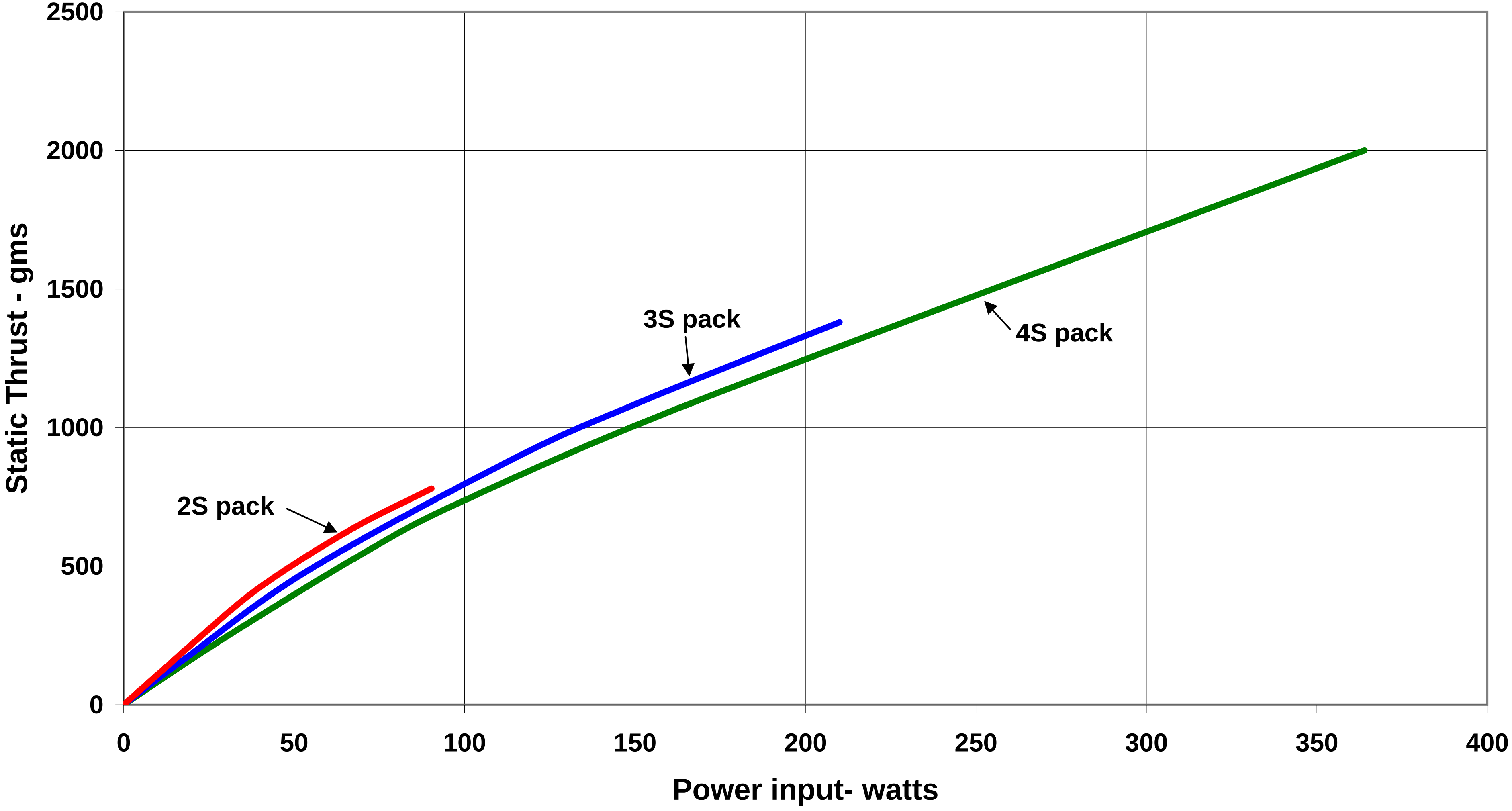

Graph 4 - Tornado Thumper 5055 on XOAR 13" x 7" - 3S pack.
Static Thrust - gms
RPM
Power input- watts
0
200
400
600
800
1000
1200
1400
0
1000
2000
3000
4000
5000
6000
7000
0
50
100
150
200
250



