The Hacker A20-6XL-10 pole with 4.4/1 gearbox.

I tested this motor last month and at the time made reference to the fact that it was an ideal motor for electric soaring competitions. Ideal or not, there are always flyers who want more performance, or in some cases more specific performance, and the Hacker company are willing to produce special motors wound to a customer's particular requirements. West London Models told me at the time that there were some special wind versions on the way and since I now have one of these to hand, felt that it would be a good idea to start by re-testing this version under exactly the same regime as I had used with the original.

The theory behind the request was that whilst the original motor was efficient, use in the standard form (with a Kv of 2500 rpm/volt) meant that the propeller diameter had to be restricted to fit the rules for the 200 watt/Kg competitions. Flyers in these comps have been using progressively larger models and larger matched propellers to achieve more efficient climbs, so a request was put in for a small number of motors wound to a Kv of 1500 rpm/volt and it is one of these that I have been testing. Looking at the photos (with the 2500Kv on the left and the 1500Kv on the right) you will see that the changes are not as simple as different winds. The theory behind brushless outrunner design is quite complex (and some of it is linked to patented features) but I could not begin to explain some of these variations. Some are superficial (such as the colour difference of the anodised cases and the cooling fan on only the original version), but others are clearly very technical. Both motors are the same size, the gearboxes are identical, and the armatures both have twelve coils. The coils look initially to be identical but closer examination showed the 1500Kv version to be of slightly finer wire and more turns. I do not know the winding pattern of either motor (star or delta). The biggest difference is in terms of the magnets. The photos show that the 2500Kv motor has 10 magnets whilst the 1500Kv unit has 14.

Even though I am not able to offer a technical explanation of the differences, I can take a more pragmatic approach and look at the differences in performance of the motors under identical scenarios. The original tests used both 3S and 4S LiPo batteries but the 4S format required the use of a smaller propeller to keep the current draw within acceptable limits. In view of the requirement for the ideal motor to turn the largest possible propellers, I only tested the new motor with the 3S battery, and the initial results allowed me to compare the motors on the 16" x 8" propeller as shown in Graph 1. You will see that the graphs for the two motors overlap very well with the 1500Kv producing around half of the thrust of the 2500Kv motor but at about half of the power input. In this situation the advantage of the 1500Kv motor becomes fairly clear in that the propeller size (both diameter and pitch in any ratio) can be increased so that the power input is lifted to the required level. Remember, however, that there is a limit to the diameter of folding propellers for any particular model beyond which the blades will foul the wings when folding. Large diameter folding propellers are not all that easy to find but I managed to get hold of a pair of 18.5" x 12" blades and repeated the test with these to give the curves in Graph 2.

Analysing the results.

You can look at the test data from several different points of view but since the origin of the tests were in terms of electric soaring competition, I decided to concentrate on this area. In general terms you would normally wish to extract the maximum power from whichever motor you chose (usually in terms of a maximum height climb in minimum time). The main limitation in this case is not to overload the motor but this possibility is usually diminished by short power-on periods. The basic A20 motor (without gearbox) is limited to 200 watts (for 15 seconds), but the geared version has an up-rated value of 400 watts (for 15 seconds) with one of Hacker's own examples showing 600 watts (for 15 seconds). In my initial tests of the 2500Kv motor the maximum input power at full throttle was 360 watts on 3S lipo, and 600 watts on 4S lipo.

These figures would be applicable to flights using very short power climbs (say around 10 seconds), but the other aspect of the original development was the 200 watt/Kg rules. In this competition the need to climb to maximum height is restricted by both the power-on limitation of 30 seconds at the start of the flight, and the 200 watts per Kg, such that the ideal flight is one where the input power to the motor is close to (but not exceeding) the model weight in grams multiplied by 0.2, and that this power gives the model a rate of climb sufficient to reach a height within the limit of the pilot's visibility in just under 30 seconds.

Bigger models are easier to see at height, increased model weight allows greater power (though only up to a maximum of 2 Kg and 400 watts), and bigger models require bigger (more effective) propellers. All of these factors lead the flyer towards a model with a wingspan exceeding 2.5 meters and a flying weight of 1.0 to 1.5 Kg and the Hacker 1500Kv fits these requirements very well. With the 16" x 8" propeller the full throttle power is 180 watts so it is ideal for a 1.0 Kg model (say 2.3 m span) and this would give a 1:1 thrust/weight ratio. Remember, however, that this is with the 2250 mAh pack. Using a larger pack would give higher voltages and hence higher currents but the increased weight might easily lift the allowable wattage to cover this change. With the 18.5" x 12" propeller the increased load has lifted the input power to over 300 watts so that this would match a 1.5 Kg model. The static thrust reading is, however, no better that with the smaller prop, and this is the unfortunate result of the increased pitch. As propeller pitch is increased in a static test so the blade stalling effect increases which actually reduces the efficiency. When the propeller is in flight this effect is much reduced which means that the thrust in flight is higher than in the static test. There is therefore no substitute for flight testing and particularly so when propeller pitch is involved. Quite a complex area but mainly of interest to the competition flyer.

