

Nitro-to-Electric Conversions

Why and how! *by Chris Long*



VEHICLE OPTIONS

There are plenty of available options to convert your nitro car or truck into a brushless basher or a race car. RC-Monster.com, Novak, Tekno RC and Castle Creations are just a few of the companies that offer conversion kits for all of the most popular models and scales.

The kits vary with respect to motor mounting. Tekno RC and Novak make use of the existing motor-mount holes, and RC-Monster.Com and Castle Creations replace the rear center diff with a CNC-machined motor mount. It's your choice: Putting the motor in the rear of the car behind the steering servo leaves more room for the battery on the left. This helps to maintain a car's overall balance. As long as you're familiar with your car, installing either type of kit is can generally be completed in a couple of hours.

For a 100-percent factory look, RC-Monster.com and Tekno RC recently introduced complete custom electric chassis for nitro cars such as the CRT.5 and the RC8. This allows you to optimize the chassis layout for electric, and it eliminates unnecessary holes (and dirt).

Losi, Traxxas and HPI have all announced ready-to-run (RTR) brushless motor versions of their nitro vehicles. The HPI e-Savage and Traxxas E-Revo both include re-branded versions of the Castle Creations Mamba Monster Max with the 2200Kv brushless motor. Both trucks will take lots of abuse and can easily go straight from the box to the starting line. For racers, Losi and Caster offer the 8-sight and Caster EX1. Both are more than capable of going head-to-head with their nitro counterparts.



Adances in motors and batteries have made $1/8$ -scale electric racing really popular, and I'm sure that tracks near you hold such events. If you already run a $1/8$ nitro but are ready for a power change, why not try an electric conversion? Battery power offers many advantages for average bashers and hardcore racers. No more tuning and tweaking carburetor needles to accommodate changes in temperature and humidity, and no more cleaning off spilt nitro fuel at the end of the day.

Now, with the simplicity that electrical conversion kits offer, you can load your set-

tings into your ESC, plug in a battery and head out to the track. Warm-up laps? Not required—thanks to electrical conversions.

Converting from nitro fuel to electric was a DIY project, and many were put off by that and the unavailability and/or cost of the electronics. This has changed; most hobby shops stock conversion parts, so the technology is widely available—and at competitive prices. An electric conversion is now a viable option. This year, ROAR and RC Pro will allow the use of electric conversions, and most local tracks now allow $1/8$ electric conversions to run with the nitro vehicles.

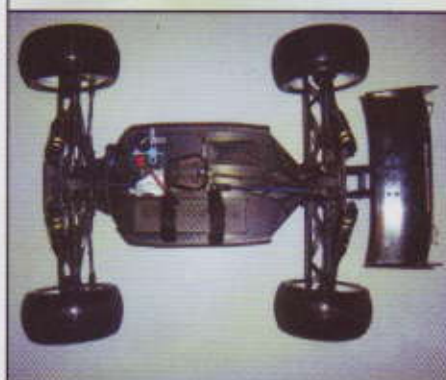
Slowly, but surely, my last nitro fuel truck disappeared a few months ago. Today, having completed over 10 nitro-to-electric conversions, I run only with electric power—brushless motors. This includes everything from my $1/8$ Revo 3.3 monster truck, HoBoa Hyper ST Pro truggy and Jammin' X1-CR Pro Buggy to my on-road Ofna GTP2 and the ever versatile $1/12$ Ofna CRT .5 truggy.

I'll tell you how to complete an electrical conversion, explain your options and clue you in on the new terminology associated with electrical conversions.

Team Losi Bight with Losi electric conversion



Team Associated RC8T with Tekno kit



Team Associated RC8T with RC Monster Kit



Team Losi Bight with Novak conversion

BRUSHLESS & BRUSHED—AN EXPLANATION

Brushless motors produce more power and are more durable and more efficient than brushed motors of equal size.

- **Brushed** Has static "brushes" that make mechanical contact with electrical contacts on the rotor (commutator) to complete an electrical circuit between the DC power source and the rotating armature coil windings.



- **Brushless** Has electromagnets around the can's perimeter; has static coils and a rotating magnet that is connected directly to the motor shaft. The coils are grouped in three phases, and the ESC switches the electricity between each coil in sequence to change the polarity of each phase. This causes the magnets and, hence, the shaft to rotate. Since there are no physical connections inside the motor, there's no friction and nothing to wear out.

LATE BREAKING RELEASE

Speed Passion Silver Arrow $1/8$ Brushless system



As we went to press the first Speed Passion $1/8$ System was unveiled and it's packed with features.

- Perfect bolt-in size for any conversion kit.
- Ultra smooth throttle response in sensorless and sensed mode
- LED trackside programming box included
- 2200kv motor for serious racing and a 2500kv motors for big tracks

SENSORED & SENSORLESS

- **Sensored** With a brushless motor, the ESC must "know" the magnet's orientation in order to power up the coils in the correct order and frequency. With a sensed design, small motor sensors are directly connected to the ESC and tell it the motor's position at any given time.