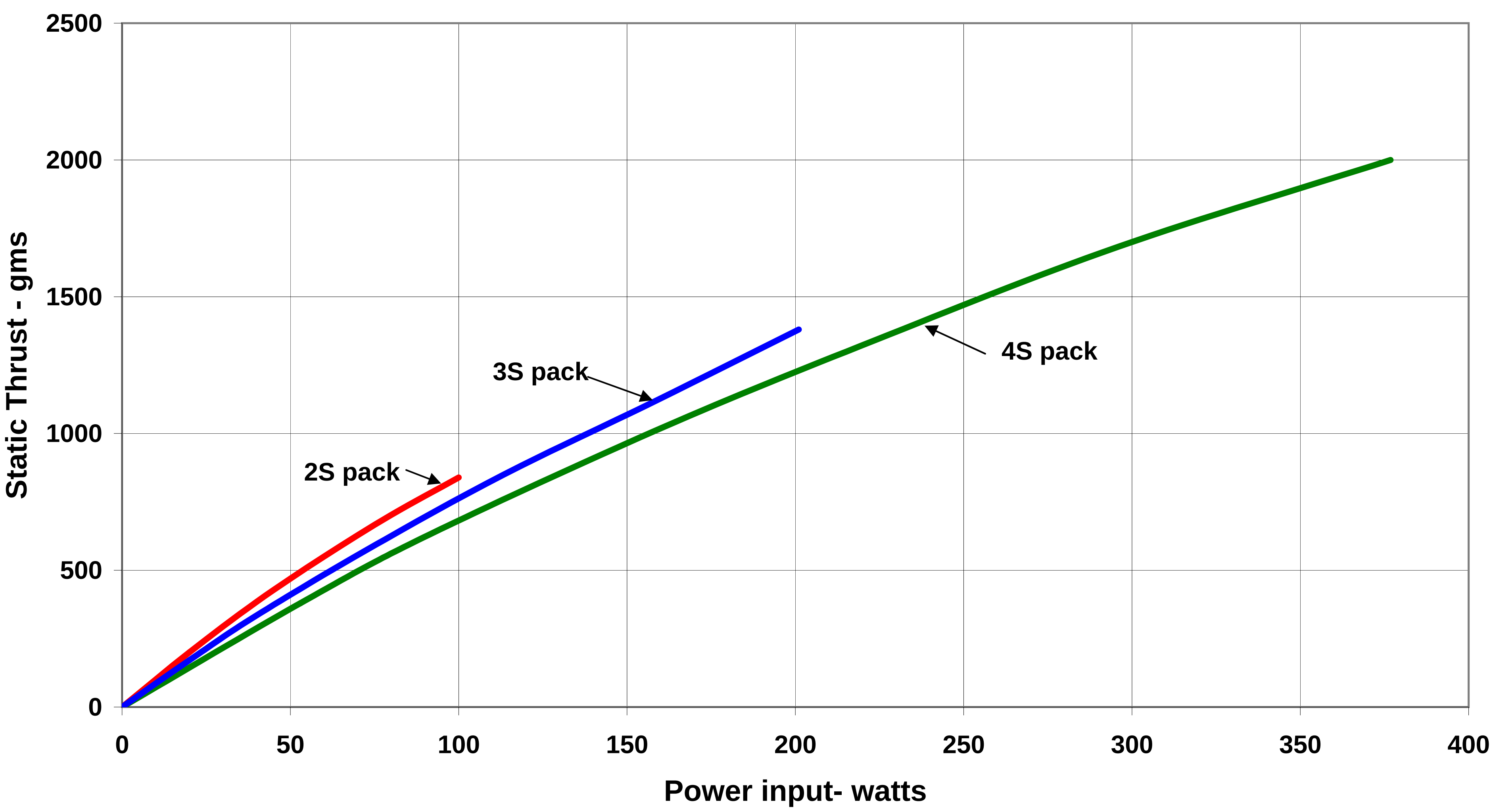
Graph 5 - Tornado Thumper 5055 on XOAR 13" x 7" - 4S pack.
Static Thrust - gms
0
400
800
1200
1600
2000
RPM
0
2000
4000
6000
8000
10000
0
50
100
150
200
250
300
350
400
Power input- watts