Logic RC.

This is a new importer based in Hertford and although they are very much in the process of establishing their product range, they do have some interesting items. I was sent a charger and a battery capacity checker to review and they turned out to be effective and well-presented units. Both are produced under the "Fusion" product label, the charger/discharger is the Paladin L120 Pro and the checker is the Smart Guard.

The Paladin L120 Pro charger.

The L120 is a universal programmable charger/discharger/cycler. You will see from the photographs that the unit has a modern style with a grey plastic case, double cooling fan, two-line LCD screen, and a four button programming facility. It can be used in stand-alone form, especially if nickel cell packs are being used, but it is supplied with a matching 12S balancer which interfaces between the charger and the pack when dealing with lithiums. This unit is the top unit in a range of 6 chargers by Fusion, and it has a powerful specification.

Features

Automatic settings for Charging/discharging NiCd/NiMH.
10 user definable memories to store individual pack Parameters e.g. type, cell count, capacity, charge and Discharge currents.
Pack Cycling (charge to discharge and reverse), 1 to 5 Repeats with 1 to 30 minutes delay.
2 line 16-character blue-backlit LCD display screen.
Warning messages for incorrect input voltage, Reversed connections, (input and output), and Battery condition.
Initial charge stage includes automatic battery Condition checking.
Pack temperature probe and limiting settings.

Specification

Input voltage	10 – 15 V DC
Pack Sizes	1 – 12 LiPo, LiIo, LiFe. 1 – 30 NiCd, NiMH. 1 – 6 Lead Acid.
Battery capacities	100 to 20,000 mAh (adjustable for Lithium).
Charge rate	0.1 to 10.0 amps (100 mA steps to 180 W max)
Discharge rate	0.1 to 10.0 amps (100 mA steps to 80 W max)
Trickle charge	0 to 500 mA including balancing with 12S Fusion Balancer.
Charge Termination	Delta peak – Nickel packs Const.current / const.volts - Lithium packs.

This unit is supplied with a very complete set of accessories. In addition to the balancer already mentioned, the box contains crocodile clips for use on a 12 volt battery supply, two sets of balancing adapters (including cables and boards to suit the commonest balance leads), an interface cable (balancer to charger), and a particularly neat thermal probe. The balancer is able to operate in both the interfaced and the stand-alone modes and can be switched between LiPo and LiFe battery types. Both the charger and the balancer are supplied with detailed and well-written instructions.

Using the combined charger balancer is relatively straightforward. The instructions include a series of flow charts which guide the user through the set-up process using the four buttons on the front of the charger with the scroll up and down controls taking you to the features you require. It takes awhile to begin to remember where the features you need are positioned in the various fields but the scrolling is continuous so even if you set off in the wrong direction you will still eventually arrive at the input you need. The balancing interface allows the voltages of individual Lipo cells to be checked as the charge progresses and this is a help in keeping a check on the health of your packs. Although the current model does not have it, I am told that future models will also have a computer interface and the appropriate software.

There are so many chargers on the market now that it has become difficult to compare like with like, and of course everyone has their own preferences, but this unit seems to be one which will do what the majority of flyers need a charger to do, and to do it both effectively and efficiently. It is powerful enough to handle large packs and sensitive enough to produce accurate data. I feel sure it will become popular with all electric flyers.

The Fusion Smart Guard digital battery checker.

This little unit is an ideal addition to any electric flyer's flight box. Although described as a capacity checker it actually works as a voltmeter but since the voltage and the remaining capacity of any battery are related it is still an indicator of the condition of any pack. There are several units on the market which display voltage as a series of LEDs, but this is much more accurate in that the values are digitally displayed up to 3 decimal places on the LCD screen. It is powered by the battery being checked and has 3 buttons on the front of the case which allow the unit to select the battery type (NiCd/MH, LiPo, LiIo, and LiFe), the cell count (for lithiums), and the mode (also for lithiums). The LCD display is larger than usual and very clear and the connectors to the packs are all 2.5 mm spacing male pins. It will operate on from 4 to 7 cells in NiCd/MH and from 2 to 7 cells with lithium but here there will be a need for an adaptor with some battery balancing connectors.

When the unit is being used on a NiCd/MH pack it will only measure the total pack voltage (since these packs do not have the balancing leads familiar with lithiums) but it still provides a useful guide as to the pack condition. The display includes an analogue bar chart of capacity remaining as well as a percentage value and since this is based on the total voltage the cell count needs to be manually entered to allow a realistic estimate.

It is when the unit is used with a lithium pack that its full facilities become available. The initial display after connection shows the assumed battery type of LiPo which needs correcting if the pack is different, the total pack voltage, the estimated cell count (based upon the cell voltages involved), and the capacity bar chart with percentage. Pressing the cell button checks the voltage of individual cells and further presses move you through the cells in numerical order. The capacity chart and percentage then applies to the cell rather than the whole pack, and the display also indicates the cell with the highest voltage and that with the lowest. The mode button then switches the reading in

volts between the pack total, the difference between the highest and lowest cell, and the actual highest and lowest cell values.

