



## November 2005 Edition

### 2005 Officers:

President:	August Bruno	(303) 828-0910	Secretary:	Rudy Glick	(970) 532-2488
Vice President:	Rich Anderson	(303) 652-2224	Treasurer:	Ken Jochim	(303) 444-3206
Vice President: & Safety Officer	James Mack	(303) 819-6669	Newsletter Editor:	Boris Sergeev	(303) 530-2063 BSergeev@excite.com

**CLUB MEETING:** *November 9, 2005 at 7pm*  
at VoTech (across Arapahoe from the  
power plant)

**Bring your new model for Show-and-Tell!**  
**Grab a cool R/C DVD from the Club DVD library!**

### CLUB DVD LIBRARY OPEN

The Club DVD library has opened its virtual doors:  
[milehighwings.com/club/dvd.htm](http://milehighwings.com/club/dvd.htm)  
You can request a title via e-mail and pick up the DVD at  
the club meeting.

Please feel free to [e-mail](mailto:) me your suggestions regarding  
the new DVDs to add to the library.

*Boris Sergeev, Club Librarian*

### FIELD PARKING

There are parking spaces at the field marked and  
designated as handicap parking. We've been notified that  
if City Park Rangers see vehicles parked in those stalls  
without a proper handicap tag displayed they will start  
issuing violation tickets. **The fine for this type of ticket  
is \$125.00.** All members need to be aware that, if you  
park in a handicap stall without a tag and a ranger comes  
by, it could become *an expensive day of flying.*

### BAS MEETING MINUTES

Boulder VoTech Center  
October 12, 2005

Meeting called to order by President Augi Bruno at 7:00 PM  
with 10 members present.

### **Minutes**

Minutes of the September meeting were read. Motion made  
to accept minutes as read. The Motion was carried.

### **Treasurers Report**

Treasurer Ken Jochim reported the clubs bank balance as  
\$7577.02.

### **Old Business**

Our meeting place at the Votech Center was discussed they  
have raised their price for us to use their facility If any  
member had any ideas as to where to hold our meetings in  
the future bring your thoughts to the next meeting.

Ken Jochim reported on the meeting he attended of the  
Colorado Model Cubs. His feelings are most clubs seem to  
have the same problems and the group does not have a real  
direction. He will continue to attend the meetings in our  
clubs interest.

### **New Business**

Rich Anderson reported he would be making contact with the  
city of Boulder on seeking a long-term contract for our flying  
field.

President Augi received a letter from AMA VP Mark Smith  
warning us about frequency control. Park flyers type  
models now use 6 channels on the 72 MHz band so we  
should be aware.

### **Show & Tell**

Tony Klwein demonstrated an enlarged version (Tony just  
can't build small!) of Great Planes Micro Whizz electric  
model. With more power upfront, he thinks it should go  
vertical. Good work Tony!

Motion to Adjourn by Dean Chandler, Second by Rich  
Anderson. Motion passed.

Respectfully submitted,  
Rudy Glick

## ARTICLE OF THE MONTH

### **Electric Power On A Budget, Part 1: Brushless Motors**

Electric power used to be a one-out-of-two deal: it was either cheap or powerful. Fortunately, things have changed (thanks to the Far East) and now you can have both—cheap and powerful electrics. As many catchy phrases, the previous statement is somewhat an oversimplification: only “sport” power systems for small-to-medium models are reasonably cheap, large and high efficiency/power competition systems are still pricey. Nevertheless, let’s examine a typical budget electric setup with plenty of power and bearable price tag. Let’s try to come up with a power system for, say, a 15oz 3D plane or a 20oz aerobatic plane with 30oz thrust for less than \$100.

An electric power system consists of at least three components: a battery, an electric speed control (ESC), and a motor (possibly, with a gearbox). If ESC can’t provide enough juice to feed the power hungry servos, a separate battery elimination circuit (BEC or uBEC) is employed—it converts the high voltage of the main battery into 5 or 6V suitable for servos. Let’s assume that the BEC, built into the ESC, is powerful enough, and let’s go with brushless motor and ESC—even though they are still somewhat more expensive than their brushed counterparts of similar power, the price difference is pretty small to justify lower efficiency and service life of a typical brushed motor. Let’s also stick to Lithium Polymer (LiPo) batteries, despite them being substantially more expensive than NiMH cells. LiPo batteries are so much lighter than similar capacity NiMH packs (or so much higher capacity than a similar weight NiMH battery), that it’s worth spending extra for a LiPo battery.