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- **Sensorless** With this design, the ESC has a special startup sequence to orient the rotor and start it spinning. Once it's moving, it uses back EMF (feedback) to track the position of the rotor as the motor spins.
- **Sensored** technology has traditionally been favored for RC cars, as it eliminates "cogging," i.e., motor stuttering when starting to move. But with advances in sensorless technology, cogging has almost been completely eliminated, and sensorless motors now offer a simpler, more powerful solution.

MOTOR RATINGS—KV & RPM

Brushless motors are given a Kv rating, which is equivalent to the rpm (rotations per minute) per volt; it lets you determine how fast that motor will rotate when supplied with a given voltage. With no load, a 2200Kv motor powered by a 4S LiPo pack (14.8 volts) would spin at $2200 \times 14.8 = 32,560$ rpm. The current rating (C) specifies the maximum

continuous and/or burst current that the motor is able to handle. When selecting a battery and ESC, be sure to select ones with a continuous-current amp rating that's at least 20 percent greater than that of the motor.

Generally, to match a nitro engine, racers aim to keep their motor rpm within the range of 30,000 to 45,000. This also enables lower-end motors such as a Feigao to run cooler; more expensive motors such as those by Neu and Castle Creations are more efficient and are rated to 60,000 rpm.



ESC & MOTOR SELECTION

You must choose a motor and ESC of the appropriate size for your car. You wouldn't expect a 4-cylinder, 1.5L engine to drive your Dodge pickup, and neither will a V-10 diesel run in a Civic, so choose carefully for the best results.

You are probably looking for a motor in the 36- to 44mm-diameter range with a length of 60 to 80mm; 60mm is usual for 1/8 buggies, and 70 to 80mm is usual for 1/8 truggies and monster trucks.

Your desired kilovolt (Kv) rating will depend on your supplied voltage, but as a rule:

2000 to 2700Kv = 4S LiPo = 5S A123 pack

1800 to 2200Kv = 5S LiPo = 6S A123

1500 to 2000Kv = 6S LiPo = 8S A123

Castle Creations, Losi and Novak all offer ESC and motor combina-



tions for 1/8 conversions. Each combination has its own pro's and cons; it depends on what you are looking for and how much money you can spend. When set up appropriately, these off-the-shelf combinations provide exceptional performance that overshadows that of their nitro counterparts.

The Castle Creations Mamba Monster Max (MMM) provides two motor options—the 2200Kv for 1/8 truggies and the MT and



2650Kv for buggies. The ESC runs the same software as the renowned Mamba Max, so it can be configured from your PC and supports everything from 2S to 6S. The MMM combination was recently selected by Traxxas and HPI for the new 2009 Brushless E-Revo and E-Savage models.

Losi's X-Celarin conversion kit comes with four motor options from 1300Kv to 2400Kv for plenty of options to suit your battery choice. This ESC typically supports 2S through 5S LiPos and is easily configurable at home as well as at the track because it can be programmed via "Card" or laptop.

The Novak HV kits have been around for some years but were recently refreshed to include a low-voltage cutoff (LVC), and the motors have upgraded, larger, 5mm shafts. The Novak HV is rated for up to a 4S LiPo, and it has a higher, 3000 to 5000 kilovolt, range. The advantage of the Novak ESC was its use of sensored technology to provide smooth starts, but with advances in sensorless motors and ESCs, this isn't much of an issue anymore.

Above and beyond the conversion kits already mentioned are a number of other motor and ESC manufacturer combinations. The main motor alternatives include, but are not limited to, Felgao (at the lower end), Medusa (in the middle) and Tekno/Neu Motors at the high end. Every manufacturer offers brushless motors in various sizes, colors and Kv ratings. Tekin is due to release an 1/8-scale combo soon; its RX8 promises strong performance.

When choosing your ESC, consider the manufacturer support; that \$60 eBay special might look attractive, but if it fails within the warranty period, you might not have the support that U.S. vendors such as Castle Creations, Novak and Losi—to name a few—provide.



PROPER GEARING

Your motor and battery choices (and the speed you want) will determine the gearing of your new brushless build. One of the best resources available for gearing is this website gearing guide http://scriptasylum.com/rc_speed/. Here, you have the options of entering all of the vehicles, voltage, motor, tire choice and desired speed, and it will compute the required pinion gear.

Most conversions run the pinion directly against the spur gear, which is fine as long as you use the "hardened pinions" from RC-Monster.com, RRP, or Novak.

In terms of speed, for the track, you'll generally be gearing for a high 30 to low 40mph. Bashers might want 50mph. After changing your gearing, check the temperature of your motor and ESC every 5 minutes to ensure that they are not running too hot because temps over 200 degrees will destroy your motor and possibly your ESC. Motor temp should be less than 170 degrees. If you are geared appropriately, this should not become a problem.