This unit does not look anything special at first sight but I think it will prove to be very useful. Anyone in electric flight needs to be able to find out the condition of their batteries (how many flyers of all types have changed a receiver battery for what they thought was a fully charged one, only to discover too late that it was actually virtually discharged). This kind of information is even more critical with lithium flight batteries, and when you add in the need to know exactly how the individual cells are performing, it begins to look like an essential tool. Easy to use and versatile, it must be going to appear on a few Christmas lists.

Contacts.

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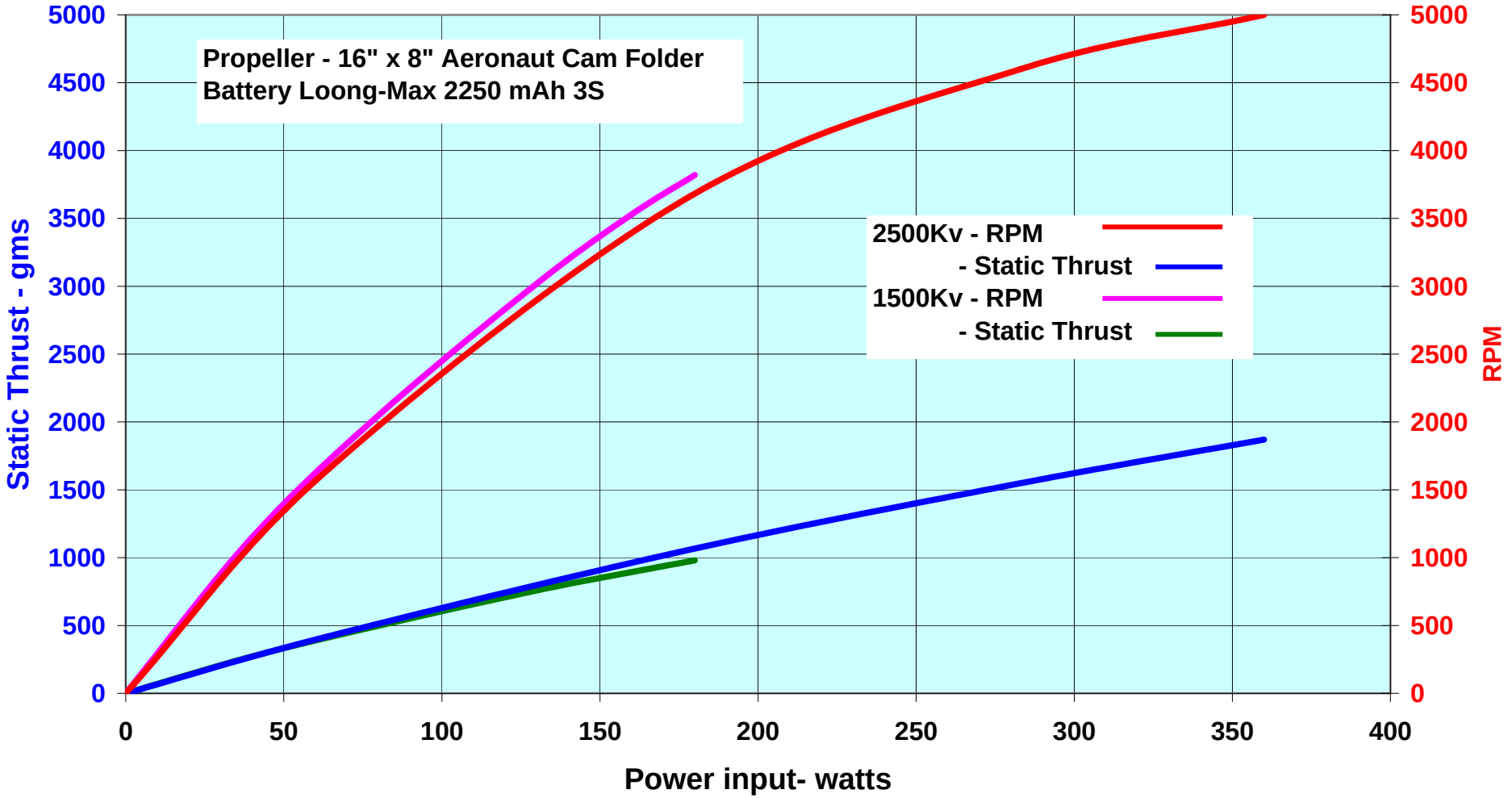
Email **mail@LogicRC.com** Website **www.\logicRC.com**