Let’s examine each of these three components starting with the motor. Brushless electric motors used in R/C (of three-phase asynchronous type) came in two flavors: traditional “inrunners” and newly popular “outrunners”. The former have magnets spinning inside the stator windings, while the latter have magnets glued on a bell, which encompasses the stationary stator. If a prop is attached directly to the motor shaft (it’s called Direct Drive, or simply DD), inrunners can only spin tiny props real fast, so gearboxes are employed to use inrunners with practical size props. Budget gearboxes, typically a one stage units with a plastic spur and a brass or steel pinion gears, usually suffer from somewhat low efficiency and are susceptible to damage (and high efficiency planetary gearboxes are usually expensive). Outrunners, from the other hand, develop high torque at low RPM, thus, they can work with larger props DD, i.e. without a gearbox. This saves us both weight and money (a gearbox usually costs as much as the motor), so, let’s go for an outrunner.

In the first approximation, the RPM of a motor is considered proportional to the supplied voltage and is characterized by a so called Kv constant:

$$\text{RPM} = \text{Kv} \times \text{voltage}$$

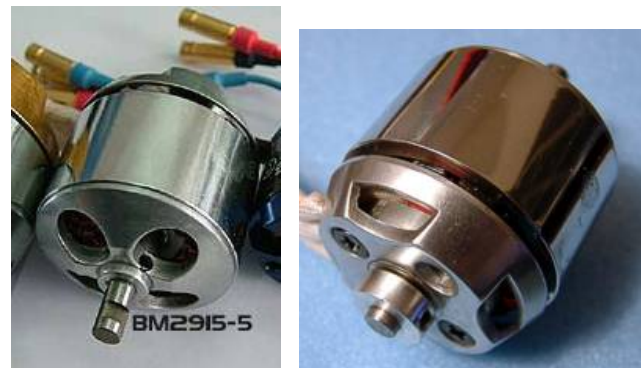
A typical Kv of an outrunner motor (or an inrunner with gearbox) of 700 RPM/V yields 7700RPM for 11V battery.

The same simplified motor model suggests that the current flowing through the motor-ESC-battery chain is proportional to the motor torque, which is equal to the torque required to spin the given prop at a given PRM (at a given altitude above the sea level at a given temperature and air humidity, etc.). The higher the RPM, due to the high Kv or the battery voltage, the faster the prop spins, thus, causing the current to rise. The rule of thumb is: pick lower Kv motor if you’d like to use larger props; reduce the prop diameter/pitch, if you need to lower the current (as the maximum current is usually the limiting factor for the battery and the ESC).

As it is rather hard to estimate or measure the prop torque (and propeller manufacturers do not supply torque curves), usually, the motor manufacturers and/or vendors simply test their motors and provide RPM and current for a given propeller. Thorough tests, like published by Steve Neu in *Quiet Flyer* magazine, also include the motor efficiency numbers, which show what portion of the incoming electric energy is converted into the mechanical work of spinning the prop, and what is lost for heating the motor (for outrunners, mainly due to eddy currents heating the stator armature). High motor efficiency not only helps to prolong the flight time by conserving the battery charge, but also allows the motor to process more power without overheating and damaging its rare-earth magnets. Also, for the same mechanical power (the same RPM of the prop), higher efficiency motors require lower current, which permits the use of cheaper batteries and ESC. Unfortunately, high efficiency motors, like German Plettenberg (upper 80 to lower 90% efficiency at working loads), cost substantially more than somewhat lower efficiency Chinese-made Hacker outrunners or average efficiency Czech AXI motors (70...80% efficiency larger models, 60...70% smaller models). Don’t be fooled by inflated efficiency numbers quoted by some indiscrete manufacturers/vendors—they often show high efficiency, which can only be achieved at very low power (it’s like car’s highway mileage measured at 48m/h speed).

