

Using the HobbyKing Boat ESC Program Card

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The HobbyKing Boat ESC Program Card is a low-cost, convenient and effective tool for setting up and changing the running parameters of a wide range of HobbyKing Boat ESCs (Electronic Speed Controllers) that are used with brushless motors in R/C marine propulsion. The card is optimized only for these Boat ESCs; as such, it should NOT be used with aircraft ESCs, including helicopters. At this writing, the following ESCs are compatible with this Program Card:

- **HobbyKing 30A Boat ESC** with 3A UBEC
- **HobbyKing 50A Boat ESC** with 4A UBEC
- **HobbyKing 70A Boat ESC** with 4A UBEC
- **HobbyKing 90A Boat ESC** with 4A SBEC
- **HobbyKing 120A Boat ESC** with 4A UBEC

Program Card Panel Layout: (photo: HobbyKing.com)



QUICK GUIDE TO HOBBYKING BOAT ESC PROGRAM CARD

1. First make sure your LiPoly (or other) main battery is disconnected from the ESC!
2. Disconnect the ESC's small 3-wire cable connector from the R/C receiver.
3. There are two 3-pin sockets in the rear edge of the Program Card. Connect the ESC's 3-wire connector to the socket that has THREE symbols: - + Π
Leave the other socket unused. Make sure the black wire is attached under the - symbol and the white wire under the Π (signal) symbol.
4. Now, connect the main battery to the ESC. After a moment, the two windows in the Program Card will light up with numeric digits – the **ITEM** window should show **1**. The Program Card is now loaded with the existing status of all six ESC programmable parameters.

Note: In Steps 5 through 9, refer to the list printed on the right side of your Program Card – this shows the **Value** options for each **Item** (parameter). If you ever want to set ALL parameters back to the Factory Default status (the Values printed in orange on the list), just press the **RESET** button.

5. Use the **ITEM** button to scroll down to the parameter you want to change.
6. Now use the **VALUE** button to scroll to the setting ('Value') you want to use.
7. Repeat Steps 5 and 6 for every parameter you want to alter.
8. At this point, you can review your settings by scrolling through all six by repeated use of the **ITEM** button.
9. When satisfied with all settings, press the **OK** button. This will send your chosen settings to the ESC and lock them in as the running parameters. The ESC will play a rapid 5-note musical scale to tell you it has received them and locked them in. These will remain in place until you choose to re-program them.
10. Disconnect the main battery from the ESC.
11. Finally, pull the small connector from the Program Card and re-connect it to your R/C receiver. Be careful to get the correct - + Π orientation.
12. You are now ready to re-power the ESC and receiver, and run your boat with the new parameter settings.

DETAIL DESCRIPTION: USING THE PROGRAM CARD BUTTONS

ITEM Button

The ITEM button on the Program Card is used to choose the parameter ('Item') you want to review or change. When the Card is attached to the ESC and powered up, it reads the current values of all six parameters from the ESC and then immediately shows 1 in the ITEM window and the current value of Item 1 in the VALUE window. Now, you can use the VALUE button to change the setting of Item 1 OR accept it and press the ITEM button as needed to scroll through the Items to review and/or change their values (after Item 6, pressing ITEM will re-start at Item 1 – you can scroll through all six as many times as you want).

VALUE Button

The VALUE button on the Card lets you choose the Value you want for the parameter (Item) you have selected. Note that the list printed on the right side of the Program Card lists all possible values that can be set for all six parameters. Pressing the VALUE button repeatedly simply scrolls through the possible Values for that Item. When you reach the Value you want, go back to the Item button to move on to the next Item (if you reach the highest value and want to go back, just press VALUE again and you will be starting at Value = 1 - you can scroll through the values as many times as you want).

RESET Button

The RESET button has exactly one purpose: It nullifies any changes you've made and resets ALL Items back to their Factory Default values. This is useful if you decide you don't like the changes you've made and just want to start over. It doesn't automatically reset the ESC - but if you next press OK, that will lock the reset values in. But of course, you can go back to making any changes you want before finally pressing OK.

OK Button

Pressing the OK button causes the current values of all parameters (Items) to be transferred into the ESC and locked in. In other words, with this button you will apply all the changes you've made to your ESC, so they will actually be in effect when you re-connect the ESC to your receiver and re-power. These values will remain in effect until the next time you use the Program Card to change them, regardless of how many times the ESC is re-powered. After you press OK, the ESC will play a rapid 5-note musical scale to tell you it has received them and locked them in.

THE PARAMETER / SETTINGS LIST

Because the parameters and their settings are shown in list / sublist form, the Program Card refers to the parameters as **Items** and their settings as **Values**. Here's how they're listed, but with a few added comments / recommendations by me:

Item 1. Running Model

Value 1 - Forward with brake [comment: NOT recommended!]