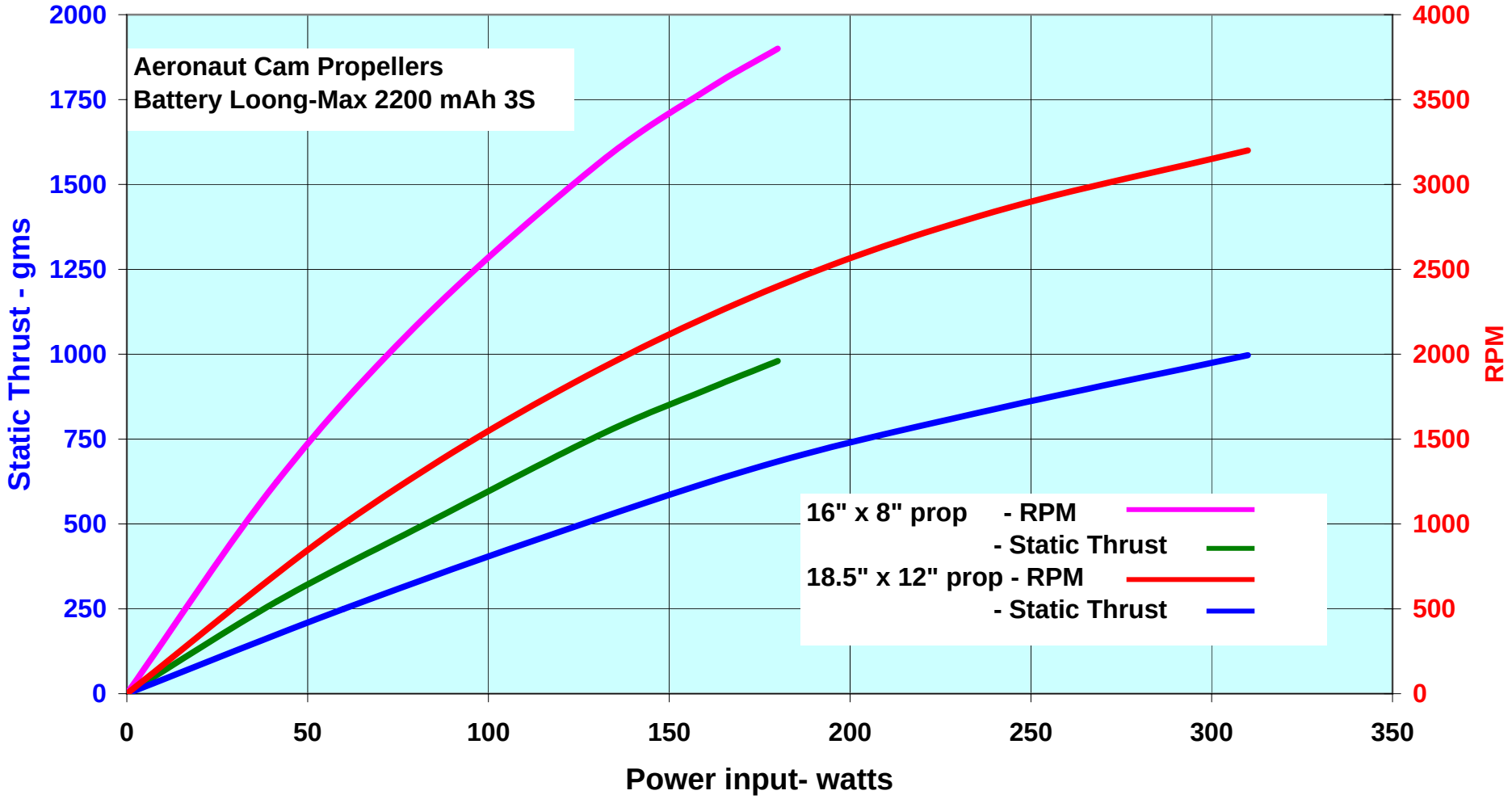
Photographs.

QEFI80-1	**The two Hacker motors, original 2500Kv on the left and new 1500Kv on the right.**
QEFI80-2	**The motors with their cases removed to show the armatures.**
QEFI80-3	**The two cases positioned to show the magnets.**
QEFI80-4	**The two cases showing slight colour variation.**
QEFI80-5	**End view of the armatures showing the winds.**
QEFI80-6	**The Fusion Paladin Li20 charger and accessories.**
QEFI80-7	**The L120 set up for a simple LiPo charge.**
QEFI80-8	**The L120 set up for a balanced charge.**
QEFI80-9	**The Fusion 12S balancer supplied with the L120.**
QEFI80-10	**The L120 screen with typical set-up data.**
QEFI80-11	**The Fusion Smart Guard Digital Battery Checker.**
QEFI80-12	**The checker connected to a 4 cell NiMH pack.**
QEFI80-13	**The checker connected to a 3S LiPo pack.**
QEFI80-14	**Total Voltage reading for the 3S LiPo.**
QEFI80-15	**An individual cell voltage (cell 3) for the 3S LiPo pack.**
QEFI80-16	**The maximum cell voltage difference for the 3S LiPo pack.**

