Boxing clever



The clever black boxes in many models aren't as complex to understand as you might think and offer some pretty essential features.

SHAHID BANGLAWALA DECIPHERS THE BLACK BOX AT THE HEART OF MOST LARGE MODELS

Perhaps you've wandered around a show and taken a closer look at some of the large and complex models sitting in the pits. You might even have glanced at the R/C installation and seen the usual array of servos, batteries and radio equipment. However, nestled amongst the more familiar electronics you may also have spotted a small box with all manner of wires sprouting out of it. What is this box? What purpose does it serve and is it really required?

FORM

In reality these clever little boxes perform all manner of functions. They can provide redundancy so that if, say, one receiver battery fails, there is another available to keep your model in the air. They can filter bad signals and thus help to combat radio interference and, for models using more than one servo per surface (say three servos driving one aileron), they can ensure the servos work together in perfect harmony. Mind you, by and large, redundancy is why they're usually employed, the sole purpose here being to safeguard a large model from catastrophic failure. After all, you'd be pretty gutted if an airframe you've spent months or even years putting together (and costing four figures), crashed because of a faulty £10 battery.

In the early days these devices started out as simple power distribution boards, providing basic redundancy for batteries but not a lot else. However, as models have become larger and more complex, so the facilities offered have expanded to satisfy the needs of pilots, adding servo matching and data logging to name but two.

One of the most popular brands is PowerBox from Germany. PowerBox is a world market leader and, in the UK at least, it's rare to see flyers using anything else. In part it's because the brand is long established and trusted, but it's also down to the availability of a wide range of units that cover all needs and budgets. The

Large models require powerful servos that in turn make heavy demands on the power supply.





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words » **Shahid Banglawala** | photos » **RCM&E library**





The DigiSwitch and SensorSwitch are the PowerBox items you'll see the most. Sporting a built-in voltage regulator, you can plug a two-cell lithium battery straight in.

Most of the larger boxes also use a SensorSwitch.

PowerBox name has almost come to mean any form of power distribution board, in much the same way as Hoover refers to any vacuum cleaner. Similar units can also be found from Emcotec in Germany and Smart-Fly in the States and whilst there are others, these are amongst the best known.

FUNCTION

Right, let's look at the functions that PowerBox units provide. Facilities will vary from unit to unit and, of course, not all will be required for every model, so it's down to selecting what most suits your needs.

Battery redundancy. Probably the most popular feature, this is where two receiver batteries are plugged into the radio circuit so that if one is faulty or fails, the other can take care of things to make sure your model gets home safely. Most systems that provide this will also have redundancy built into the switches, too. Moreover, the systems will have features to let the pilot know when one battery is faulty or running low, such as flashing LEDs or a warning sound. This, clearly, allows any issues to be addressed and rectified before take-off or after landing. You don't need to spend lots of money if this is all you want for your model, compact and lightweight PowerBox switches such as the Gemini or SensorSwitch are available that perform this function and nothing else. The low battery warning gives a margin of error so, when your switch tells you your batteries are low, it's at a level sufficient to have another flight. Not that I'd ever recommend doing that, mind!

When should you look to get battery redundancy for your model? Is it when you've spent more than a certain amount or when it reaches a certain size? Well, it's entirely up to you. Some fit battery redundancy to petrol aerobatic models of 50cc size, others only bother when they get to 100cc size (around 2.6m span). I fit a SensorSwitch to my 2m F3A models because I simply cannot afford to lose a model worth £2500 for the sake of a £5 battery. By the way, most PowerBox switches are designed such that if they fail, they fail in the *on* position, which is very reassuring.

Voltage regulation. The use of lithium batteries to power the servos and receiver is increasingly common because not only are they lighter than equivalent NiMH batteries, by stepping down the voltage from a Li-Po (say a 2-cell pack of 7.4 volts) to the voltage suitable for a servo (4.8 to 6 volts) you're getting voltage stability, i.e. the voltage supplied to the servos stays virtually constant and doesn't fluctuate.

Normally that's not really a concern but if the supply voltage fluctuates then so too does servo performance and that can be a disadvantage if you have a large aerobatic model where precision and feel are important. In intensive manoeuvres such as a fast rolling harrier or a knife-edge loop, the demanding current drain of high-performance digital servos can cause a drop in the voltage supplied to them which in turn means your servos won't perform as well. Using a Li-Po and stepping down the voltage overcomes this issue.