Value 2 - Forward and reverse with brake [Factory Default]

Value 3 - Forward and reverse [no motor braking]

Item 2. Fixed Area Accelerator [comment: This is just an overly fancy name for what is simply the neutral area or 'deadband' separating forward and reverse throttle ranges]

Value 1 - 6 percent

Value 2 - 9 percent [Factory Default]

Value 3 - 12 percent

Item 3. Battery Low Voltage Protection [this is the PER CELL low point where low-voltage protection kicks in - especially important for LiPoly batteries]

Value 1 - Non-protection [NOT recommended!]

Value 2 - 2.6 volts

Value 3 - 2.8 volts

Value 4 - 3.0 volts

Value 5 - 3.2 volts [Factory Default - ideal for LiPoly batteries]

Value 6 - 3.4 volts [more conservative value for LiPoly batteries]

Item 4. Start Mode (Punch)

Value 1 - Level 1 [large / slow scale]

Value 2 - Level 2 [slow sport scale]

Value 3 - Level 3 [slow sport scale]

Value 4 - Level 4 [sport scale]

Value 5 - Level 5 [sport scale]

Value 6 - Level 6 [Factory Default - sport scale / scale speed / racing]

Value 7 - Level 7 [scale speed / racing]

Value 8 - Level 8 [recommended for racing only]

Value 9 - Level 9 [recommended for racing only]

Item 5. Reverse Force

Value 1 - 25 percent [Factory Default]

Value 2 - 50 percent

Value 3 - 75 percent

Value 4 - 100 percent

Item 6. Timing Set [commonly known as motor 'Entrance Angle']

Value 1 - 0 degrees [in-runner motor]

Value 2 - 5 degrees [in-runner motor]

Value 3 - 10 degrees [in-runner motor]

Value 4 - 15 degrees [in-runner motor]

Value 5 - 20 degrees [Factory Default - any brushless motor]

Value 6 - 25 degrees [out-runner]

Value 7 - 30 degrees [out-runner]

Value 8 - Automatic [ESC adjusts angle to motor type and speed]

DETAIL GUIDE TO HOBBYKING BOAT ESC PARAMETERS

Note: In the following discussions, I use the proper nautical term 'screw' rather than the more popular common terms 'propeller' or 'prop'.

Do We Really Need Braking on a Boat? (Part of Parameter Item 1)

These ESCs are capable of a 'Braking' option. What happens to perform braking is this: When the throttle control is suddenly cut to zero power, the motor is not allowed to wind down gradually in its natural fashion; instead, the ESC applies reverse power to impose an instantaneous lock-up of the motor. A locked screw has considerable drag in the water, and this produces braking action against the forward motion of the boat.

Braking effectiveness has many variables, the most obvious being speed - at high speed the stalled screw has a LOT of drag, while at very low speed there's hardly any. But another thing that makes a difference is the pitch of the screw: A locked-up 'tractor screw' (low-pitch prop) has MUCH more drag at any given speed than a locked-up 'speed screw' (e.g. a 'racing prop'), since the blades of the former are much 'flatter' against the flow. So, don't expect a high-speed racing boat to have terrific braking, because its locked screw is almost perfectly streamlined to the water going 'through' it.

There are a few good reasons to have braking available. It can help if you accidentally speed into a crowded situation near other boats. It gives you a 'panic stop' capability (WARNING: in the case of a racing boat, you're still going to coast some distance before your speed is really gone). It can be used for maneuvering: You can pull the throttle full off, wait for braking to take out most of your speed - then make a sharp turn you'd never get away with at full speed, bring up 1/4 to 1/3 throttle to complete the turn and then blast off at full throttle again (some practice required!). Braking can be especially helpful to beginners, where 'panic stops' are often needed when they happen to get too close to shore or obstructions.

On the other hand, I can't really think of a lot of situations when braking would be a disadvantage; maybe if you have a pack of competitors close on your tail in a racing scenario or something.

About Reverse Operation (Also Part of Parameter Item 1)

Whether to allow reverse motor operation is an interesting question. Propulsion in reverse obviously allows an added dimension in maneuverability, especially when working in close quarters (such as when docking) or when you want to get out of any situation where forward motion seems risky. The trouble is that operating a screw in reverse brings its own set of potential problems.

One problem with reverse operation has to do with outboard motor designs (or any motor arrangement that uses a flexible shaft to drive the screw). The flexible shaft is a very tightly wound wire spiral, wound in the direction that causes it to snug up against itself in the forward direction of the motor. This means that in the reverse direction, it is trying to 'unwind' itself. As long as the motor is lightly loaded, it's no problem – the shaft has enough strength and stiffness to stay together. However, if the screw encounters high resistance, there will be a strong unwinding force between the screw and the motor, and eventually the shaft will elongate or a weakened spot will simply break. It is not fun to have to remove the top piece of a broken shaft from most model outboards!