Graph1 - Hacker A20 motors with 4.4 to 1 gears on 3S battery



Graph2 - Hacker A20 1500Kv motor with 4.4 to 1 gears on 3S battery




maxon gear
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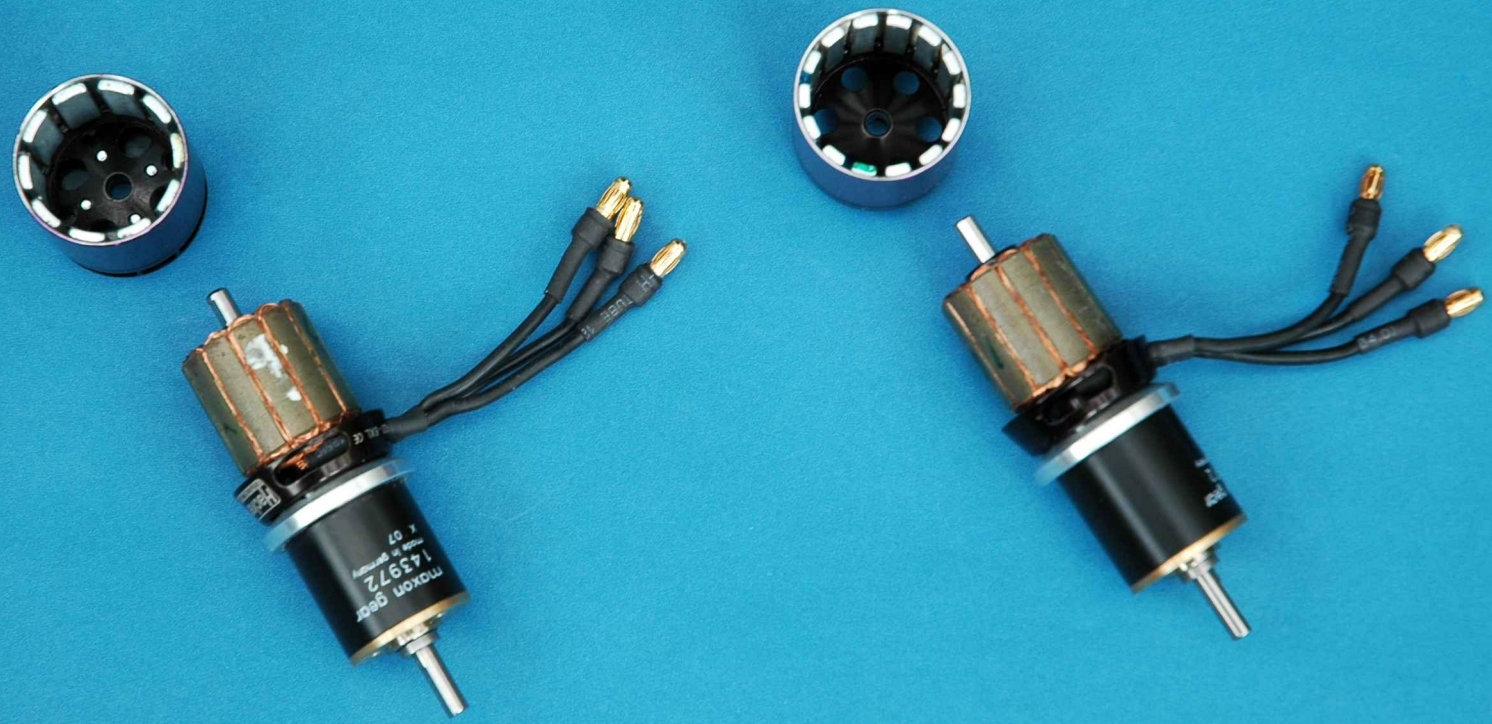
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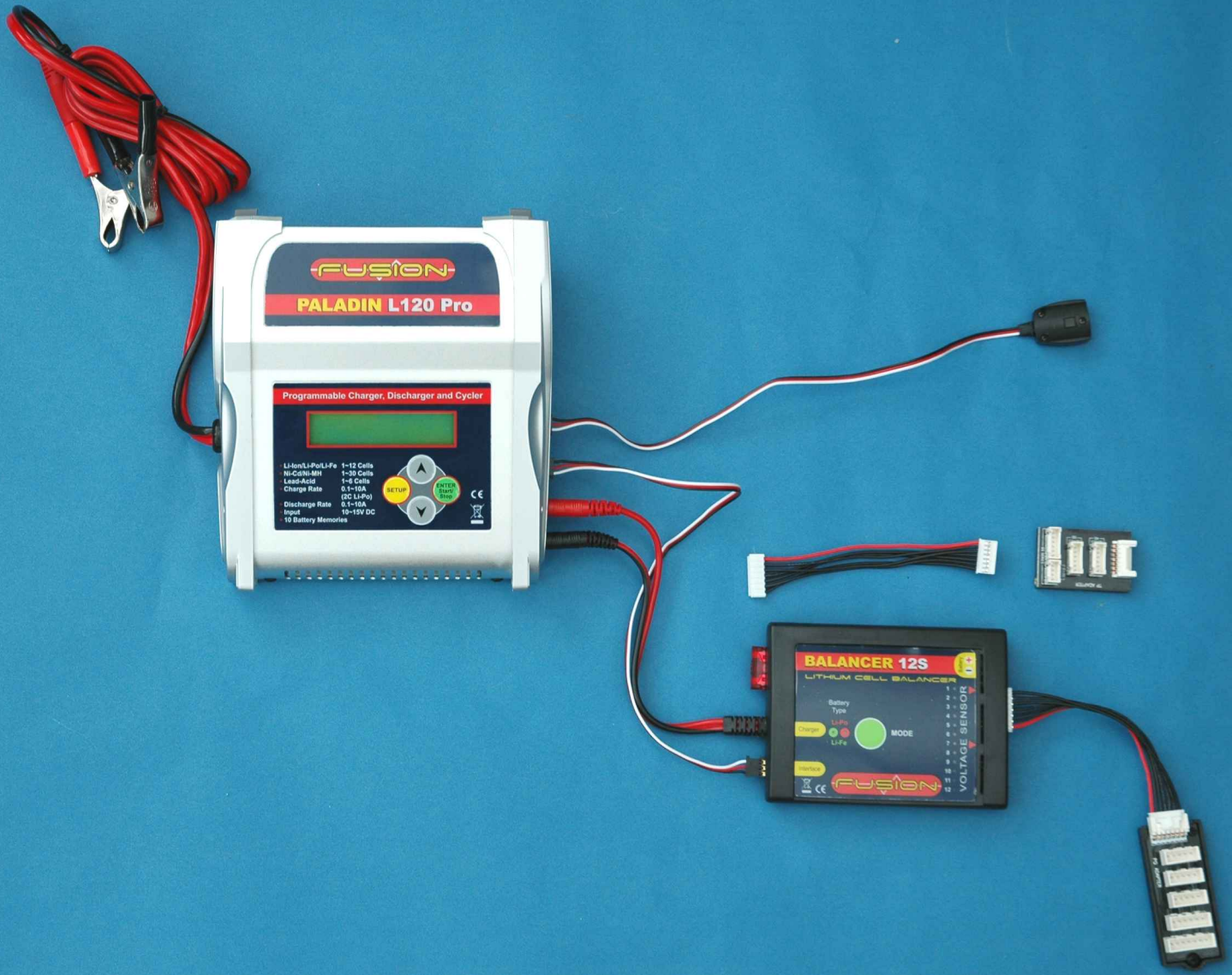
FUSION
PALADIN L120 Pro
Programmable Charger, Discharger and Cycler
Li-Ion/Li-Po/Li-Fe 1~12 Cells
Ni-Cd/Ni-MH 1~30 Cells
Lead-Acid 1~6 Cells
Charge Rate 0.1~10A (2C Li-Po)
Discharge Rate 0.1~10A
Input 10~15V DC
10 Battery Memories
SETUP
ENTER Start/ Stop
BALANCER 12S
LITHUM CELL BALANCER
Battery Type
Charger
Li-Po
Li-Fe
MODE
Interface
FUSION
VOLTAGE SENSOR


