RC Driver TESTS:

The Scorpion 2s Charger and new Li-Poly Car Packs

REVOLUTION!

Scorpion Li-Poly car packs BEAT matched NiMH race packs

by Tom Atwood,
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Li-Poly Terms

2S Pack: a Li-Poly pack consisting of two 3.7V cells wired in series.

2S2P Pack: a Li-Poly pack consisting of two 2S packs wired in parallel; capacity doubles to 6400mAh and voltage remains at 7.4V. Runtime is doubled.

C RATE: How much current a Li-Poly battery can provide under load is described as a multiple of its capacity. A Kokam 7.4V 3200mAh battery contains 3.2 Amp-hours of useable current. The capacity of the pack is described by the letter "C". A 1C discharge rate means that the battery is being discharged at 3200mA—a rate that would deplete the pack in one hour. A "10C" discharge rate would represent a steady 32-amp current drain—which would deplete the pack in something under six minutes (any battery chemistry delivers something less than its rated capacity as higher currents are applied; Li-Poly cells perform better than nickel cells in this respect). The new Kokam cells in the Scorpion packs are rated at a "20C" continuous discharge rate—that's 64 amps, continuous! They can withstand a "burst" of current of up to 40C, or 128 amps.

Li-Poly Battery: Lithium Polymer batteries are alternately referred to as Li-poly and Lipo packs.

In our last issue we announced the exciting new Scorpion Lithium Polymer (Li-Poly) RC car and truck batteries from FMA Direct as well as FMA's new Scorpion 2s Li-Poly cell-balancing charger. In that announcement we referred to the new packs as "Kokam" packs. FMA has decided to call these new car and truck packs "Scorpion" packs, but it is nonetheless important to note that they contain the latest generation Kokam Li-Poly cells.

Since that announcement, we have extensively tested the Scorpion 2s charger and the Scorpion 7.4V 3200mAh Li-Poly packs, and the results are awesome. When these "beta version" preproduction products were provided to us they were still being tweaked and improved for production. This is truly a revolution in RC electric power—we'll tell you why!

The new 7.4V Scorpion packs weigh 7.5 ounces or 5.5 ounces less than a typical 3000mAh NiMH sport pack. That's a third of a pound less battery weight in a typical backyard-bashing buggy. All things being equal, you've got a lighter, more agile car.

The cool thing about Li-Poly batteries is their nominal voltage is slightly higher than that of NiCd or NiMH cells, and their internal resistance is significantly lower so that you experience greater punch when you hit the throttle. A rigorous 35A discharge test on a Competition Electronics Turbo 35 GFX charger-discharger backed up what we found on the asphalt (see chart): the new Scorpion 3200mAh car pack outperforms a $100 matched NiMH racing pack. Before we get into the details of performance, let's look at how these batteries are different from Nickel-based cells—and at the unique capabilities of the new charger.

ABOUT LI-POLY BATTERIES

Li-Poly cells became a mature battery technology in the computer and cell phone worlds in the '90s, and over the last few years have emerged as the new standard for powering many categories of RC electric airplanes. These batteries are typically made up of thin, flat plates embedded within an electrolytic gel that is wrapped in an aluminized, mylar-like plastic covering material. There are no contacts that you solder leads to; rather, the leads are already assembled and in place and fitted with Deans Ultra Plug connectors. The battery is covered with plastic shrink-wrap that covers the attachment points of the leads.

Li-Poly batteries are lighter and able to deliver more current than other battery types on a per-ounce basis. The new Scorpion 2-cell (2S) 3200mAh packs are manufactured using Kokam "super high discharge" cells, and represent the 4th generation in Kokam Li-Poly batteries. These are every bit as competitive and powerful as any Li-Poly batteries we have tested to date in the RC market, and are a step ahead. They are the first 3200mAh packs we have had the chance to run and test. Li-Poly battery chemistries are rapidly improving, and the leading brands have time and again leap-frogged each other in the RC airplane market. The new Scorpion car packs combined with the Scorpion 2s charger makes FMA and Eagle Picher Kokam the clear leaders in the RC car market.

PHOTOS BY WALTER SIDAS AND TINA HORAN

Li-poly batteries have a nominal no-load voltage of 3.7V per cell, and these new packs have two Kokam cells wired in series, which is why the packs are rated at 7.4V (a rough average of voltage under load). A fully charged Li-Poly will have a no-load voltage of 4.2V per cell, or 8.4V per 2-cell pack. A 2-cell pack is called a "2S" battery, which means two cells in series. If two of these batteries are wired in parallel to produce a larger "unitized" 6400mAh battery, the pack would be called a "2S2P" pack. The 2P means two packs in parallel.