GENERAL RULES OF BRUSHLESS GEARING

Hot motor, cool controller, cool batteries = Undergeared; use smaller pinion
Cool motor, hot controller, hot batteries = Overgeared; use smaller pinion.

Warm motor, warm controller, warm batter-



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ies = Happy components

In addition to changing the gearing, brushless motors provide instant torque from stationary. This can result in the front wheels unloading during rapid acceleration. This can be addressed by using thicker centre diff fluid of between 10,000WT and 30,000WT.

MOTOR OR ESC BRAKING?

This comes down mainly to personal preference, your choice of conversion and your driving style. In most conversions, the ESC provides the braking, but in most configurations, you can disable the motor brake and use the traditional servo setup. This increases complexity but, at the same time, it enables you to adjust the front-to-rear brake bias. In addition, the ESC will run cooler, as it no longer handles braking.

Most of you will find that the braking provided in ESC software will work perfectly well, but advanced drivers may want to try a servo-brake configuration.



BATTERIES & WIRING

For brushless power, lithium batteries are really your only viable option—NiMH cells just can't take the amp draw of an 1/8-scale setup, and they weigh too much.

Most racers now opt for a LiPo (lithium-polymer) pack that, when properly used and charged, will offer amazing performance at a great price. Note that LiPo batteries are sensitive to abuse; they should not be crushed, punctured, over-discharged (below 3 volts per cell) or over-charged! They require a LiPo-specific charger and balancer. Most new chargers can now do self-balancing and can charge LiPos, NiMHs and A123 batteries.

ROAR recently set rules that standardize LiPo pack sizes and require LiPos to have a hard, flameproof case. Before you invest in them, be sure to check at your local track to confirm their requirements; some tracks only



let you race with ROAR-approved and/or other hard-case LiPo packs; others are not as strict.

BATTERY SELECTION

- **Voltage** Each cell has a nominal (resting) voltage of 3.7 volts and a fully charged voltage of 4.2.

A pack's voltage of is often expressed as the number of cells (S): 2S (7.4 volts), 3S (11.1 volts), 4S (14.8 volts), etc.

- **Capacity** Normally measured in thousands of milliamp hours
- **C rating** This refers to a pack's maximum discharge rating, and it's a multiple of its capacity. For example:
 - a 25C 5000mAh pack could sustain 125 amps
 - a 20C 4000mAh pack could sustain 80 amps

Individual cells can also be linked in series with adapters to increase voltage, or in parallel to increase capacity:

- 2x2S (7.4 volts) 5000mAh wired in series is equivalent to 4S (14.8 volts) 5000mAh
- 2x2S (7.4 volts) 5000mAh wired in parallel is equivalent to 2S2P (7.4 volts) 10000mAh

For any 1/8-scale buggy or truggy, look for a 4S 5000mAh pack with a minimum 20C rating; it should provide approximately 15 minutes of race time. Caution: when you think about using much larger packs, remember that they'll add more weight, and that can lead to more breakages. And choosing a pack with a low amp rating could result in its being overheated, in which case it will "puft" and be ruined or worse: it might catch fire and/or explode.

As a pack is used (discharged), the indi-

vidual cells can be depleted at a different rates, and the pack may be out of balance. So use a balancing charger to ensure that the voltage in every cell in a pack is the same. Most LiPo chargers now have a built-in balancer.

Do not allow LiPo cells to be discharged to below 2.8 volts, or they may be ruined. Most 1/8 ESCs have a built-in low-voltage cutoff feature that cuts the power when the cells' voltage reaches the cut-off—usually 3 volts per cell. Check your ESC's manual to ensure that you understand how to use this setting correctly.

A123 batteries are an alternative to LiPos. They have similar characteristics and a high discharge rate of 30C, but they will not ignite, etc., if damaged. The downside is that they are slightly heavier, they're available only in 1100mAh and 2300mAh capacities, and they have a resting voltage of 3.4 volts per cell. They are generally wired in parallel. A 5S2P A123's equivalent would be a 4S LiPo. They aren't generally used for racing, but they're great alternatives for a basher with a monster truck!

WRAP-UP

With so many advances in technology and choices for brushless conversions, 2009 promises to be a great year for RC. If you ever have an opportunity to drive a brushless, e-powered car or convert your nitro car, try it. You might find that you prefer it. I do! ●

Links

Castle Creations, castlecreations.com, (785) 883-4519

Caster Racing, www.casterracing.com

Feigao Electric Motor Co., feigao.com, 86-731-2925964

HPI Racing, hpiracing.com, (949) 753-1099

Medusa Research, Inc., medusaproducts.com, (508) 675-0200

Neu Motors, neumotors.com, (858) 674-2250

Novak Electronics Inc., teamnovak.com, (949) 833-8873

RC Monster, rc-monster.com

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

Tekin, Inc., teamtekin.com

Tekno RC, teknorc.com, (877) 857-2872

Traxxas Corp., traxxas.com, (972) 265-8000



For more information, please see our source guide on page 121.