FUSION
PALADIN L120 Pro
Programmable Charger, Discharger and Cycler
LiPo 0:45 31%
N/A 2.10A 11.81V
Li-Ion/Li-Po/Li-Fe 1~12 Cells
Ni-Cd/Ni-MH 1~30 Cells
Lead-Acid 1~6 Cells
Charge Rate 0.1~10A
(2C Li-Po)
Discharge Rate 0.1~10A
Input 10~15V DC
10 Battery Memories
SETUP
ENTER
Start/
Stop
Graupner
LiPo 2100
11,1 V
2,1 Ah


FUSION
PALADIN L120 Pro
Programmable Charger, Discharger and Cycler
CHG 0:58 29
N/A 0.00A 11.66V
Li-Ion/Li-Po/Li-Fe 1~12 Cells
Ni-Cd/Ni-MH 1~30 Cells
Lead-Acid 1~6 Cells
Charge Rate 0.1~10A (2C Li-Po)
Discharge Rate 0.1~10A
Input 10~15V DC
10 Battery Memories
SETUP
ENTER Start/ Stop
BALANCER 12S
LITHIUM CELL BALANCER
Battery Type
Li-Po
Li-Fe
Charge
MODE
Interface
FUSION
VOLTAGE SENSOR
TORNADO 2200
PROFESSIONAL 11.1V 3S1P
25C


BALANCER 12S
LITHIUM CELL BALANCER
Battery
Battery Type
Li-Po
Li-Fe
Charger
MODE
Interface
FUSION
VOLTAGE SENSOR
1
2
3
4
5
6
7
8
9
10
11
12
TORNADO
PROFESSIONAL
11.1 V
25C