Li-Poly packs cannot be discharged below a certain voltage without damaging the packs in a way that will diminish performance. When you mount a Scorpion pack in an RC car, the speed control lead plugs to a port on the battery, and a lead from the battery plugs into the receiver ESC port. When the pack sags to 6V at the end of a run, the chip in the battery terminates the throttle signal between the receiver and the speed control.

On loss of signal, the speed control kills motor power. When the motor load is removed, the pack's voltage recovers; this process leads to motor pulsing—an indication that the charge is depleted yet there is enough power to drive back to the pits at low throttle.

SCORPION 2S CHARGER AND BATTERY SYSTEM

The new Kokam 2S car batteries cannot be charged using a NiCd or NiMH charger. NiCd and NiMH chargers use an entirely different charging algorithm. (You should never charge a lithium battery with anything but a lithium charger or you will overcharge the battery, which could lead to a fire.)

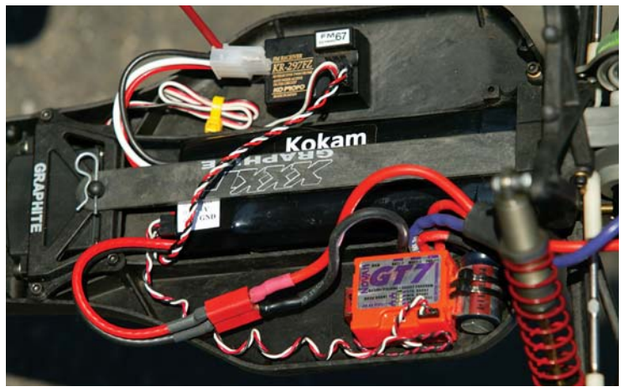
The new Kokam 2S 3200mAh batteries have unique 3-prong charging plugs that are incompatible with other chargers. A 3-prong charging port on the side of the Scorpion 2s charger will accept only this plug. Scorpion packs are warranted only if they are used exclusively with the Scorpion 2s charger.

One of the most important issues with Li-Poly batteries has been the need to ensure that

The company behind the NEW technology

FMA, in addition to being a manufacturer of receivers, flight systems and other products for the RC market, is a developer of Lithium battery technologies and electronics systems for the Navy. FMA's service to the RC market is legendary: Fred Marks, founder of FMA, was a leading member of the team that secured government authorization of our ground and air RC radio frequencies. With such deep credentials in electronics and the hobby, it is not unexpected that FMA, teaming with EaglePicher Kokam, would be the first to bring this product suite to the RC car market. FMA is actively developing additional innovative LI-POLY products for both RC car and airplane enthusiasts.

the individual cells within a pack are properly balanced. The new Scorpion 2s charger is unique in the RC world in that it employs an extremely reliable and safe "cell-balancing" charging system that checks the voltage and charge current being delivered to each cell multiple times a second. This guarantees that the cells are matched to within hundredths of a volt when charging is completed. The ability of a charger to monitor all cells in a series pack individually is a major breakthrough in improving charging reliability and safety.



The Scorpion 7.4V 2S pack is shown mounted in a Team Losi XXX-T. Note that the speed control lead is connected to a port on the battery, and a lead from the battery goes to the speed control. This enables a chip in the battery to induce a motor cutoff when the pack is depleted and the motor voltage drops below 6V.

GETTING STARTED

The Scorpion 2s charger can fast-charge Kokam Li-Poly car packs to 90% capacity in only 20 minutes, and it is very easy to use. When you plug the charger into an 11 to 15V DC power source, the red light on the left side of the charger's top panel illuminates to indicate power is on. When you plug the battery's charging lead into the special port on the charger, the yellow "Fast Charge" light on the charger front panel illuminates. A dial lets you select a fast charge rate of from 500mA to 10A. If you are fast-charging a Kokam 3200mAh pack, you would set the charger to 9.6A (a "3C" rate—see the Li-Poly Terms sidebar).

When the charge is midstream, the yellow light illuminates steadily and the green light slowly flashes. When you have reached 90% of charge, the yellow light goes out and the green light rapidly flashes. You can now run your pack in an RC car—it is ready to go, and at 90% will probably outperform any 6-cell nickel pack you have previously run—or you can wait if you want that last 10% of capacity.