And the last, but not the least, parameter of a motor is its weight for a given power. Obviously, cheaper motors tend to be heavier, though, there are some notable exceptions, like American build MicroDAN line of small brushless motors.

The design of a typical outrunner is well illustrated by a [review](#) by Lucien Miller (RCGroups ID: LBMiller5) of a Chinese TowerPro BM2915-5 motor (though it’s a larger, 400W class motor) sold for only \$45 by [HiModel.com](#).



The motor mounts to the airframe via the rear flange on its stator. The rotating bell has 14 rare-earth magnets glued inside. The front of the bell has four cooling holes:



The stator has 12 teeth, like for most commercial motors and some DIY motor kits. The stator housing also holds two ball bearings, which support the shaft and attached to it rotor bell:



The stator is wound with several wires in parallel (commonly employed in commercial motors due to technological considerations) using a so called “distributed LRK” scheme.

In the next installment, I will discuss popular DIY motor kits, compare leading brands of smaller brushless motors, touch the subject of electric props, and list my favorite on-line vendors.

Yours truly,  
Boris Sergeev

### FLYING FIELD HOURS

9:00am to dusk on weekdays  
10:00am to dusk on weekends

### CLASSIFIEDS

There were no new classifieds submitted.  
Previous classified ads can be found at the Club Classifieds page: [www.milehighwings.com/club/classifieds](http://www.milehighwings.com/club/classifieds)

### INSTRUCTORS LISTING

Call if you need help getting started:

Dean Chandler	303-652-2125	Futaba
Steve Croft	303-651-9104	Futaba
Tony Kilwein	303-438-8500	Futaba
Wendell Wickstrom	303-494-9324	Airtronics
Ken Jochim	303-444-3206	JR
James Mack	303-819-6669	Futaba

### THE YELLOW PAGES

A listing of area merchants, whose products are of interest to R/C enthusiasts; provided as a service to our members. Some will give you a discount with your current club card.

**Mile Sky Hobbies** (formerly known as **HSJM Ltd. Hobbies**),  
1300 W Midway, Broomfield (303-439-2640), Steve Clark

**Action Hobbies**, 1477 Carr, Lakewood, (303-233-6275),  
Glen A. Magree

**Hobby Town**, 800 South Hover Rd. Longmont, (303-774-1557)

**Mile High Wings** [store@milehighwings.com](mailto:store@milehighwings.com)  
Your source of R/C Simulator interfaces and all-composite ARFs: [www.milehighwings.com](http://www.milehighwings.com)

**Don's Hobbies**, 815 10th Street, Greeley (970-353-3115)  
Tony Farro

**Things with Wings**, 6268 W. 10th #2 Greeley (970-352-1067) Jim Richardson

**Hobby Town**, 6815 W. 88th Ave., Westminster, (303-431-0482), James Miley

**Hobby Giant**, 5545-A, Olde Wadsworth, Arvada, 303-940-9238, Larry Cencich.

**Heliport Hobbies**, 1400 W. 70th Street, Denver 303-430-8828, also Magnum Fuels

**Note to members receiving newsletter by snail mail:**

***If you send the editor your email address, we can send you the newsletter by e-mail. This saves the club 37 cents each newsletter PLUS you get all the links clickable and all the pictures in color rather than black and white. And you get it a couple of days sooner.***

*The Inverted Flyer is published monthly by the Boulder Aeromodeling Society as a service to its members. Submissions for publication are encouraged and can be but are not limited to: articles pertaining to Aeromodeling, letters to the editor, short news items of general interest to BAS members, and announcements. Space permitting, all submissions will be published except as follows: no anonymous letters or any submission*

*containing morally objectionable content or language, as judged by the editor. Classified ads will be provided to the members of BAS free of charge. The deadline for all submissions and classified ads will be the first of the month for publication on or about the first Wednesday of the month. Opinions expressed in the Inverted Flyer are not necessarily those of the Boulder Aeromodeling Society general membership.*



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