PALADIN L120 Pro
Programmable Charger, Discharger and Cycler
LiPo 1:45 41%
N/A 2.11A 11.93V
• Li-Ion/Li-Po/Li-Fe 1~12 Cells
• Ni-Cd/Ni-MH 1~30 Cells
• Lead-Acid 1~6 Cells
• Charge Rate 0.1~10A (2C Li-Po)
• Discharge Rate 0.1~10A
• Input 10~15V DC
• 10 Battery Memories
SETUP
ENTER Start/ Stop
CE


FUSION
Li-Po • Li-Fe • Li-ion • NiCd • NiMH
SMART GUARD
Digital Battery Capacity Checker
TYPE
CELL
MODE
NiCd
NiMH
Lithium
7 6 5 4 3 2 1
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FUSION
Li-Po • Li-Fe • Li-Ion • NiCd • NiMH
SMART GUARD
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8%
Digital Battery Capacity Checker
TYPE
CELL
MODE
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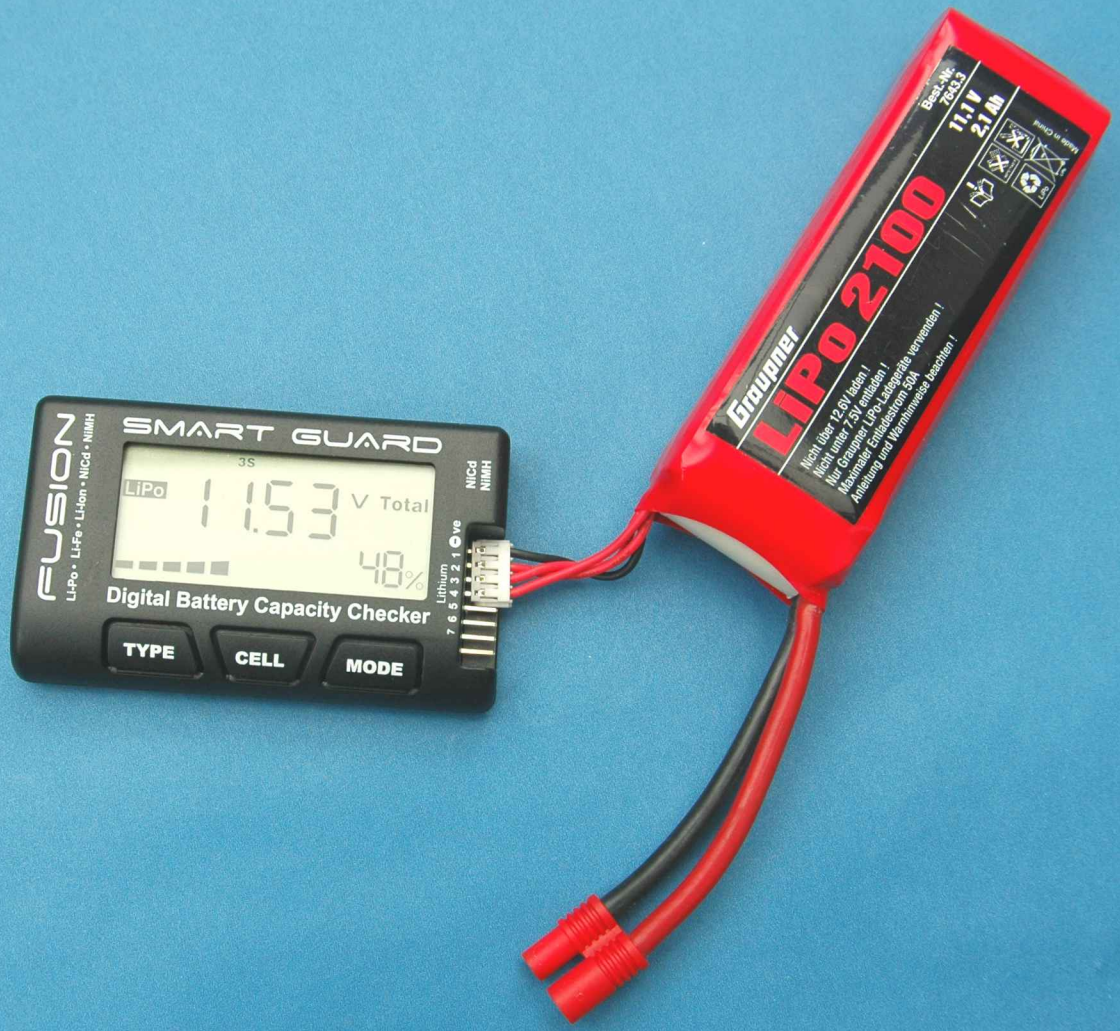
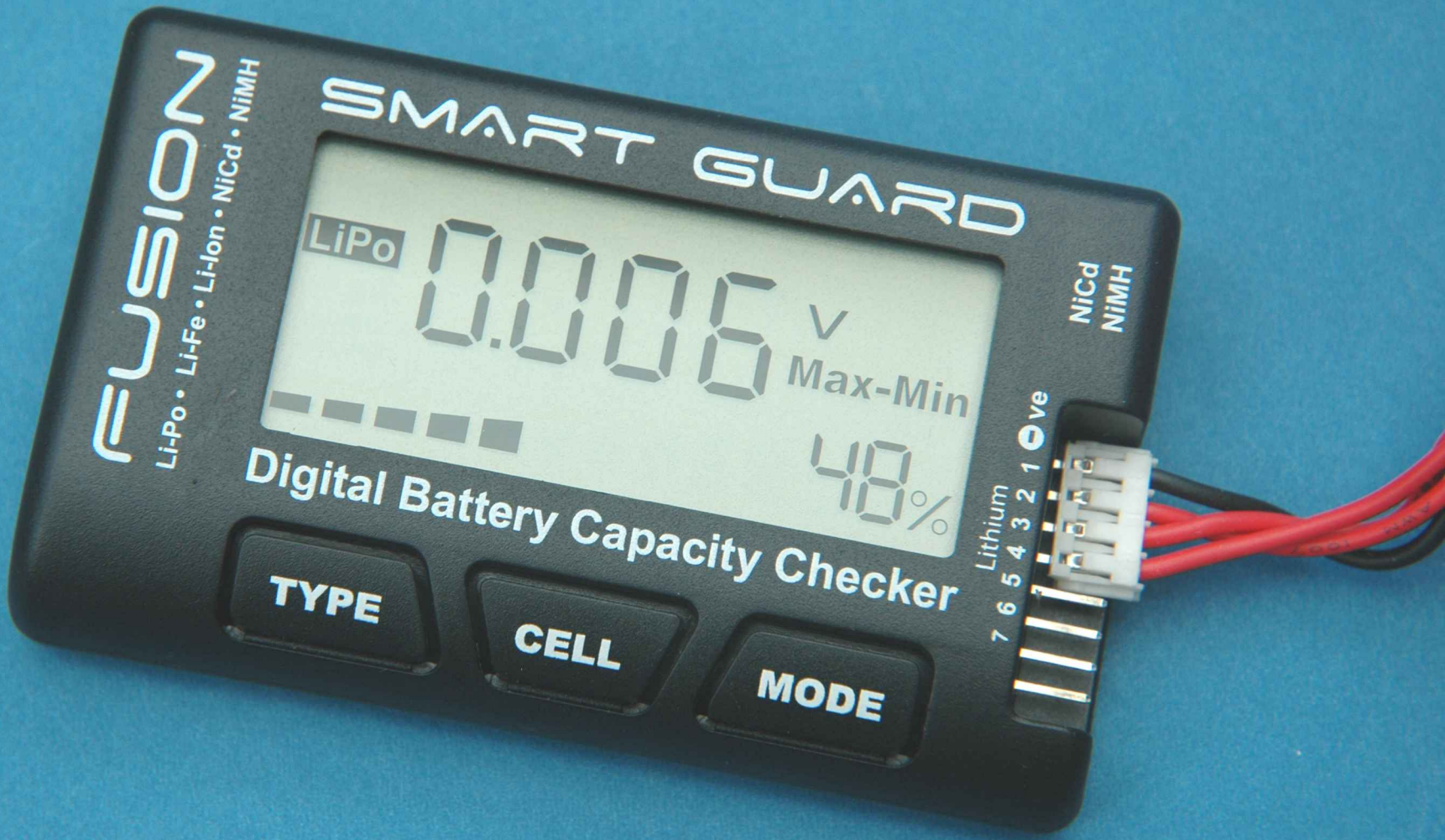
7 6 5 4 3 2 1 ve
NiCd
NiMH