Another effect is that when running in reverse, the screw applies a 'stretching' force to the shaft which can also help to unwind it. In forward thrust, the screw pushes forward on the outboard's thrust washer (usually a thin Teflon washer). In reverse, the screw pulls back from the thrust washer a few mm, pulling the boat sternward by pulling on the flexible shaft. This 'stretch' also allows extra water to get in around the shaft – a good reason to make sure you keep the shaft well greased.

External resistance to reverse rotation of the screw can come in several ways. Obviously, running aground in sand or rocks could do it, as could trying to back out of seaweed. But, even running in reverse in open water causes a high loading, just because of water drag – especially with a speed screw. You can't do much heavy reverse running before a flexible shaft will fail.

Allowing full-speed running in reverse has another pitfall: Many boats will have the stern quickly dragged under by a high-power burst of reverse thrust. This is the main reason there is another option to limit the maximum reverse speed to a fraction (25, 50 or 75 percent) of full speed.

Is there anything bad about NOT setting up reverse? Well, reportedly, if you choose not to set up a reverse throttle option, but then inadvertently pull reverse throttle, it “seems to confuse the ESC”. I have no idea what this means, but I'd rather not have to deal with Yet Another Problem – so, I always set up 'Forward and Reverse With Braking' and set the reverse speed limit to 25 percent. You can experiment with these for your boat, but this combination seems to work well for my tunnel hull racer.

One last thing that should be mentioned about reverse in these ESCs is that after forward running, you don't get reverse running immediately – instead, you have to move the throttle control into reverse, back to neutral and then back to reverse again to get it. For me, this is a nice safety feature, especially since I use a transmitter that has a throttle lever rather than a trigger type throttle - it means that I can do a panic stop by quickly pulling the throttle all the way down without accidentally running in reverse. Note that once you've used reverse and gone back to neutral, it will then work IMMEDIATELY as many times as needed UNTIL you throttle forward again.

How Much Neutral Range? (Parameter Item 2)

What the Program Card labels **Fixed Area Accelerator** is really nothing more than a choice of how much neutral space you want between forward and reverse throttle commands. The minimum value will provide the largest (and therefore, smoothest) forward throttle range. The largest value will give the most throttle sensitivity, but might make any specific throttle setting hard to hit exactly.

In the case of a pistol grip type transmitter, the throttle is auto-centering with a spring that reliably takes you back to the center of its range (i.e. to the neutral end of the throttle pull). In this case, you should be able to set this parameter to its minimum (Value = 1, 6 percent).

In the case of a non-spring-loaded throttle lever, you probably want the neutral area to be larger so you can get into it easily without careful hand-eye coordination. So, a setting of 9 percent (Value = 2) or 12 percent (Value = 3) might be appropriate. Note that if you have either of the 'Forward and Reverse' modes set in Parameter 1, you don't have to worry about running past neutral into reverse running. I find a setting of 9 percent quite comfortable to use with my older 4-channel Futaba transmitter.

Low Voltage Protection Level (Parameter Item 3)

Modern battery types such as LiPoly (Lithium Polymer) can be damaged by drawing the voltage below a certain point under heavy loading (such as a motor). So, the ESC provides protection at a certain voltage level. You can select the PER CELL protection voltage level to correspond to the type of battery you're using, and how careful you want to be. The protection action is simply that the ESC reduces motor power, but still allows you to continue running under very limited speed – this operating mode is supposed to last long enough for you to get your boat back to shore.

Note: Your ESC tries to determine the type and number of cells in the battery you're using as soon as you connect it to the battery. The number of cells determined is confirmed by emitting that number of audible beeps at about 1-second intervals, followed by the two-beep 'Ready' signal.

There is an option to have no low-voltage protection at all. I would recommend NOT choosing the No Protection setting (Value = 1) when using a LiPoly battery, because these batteries are so easily damaged by running them down. You might be able to use this option with some other battery types – check your battery instruction sheet.

In the case of a LiPoly battery, choose 3.2 volts (Value = 5, the Factory Default) or 3.4 volts (more conservative, i.e. safer; Value = 6) – the higher value will, of course, give you a shorter run time on the water before the protection feature cuts in to stop your boat.

For some other battery types, you might be able to safely use the lower settings (Value =2 for 2.6V, Value =3 for 2.8V, Value = 4 for 3.0V). Check your instruction sheet. Again, the higher value you use, the safer it will be but the less running time you'll have before protection kicks in.

Throttle Punch (Parameter Item 4)

Punch (called **Start Mode (Punch)** on the Program Card) is simply how quickly the ESC will bring the motor speed from zero to full speed on an immediate full throttle command from the receiver. At maximum (Value = 9), full speed is achieved almost instantaneously. At minimum (Value = 1), it will take the better part of two seconds to get to full speed. So, punch is simply the ability of the motor speed to correspond to the throttle control movement in real time.