Having said that, servos are now emerging that run at around 7.2 – 7.4 volts and good voltage stability here requires the use of a 3-cell Li-Po. There aren't many products that do this, but for now, most needs are well covered. Besides, high voltage servos have better performance than their 6V or 4.8V counterparts, so any loss



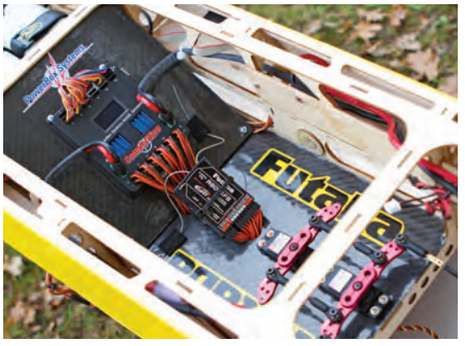
Designed for 2 – 2.6m span models, every element in PowerBox's Evolution is duplicated.



Big wings with multiple servos? You'll be needing a box, then!

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How do you spot a sponsored pilot? Stickers on the inside of his model! Seriously, there's a very good reason why some of the best pilots in the country use PowerBox products.



In situ and wired, you can see how batteries and servos first feed into the box that in turn supplies the receiver.

in performance due to voltage fluctuation is not such a big issue.

If you use a switch or system that has battery redundancy and voltage regulation then the chances are it will use two regulators, so you get redundancy in voltage regulation, too. Be wary of battery redundancy systems that offer voltage regulation and claim total redundancy, but only use one regulator.

Some PowerBox units can do a neat trick whereby different voltages are supplied to the receiver and servos. So, you can have the servos running at just over 7V but supply a lower voltage to your receiver. Why? Well, although there are high voltage servos on the market, not all receivers support this higher voltage. This being the case, it's always worth checking the manufacturer's specifications.

I mentioned that lithium cells were lighter than traditional batteries yet you may be wondering about the need to save a few grams on a large model? Surely a few grams don't make a difference? Well, some of these beastly airframes use two receiver packs of up to 5000mAh each so the difference between a NiMH and a Li-Po can save a lot of weight. It may help you shift the C of G, too!

Servo matching. Some large models use more than one servo per surface, indeed scale aerobatic machines spanning 3m often use three servos per aileron, two per elevator half and three or four on the rudder. That's fourteen servos guiding the airframe, sixteen if you add the engine throttle and choke servos. The reason for this is that no single servo is strong enough to safely operate the surface so servos are ganged to increase the total torque being delivered. You could, of course, just screw the servos in and forget about them, but this is ill advised. Even allowing for tight manufacturing tolerances, individual servos have neutral and end points that may well be different to the others (even within the same brand and model) which could lead to servos fighting one another by centring in different locations or travelling different amounts. It's not good and can lead to control surface warp and twist with imprecision in flight. Of more concern, on a large model, these servos are likely to be very powerful digitals so, when they fight, they'll be drawing a fair bit of current, draining batteries quicker and accelerating wear and tear. In the extreme cases servo failure could render the control surface unusable.

Some PowerBox units have a feature that allows gangs of servos to be matched by the user so you can set each with exactly the same neutral point and throw. Essentially the ganged servos plug in to one side of the PowerBox while a single lead coming out of the other side plugs into the corresponding receiver channel, keeping things nice and tidy.

There is another way though: Some Hitec servos can be programmed individually so you can match a bunch of servos without the need for a circuit board. It's an option that some flyers prefer as it reduces complexity and, since one servo programmer can be used to match servos across as many models as you want, there's no need to purchase a matching system for each of your airframes.



At around the size of a smartphone, most PowerBox units weigh between 100 and 200g.

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That said, the more comprehensive PowerBox units do provide servo matching, battery redundancy and voltage regulation all in one nice unit, as well as other features, which we'll discuss in a bit. Sure you can match your Hitec servos together but you may also want the other bells and whistles, which is why some still opt for a PowerBox.

Receiver redundancy. Much like battery redundancy, some PowerBox models support the use of two receivers so if one fails you still have the other to get you home safely. In the past modellers would use two receivers with servos shared between them. For example, servos on the right-hand side of the model would be plugged into one Rx with those on the left plugged into the other. If one Rx failed the theory went that you'd at least have the servos on one side to get your model home. Mind you, how well this worked in practice I don't know. With a PowerBox system this isn't the case, you get true total redundancy so, with one Rx dead, all servos will still function.