In Top Off mode, the Scorpion 2s will charge to 100% capacity in one to three hours, depending on battery capacity and condition. We've seen the steady green light indicate a full charge on the 3200mAh packs within 30 minutes of reaching the Top Off point. Never charge a Scorpion car pack using a 3rd party charger hooked to the Deans Ultra Plug connector that is intended to be connected to your car's ESC. This will risk imbalancing the cells and will cancel the product warranty.

Vital Stats

CHARGER: Scorpion 2s
MANUFACTURER: FMA Direct
DISTRIBUTOR: FMA Direct
INPUT POWER: 11 to 15V DC
FAST CHARGE CURRENT: 500mA to 10A
FORMING CHARGE CURRENT: 500mA
FORMING DISCHARGE CURRENT: 750mA
FOR: FMA 2s Lithium Polymer packs
PRICE: Contact FMA Direct

BATTERIES: Kokam 2S Li-Poly Car Packs
MANUFACTURER: EaglePicher Kokam
DISTRIBUTOR: FMA Direct
—1250mAh, 15C discharge rate 18.75A continuous, 3.4 oz.;
—2000mAh, 15C discharge rate 30A continuous, 4.7 oz.
—3200mAh, 20C discharge rate 64A continuous, 7.5 oz.
PRICES: Contact FMA Direct

FORMING A PACK

The Scorpion 2s charger has a unique capability—it can condition the Kokam batteries for best performance. FMA notes this could amount to a long-term gain in pack capacity and performance (we have not yet rigorously tested the forming process). It does this by cycling the batteries in "Form Pack" mode, which can be selected with the current adjust dial. When you select Form Pack, the charger cycles the pack eight times. It charges at 500mA and discharges at 750mA. This regi-

Lab testing the Kokam 3.2's
Superior voltage and throttle response

We tested the new packs in the Team Losi MF2 race truck and the Team Associated TC3 RTR on an RC Dyno Systems brand new chassis dyno and confirmed that the acceleration punch of the Kokam cells are superior to that of a matched racing pack (the TC3 repeatedly reached 12 mph about 1/10 of a second faster running the Scorpion pack than it did with the matched NiMH racing pack). We used an Astro Flight Whattmeter to monitor the amps, volts and wattage during the 7-second chassis dyno runs. For the fun of it, we also tested a regular 6-cell sport pack. In the TC3, the sport pack sucked about 76 watts during the final seconds of repeated trials. The race pack and the Scorpion pack both provided about 80 watts of power, with the Scorpion having an edge on acceleration power bursts.

We next discharged the Kokam and Racing packs on the Competition Electronics Turbo 35 GFX charger-discharger at a grueling 35A. As the chart on the following page shows, the Scorpion pack with its Kokam cells clearly won the heat with a higher average voltage throughout—and a clear voltage margin of 6.48 volts after five minutes of discharge, compared to the matched racing pack's 5.36 volts. The very low internal resistance of the Kokam cells results from a battery design that has the internal plates stacked in parallel. This allows higher surge currents than conventional batteries and that is what provides the superior throttle punch.

Driving the Kokam 3.2's Outrageous Punch!

by Greg Vogel

Watt meters, high-tech chargers, dischargers, a chassis dyno, they're all well and good if you're a numbers man, but there's no testing like track testing. We strapped the 7.4V FMA Kokam pack into a race-tuned Team Losi MF2 with Novak GTX ESC and Team Orion 10x2 Vantage modified motor—serious race gear for a groundbreaking test.

Uncontrollable punch! The trucks slipper whined and slipped and the truck spun out repeatedly. The power after grabbing a hand full of throttle from the start was overwhelming. Again and again, I tried to get the truck rolling and the pack just had a ton of punch and didn't show signs of losing its peak like a standard pack would. So it was a matter of learning to drive the truck, and of course, use the radio's throttle exponential feature to reduce the punch. Even after an Expo tweak, and rolling on the throttle, I still found the punch of the pack to be ridiculous at quarter and even at half-throttle. The acceleration and punch with the Li-Po pack was unlike anything I've experienced before. It brought so much more excitement to the truck, that it may just be what the electric vehicle segment of RC needs to challenge the rise of nitro powered cars and cement electrics as the fast, fun, long-run-time vehicles to race.