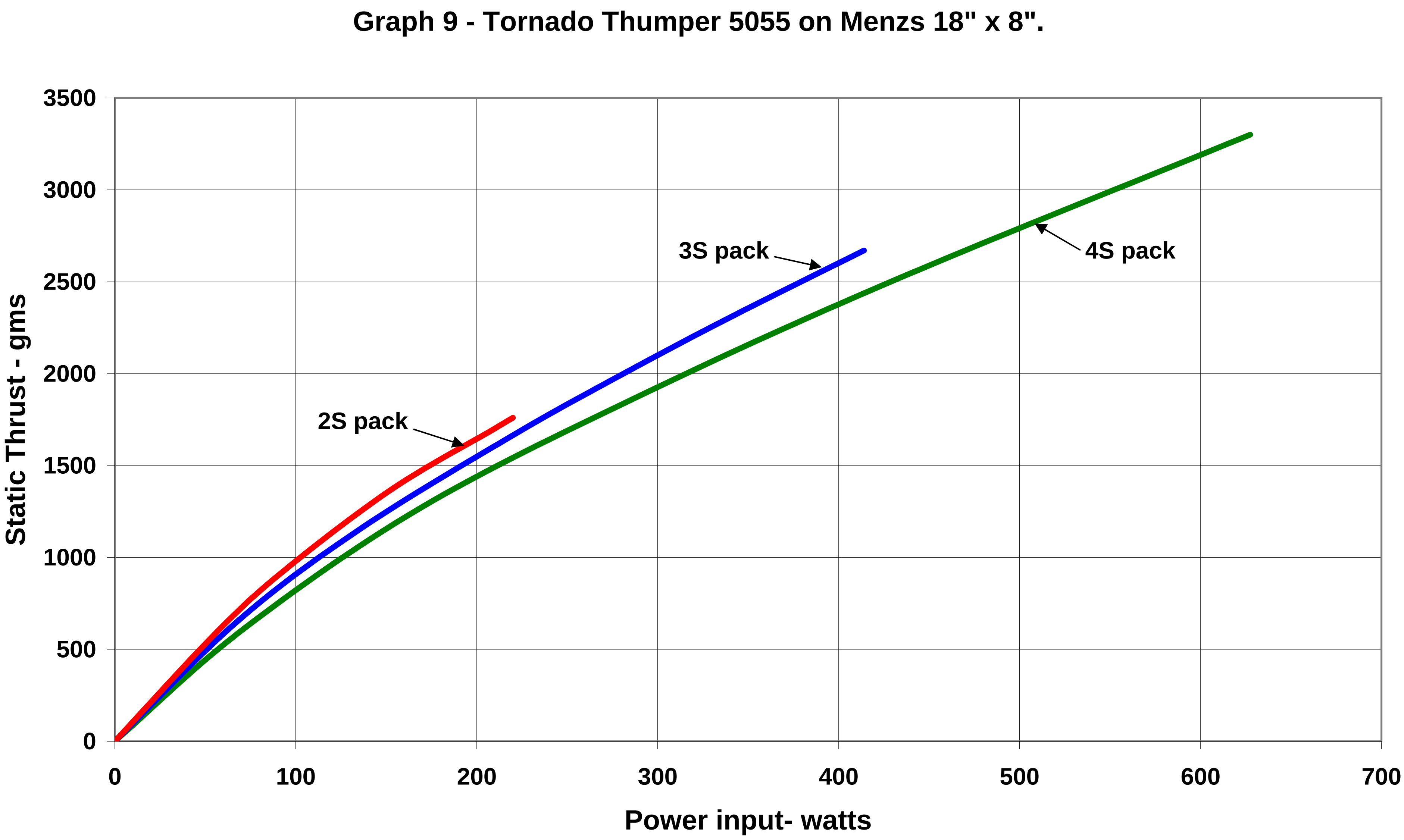

Graph 6 - Tornado Thumper 4250 on XOAR 12" x 7".
Static Thrust - gms
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
400
Power input- watts