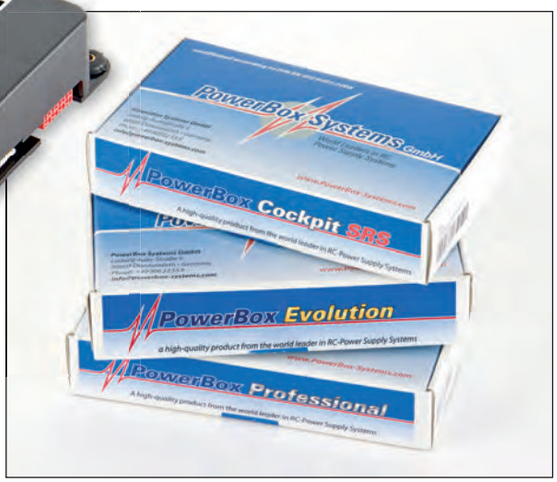
Signal amplification. Large models often require long extension leads, sometimes well over a metre in length. Some PowerBox units will amplify the signal sent to the servo so there is reduced loss as it travels along the wire. It's a nice feature, although I'm not sure how critical it is. It's often found on the higher end units and at the end of the day I guess we'd all rather have it than not.

Interference suppression. This makes sure that any electronic interference is filtered out of the signals sent to the servos and any electrical feedback from the servos is also taken care of. Remember, those digital servos can draw seriously big currents so electronic feedback is a possibility. Again, I don't know how critical this is but it's comforting to have if you've lots of money tied up in an airframe.

Data logging. Higher end units will log battery performance and radio signal data so you can go back and see if the batteries are up to the job and how much capacity has been consumed. It sounds slightly 'anoraky' but it's a useful feature because it removes the guesswork. Knowledge of the radio signal means you can identify instances of poor signal or even momentary fail-safe which could be indicative of an underlying problem. This, of course, gives you a chance to rectify things before it's too late.

Circuit board redundancy. Some PowerBoxes are designed so that every single electronic component is duplicated – an indication of the precautions that the PowerBox company takes to ensure that there is no single point of failure.





Another high-end unit, PowerBox's Professional features an OLED screen and, as you'd expect, every system is duplicated.

WHAT TO GET

With the main features covered you might fancy getting a PowerBox or similar device for your next model. If so, here's some tips to help the selection process.

- How many servos? A simple answer really, if it's for a model with a single servo per surface then you're unlikely to want to splash out on a PowerBox that can match four servos together.
- What redundancy do I want? Do you want receiver redundancy or are you happy with a single Rx? Remember that battery redundancy is almost universal across the PowerBox range.
- Do I need a voltage regulator? If you plan on using a Li-Po battery or similar then this is a big fat yes. If not, then you don't require it. Mind you, most of the higher end units have voltage regulation anyway. This doesn't mean to say you have to use Li-Pos if they do, but the option is there.
- What models am I planning to fly in the future? You might want to purchase a unit that offers more than you currently require because you're planning on getting a model worthy of it later on.
- What sort of servos am I using and how much current will they collectively draw? The smallest PowerBox units are little more than a switch with some redundancy built into the components and switching mechanism. These can handle around 5 amps, which is



They're not cheap but the peace of mind these units bring makes them near essential for pilots of large models.

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The range-topping Cockpit SRS offers redundancy and residual everything! It's designed for multiple receivers and tends to find a home in the most complex and demanding machines.

fine for most small to medium-size models. However, five or six digital servos may run the risk of exceeding the current capacity, especially if it's an aerobatic model with big throws. Pay attention to the manufacturer's specifications and consider whether the unit can handle all your servos. If in doubt ask a knowledgeable retailer.

POWER PEOPLE

You should now be far more conversant with PowerBox and other similar units. To wrap things up, let's consider how I selected a PowerBox for my F3A model.

The aircraft, a WistModel Bravo, has digital servos all around, one on each aileron, one for rudder and two minis for the elevator halves, a total of five digital servos. I don't have anything for the throttle because the model is electric powered.

Despite being an aerobatic design, the servo current draw isn't that great because F3A machines use small



throws. In fact, a friend has measured the current draw on a similar model and found the peak draw to be little over 3 amps. What did I want from my system? Well, the most basic PowerBox is probably the DigiSwitch. It's a combined switch and regulator for a single battery. If the switch fails, it fails in the on position. That's about all it does but you are, at least, buying a tested, proven device that brings peace of mind.

For this model, however, it was important to save every last gram, so a Li-Po for the Rx and servos was a must, but this meant I needed voltage regulation. I wanted battery redundancy as well, so the DigiSwitch was no good. The SensorSwitch, on the other hand, is ideal. It's a compact unit into which I can plug two Li-Pos, giving me the redundancy I want, along with voltage regulation, too. The 5 amp total current rating is plenty and I don't need servo matching because no servos are ganged together. The choice was made and, 100 or so flights later, I'm very happy.

WEB LINKS

PowerBox Systems: www.powerbox-systems.com
UK supplier: www.motorsandrotors.com



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