Keep in mind that this has no effect on the startup speed of the motor. The time lag is not really the time from zero to full speed, but from startup speed to full. There is no motor we can buy that will 'run at a crawl', just as there is no gas engine that will idle below a certain RPM. It may be a physical impossibility to design a simple lightweight motor that will start up at just a few RPM (I would be glad to be proven wrong!). Anyway, for right now, all our motors will have a definite startup speed, and that will be hundreds of RPM, not dozens.

Low punch values would probably be appropriate for large sport / scale craft, while you would want lots of punch for racing boats (for example, we need to get moving quickly into a straightaway right after coming off a sharp turn). Note that in the case of any motor equipped with a speed screw, attempting to hit full power abruptly from a standing start can result in what I call "cavitation trapping" - a condition where the screw ends up spinning freely in a big bubble of water vapor. So, the throttle has to be applied somewhat gradually at the start of a run with your racing boat.

Reverse Force (Parameter Item 5)

This enables you to set the maximum reverse speed of your motor to a fraction of its forward speed. The main reason for this is that for many boats, running in reverse at full power can pull the stern of the boat completely under. This is especially true of a low-speed 'tractor screw' - they have practically the same pulling efficiency in reverse as in forward.

A 'speed screw' is quite a different story. Here, the reverse capability is much less than in forward propulsion. So, on your racing boat, you might want to try 75 or even 100 percent. Again, the effect I've called "cavitation trapping" can easily occur if full throttle is applied too abruptly.

It's All About Timing (Parameter Item 6)

The modern brushless motors that we use are basically pulse-driven three-phase motors. The ESC provides pulses of high-frequency current that are applied to the stator of the motor, and the ESC automatically times these pulses to set the power and rotating speed of the motor. However, there is also another factor to the development of motor power (and efficiency): The ESC can provide the exact timing of these pulses in relation to the rotational position of the motor's rotor. This parameter is called **Timing Set** on the Program Card.

The position of the stator winding to the rotor's magnetic poles (at the instant the pulse is applied) is usually called the 'entrance angle' of the motor. Ideally, it would vary somewhat across varying motor speeds, but it is usually considered a fixed value. If we are lucky enough to buy a motor that has a specified entrance angle, it will be the angle setting that is ideal for efficient running at the designed full rotational speed. This is not necessarily the entrance angle that will give maximum performance, however.

In general, increasing the Entrance Angle will increase power and speed but will decrease electrical efficiency (i.e., increase power consumption). This means that tuning Entrance Angle for maximum performance will shorten running time, perhaps significantly. Also, there may be a certain point at which increasing Entrance Angle doesn't buy you any perceptible performance increase, but still degrades efficiency. Therefore, if performance is a big issue (as in racing), we should probably use the lowest Entrance Angle setting that yields good performance, and not push the setting any farther – some experimentation required.

The particular design of the motor makes a difference, too. The two-pole motor type generally called 'in-runners' will work properly only with low values, up to about 20 degrees. The multi-pole motors termed 'out-runners' only run well on angles of 20 degrees and higher. Obviously, this nicely narrows down the setting values that need to be considered.

If we try to tune for maximum performance, many (perhaps most or all) brushless motors will suffer irregular running at the very low end speed. When you advance the throttle from neutral just in to where the motor starts working, it will come up in a 'stuttering' mode, running in 'fits and starts'. This will smooth out as more throttle is applied. For some reason, this is called 'cogging'. I don't know of any cure for this except to de-tune the Entrance Angle, so if your goal is maximum performance you just learn to live with this.

For this setting, we are given choices in five-degree increments from 0 degrees (Value = 1) through 30 degrees (Value = 7), plus a setting for Automatic (Value = 8). The Automatic setting probably never gives maximum performance, but is very useful if we're using a motor where we simply don't

know the Entrance Angle design specification. It probably gives 'best efficiency' operation, because it adjusts the Entrance Angle to the actual speed of the motor in real time.

So, basically, our choices are:

1. Use the specified Entrance Angle if it is known; otherwise:
2. Use the Factory Default (20 degrees, Value = 5) - this will run all brushless motors and should give good performance for in-runner motors, but probably inadequate performance for out-runner motors.
3. Use Automatic as the simplest solution for good, efficient operation if the spec is unknown, OR:
4. Experiment based on the type of motor (in-runner or out-runner) and the performance desired.

Conclusion

I wish you many hours of pleasurable boating! I hope this guide is accurate, informative and helpful. If you have any questions, criticisms or corrections, please join the [HobbyKing.com Boats Forum](https://www.hobbyking.com/forums/index.php?board=10) and start (or join) a discussion there.

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