2S pack
3S pack
4S pack

Graph 7 - Tornado Thumper 4250 on XOAR 13" x 7".



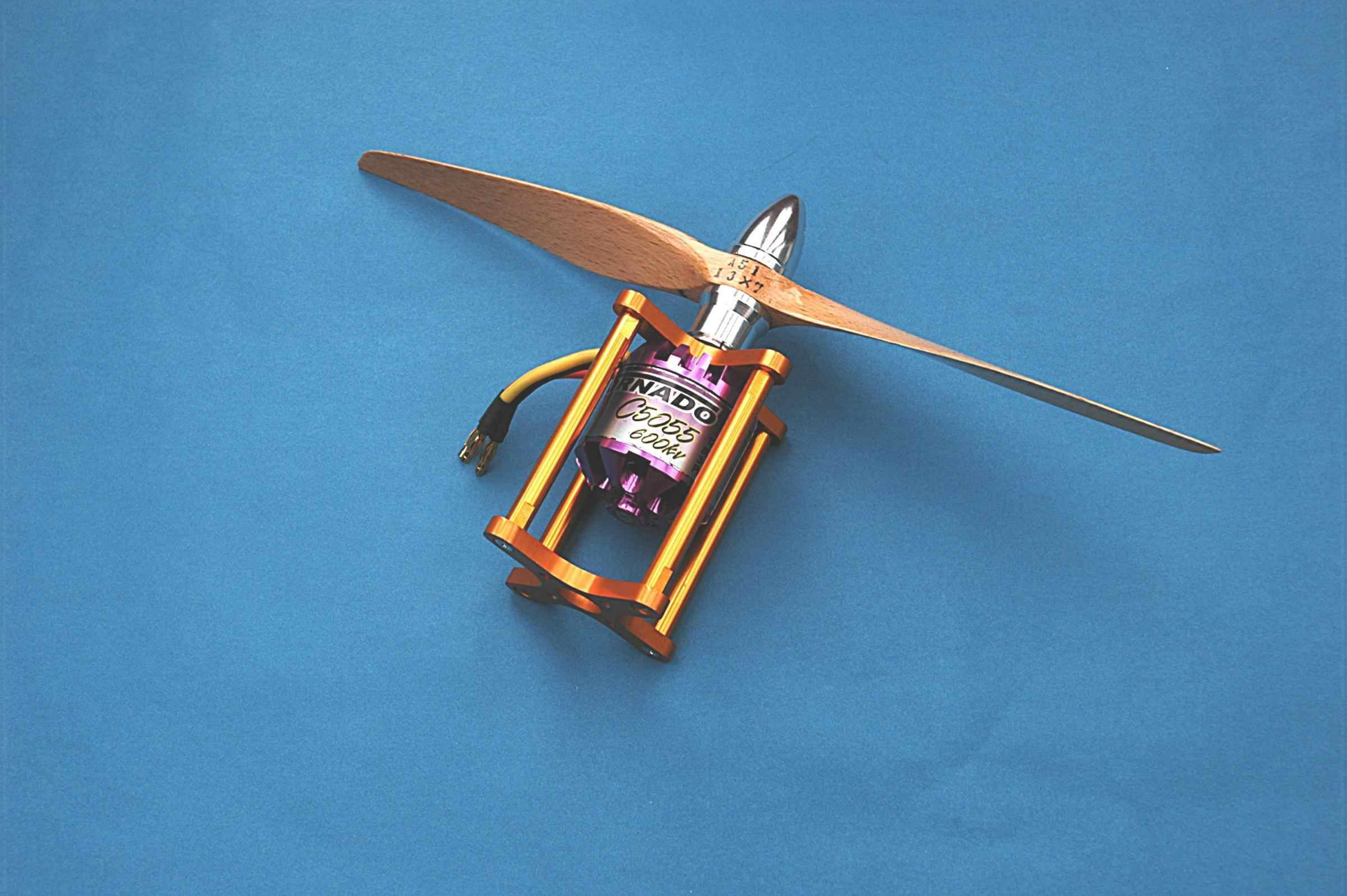
Graph 8 - Tornado Thumper 5055 on XOAR 13" x 7".