This battery is six ounces lighter than a matched racing pack and provides superior power. If we put two in parallel, we could have 12 minutes races! *[Tech note: the beta version packs we were provided had an earlier version of the software onboard the battery chip, and the packs would occasionally cut throttle when voltage dropped to 6V during high-amp accelerations on the track. The production packs will have software that prevents that from occurring during temporary current spikes. After conferring with FMA, we were authorized to disconnect the battery chip for testing purposes only with the beta version packs. Our results reflect the exact performance you will get from production packs—and it is critical to use that safety circuit to protect the batteries from over-discharge, and to protect your warranty.*

men is applied to any of the three new Kokam car pack sizes (1250mAh, 2000mAh and 3200mAh). In Form Pack mode, the yellow and green lights alternately flash.

We took a brand-new 3200mAh Scorpion pack and ran it through four forming cycles on the Scorpion 2s and then fast-charged it. I took another 3200mAh pack and fast-charged it without forming it. When I discharged both packs using a West Mountain Radio Computerized Battery Analyzer at a 1C rate (3.2A) and overlaid the plotted curves on my laptop, the discharge curves were identical. Our sample packs were impressively consistent.

FMA has noted that if you fast-charge any of the new packs repeatedly, the ability to best condition the pack via forming will be lost. You'll see from our performance evaluation, however, that the new Kokam 3200mAh packs hold their own extremely well right out of the box, even in the absence of forming.

Li-Poly battery use and storage tips

All battery chemistries, whether NiCd, NiMH, Li-Poly or Lead Acid, require responsible handling. FMA notes it has dealt with battery charging in an aggressive yet reliable and safe way. The new FMA Scorpion 2s technology is said to be unlike anything previously sold in the RC marketplace. With every charge, its cell-balancing technology ensures that the individual cells in the Scorpion Li-Poly packs will not drift into imbalance—and this same technology allows batteries to be fast-charged in just 20 minutes. Moreover, the new Scorpion Li-Poly packs utilize the most stable and robust Li-Poly cells yet produced. (Kokam 4th generation "super high discharge".)

It remains the case that any battery type, whether nickel, lead-acid or lithium based, will overheat and potentially cause a fire if allowed to dead short. For this reason, electrical connections should be periodically checked and the customary standard of care already in use in the hobby should be applied when using the new Scorpion car packs. FMA Direct states that these new Li-Poly packs can be safely stored on your workbench just like any other battery type. After a pack has reached its useful life (over 100 charge-discharge cycles in a typical racing-usage profile), it should be connected to a resistor load, drained of all current, immersed in salt water for an hour or two and then discarded.

CONCLUSION

FMA and Eagle Picher Kokam have produced a break-through electric power system for RC cars and trucks whose performance is superior to the best technologies previously developed. By putting the Li-Poly cell-balancing function in the charger while at the same time controlling cutoff of the battery in the car, FMA and Eagle Picher Kokam have brought Li-Poly power to a new standard that meets the needs of both backyard bashers and racers. Because internal cell resistance is lower in the Li-Poly batteries than in NiMH packs, the new packs outperform top racing packs with unbelievable throttle punch and consistently maintained higher voltage.

A revolution in electrics is before us. *RC Driver* will continue to give you the latest news on the emerging world of Li-Poly power now offered by FMA and Eagle Picher Kokam—stay tuned for the latest updates and new developments as we continue to wring out these new systems. ◎

PERFORMANCE COMPARISON

COMPETITION ELECTRONICS TURBO 35 GFX

35A continuous discharge to 5.4V cutoff

SCORPION LI-POLY PACK	MATCHED NIMH RACING PACK
6.48V at 300 seconds	5.36V at 300 seconds
6.78V ave. discharge voltage	6.35V ave. discharge voltage
3198mAh delivered	2916mAh delivered

Links

Astro Flight Inc., www.astroflight.com, (310) 821-6242.

Competition Electronics, www.competition-electronics.com, (815) 874-8001

EaglePicher Kokam, www.kokam.com, (877) 437-7693.

FMA Direct, www.fmadirect.com, (800) 343-2934.

RC Dyno Systems, www.rcdynosystems.com, (866) 723-9667.

Team Associated, www.teamassociated.com, www.rc10.com, (714) 850-9342

Team Losi, distributed by Horizon Hobby Inc., www.teamlosi.com, www.horizonhobby.com, (800) 338-4639

West Mountain Radio, www.westmountainradio.com, (203) 853-8080.

W.S. Deans, www.wsdeans.com, (714) 828-6494.

For more information, please see our source guide on pg. 177.