FUSION
Li-Po • Li-Fe • Li-Ion • NiCd • NiMH
SMART GUARD
3S
LiPo
11.53 V Total
48%
Digital Battery Capacity Checker
TYPE
CELL
MODE
NiCd
NiMH
Lithium
7 6 5 4 3 2 1 ve
Graupner
LiPo 2100
11.1 V
2.1 Ah
Best.-Nr.
7043.3
Nicht über 12,6V laden !
Nicht unter 7,5V entladen !
Nur Graupner LiPo-Ladegeräte verwenden !
Maximale Entladestrom 30A
Anleitung und Warnhinweise beachten !


FUSION
Li-Po • Li-Fe • Li-Ion • NiCd • NiMH
SMART GUARD
LiPo
11.53
V Total
48%
NiCd
NiMH
Lithium
7 6 5 4 3 2 1 ve
Digital Battery Capacity Checker
TYPE
CELL
MODE


FUSION
Li-Po • Li-Fe • Li-Ion • NiCd • NiMH
SMART GUARD
3S
LiPo
3.842 V
47%
NiCd
NiMH
Lithium
7 6 5 4 3 2 1 ve
Digital Battery Capacity Checker
TYPE
CELL
MODE


FUSION
Li-Po • Li-Fe • Li-Ion • NiCd • NiMH
SMART GUARD
LiPo
0.006
V
Max-Min
48%
Digital Battery Capacity Checker
TYPE
CELL
MODE
NiCd
NiMH
Lithium
7 6 5 4 3 2 1
ve