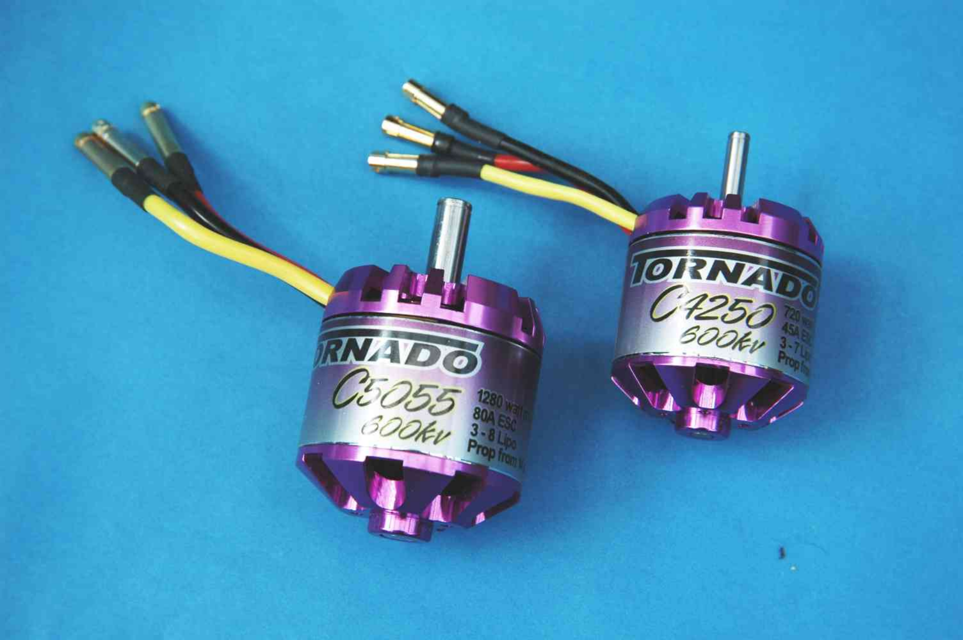


Graph 9 - Tornado Thumper 5055 on Menzs 18" x 8".
3500
3000
2500
2000
1500
1000
500
0
Static Thrust - gms
0
100
200
300
400
500
600
700
Power input- watts
2S pack
3S pack
4S pack

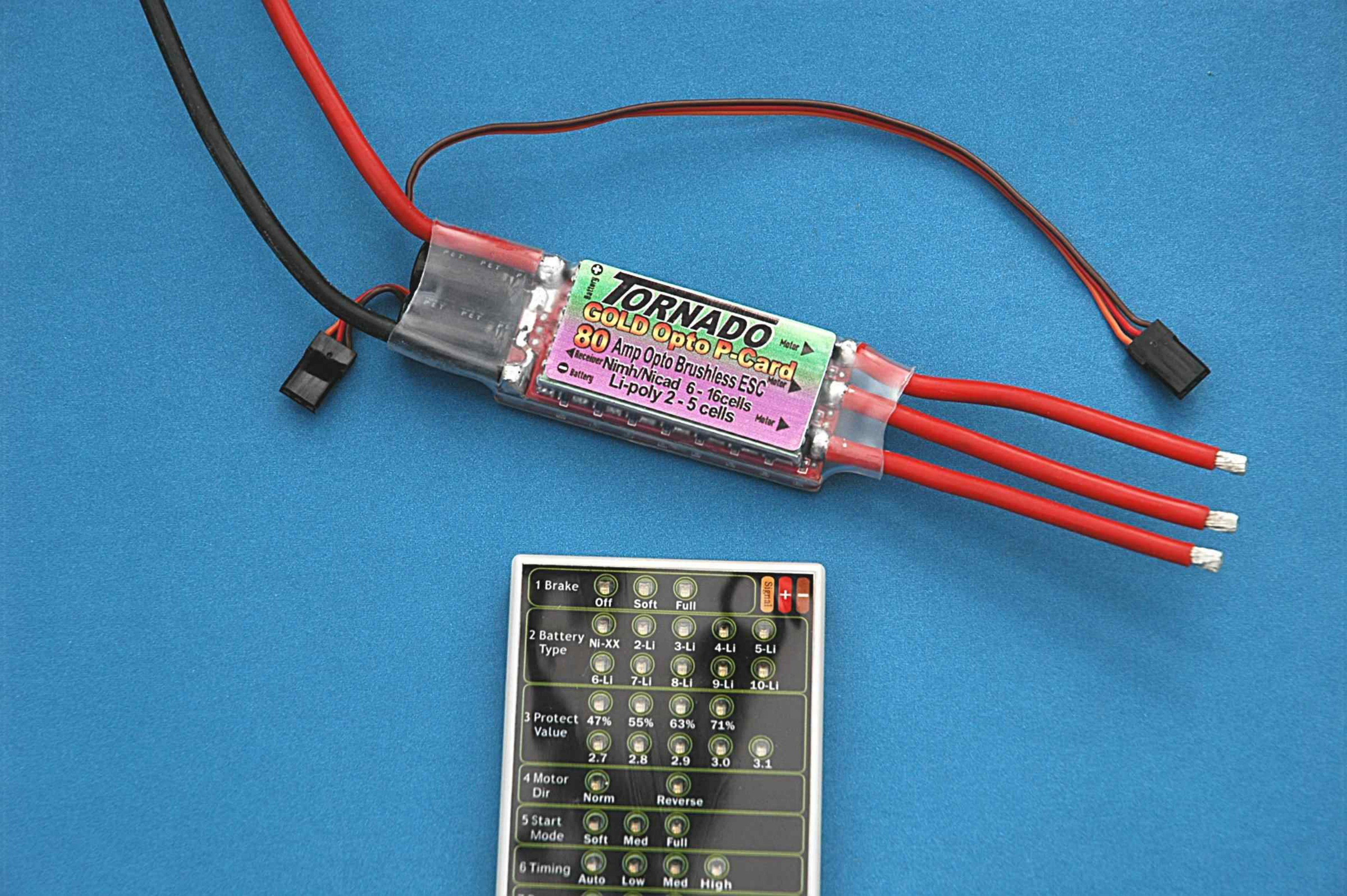

TORNADO
C5055
600kv


A51
13×7
RNADO
C5055
600kv


ONE PENNY
1


C5055
600kv
80A ESC
3 - 8 Lipo
TORNADO
C4250
600kv
45A ESC


VOX


TORNADO
GOLD Opto P-Card
80 Amp Opto Brushless ESC
Nimh/Nicad 6 - 16cells
Li-poly 2 - 5 cells
Battery
Receiver
Battery
Motor
Motor
Motor
1 Brake
Off
Soft
Full
Signal
2 Battery Type
Ni-XX
2-Li
3-Li
4-Li
5-Li
6-Li
7-Li
8-Li
9-Li
10-Li
3 Protect Value
47%
55%
63%
71%
2.7
2.8
2.9
3.0
3.1
4 Motor Dir
Norm
Reverse
5 Start Mode
Soft
Med
Full
6 Timing
Auto
Low
Med
High