Tech - Aero Designs

Tech-Tip #0601 – Redundant Power Configurations

This Tech-Tip explains the hot to set up a rock-solid redundant power delivery system for your prized model aircraft. Even though you can successfully fly with just one battery and regulator, having a backup on tap in case of battery failure has saved models on many occasions and is cheap insurance. The critical success factor requirements are:

- Use the right batteries. Assure that the voltage, capacity ratings and ability to deliver current under load meet the need.
- Select the right failsafe regulator system. High reliability design, failsafe switch design, precision programmability, low dropout rating, fast response to load demands, high current delivery capability and protection against any reverse current flow is required.

Tech-Aero FlexReg products have all of the key features to meet these requirements.

There are two basic schools of thought about how to do a redundant power delivery system and both are valid and effective. These are the **Balanced Redundant Supply** (AKA Dual Supply) and the **Hot Standby Redundant Supply** (AKA Backup Supply). We will illustrate enough here to help you make the best choice to suit your individual preference. Both methods described require two batteries and a pair of PLR5 or PLR5-I regulators (either model works the same way). Alternatively, a single PLR5-DR2 with two batteries can be used, which simplifies the configuration somewhat. The first method presented is the Balanced Redundant Supply, shown in figure 1 with a pair of PLR5-I regulators.

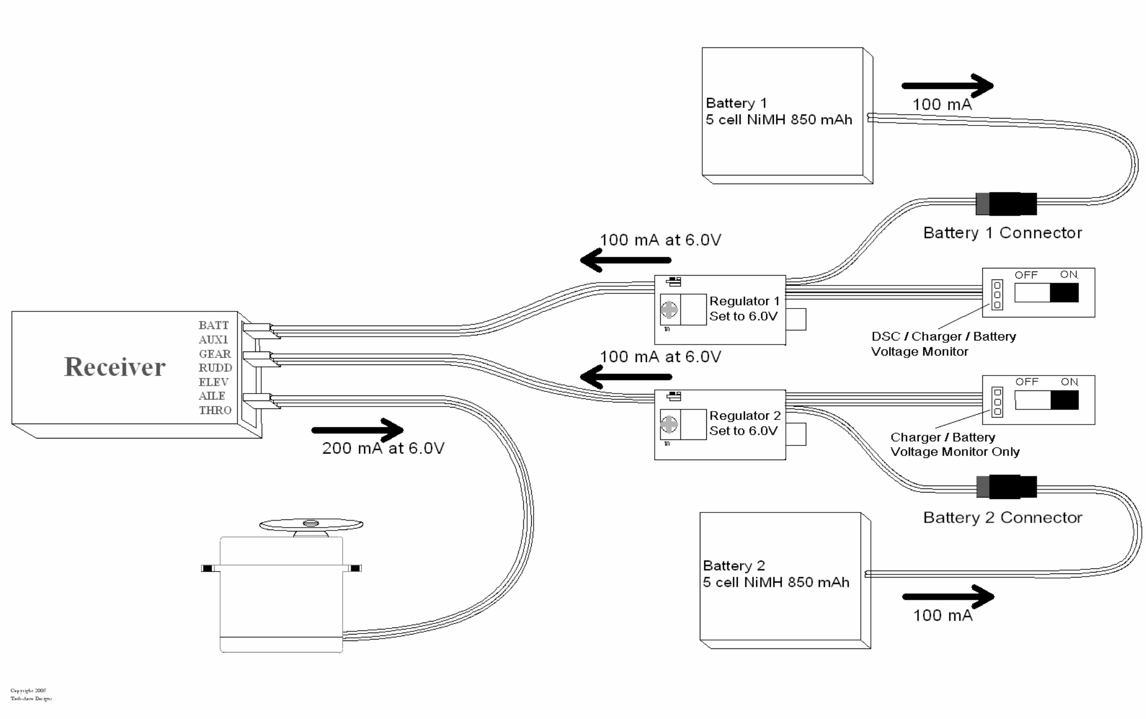

Figure 1 - Balanced Redundant Supply with everything operating normally

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The Balanced Redundant Supply: **What happens normally?**

The first thing to note is that no current ever flows through the On/Off switches when the regulator is on. The diagram shows the actual path that electrical current takes, which is from each battery, through the regulator board attached to it and then directly to the receiver. The receiver connector block is the common point that "sees" the regulated voltage from both regulators. Regulated voltage and full current needed by the servos is delivered through the connector block to each servo, just as is normally the case.

The key feature is that you now have two equally balanced sources of supply that can supply closely matched current levels under load, as illustrated. Either side is capable of supplying uninterrupted power to the receiver and servos if a failure happens with the other side. In this example things are working normally and there is a 200 mA current load from the servo. To meet this demand, 100 mA flows from battery 1, through regulator 1, and into the receiver's connector block. The same exact thing happens simultaneously from battery 2 and regulator 2. These two current sources effectively combine to deliver the full 200 mA load, in much the same way as two rivers meet to combine into one larger and stronger water current.

This configuration assures that as you use up battery capacity when flying, they will both come down the discharge curve fairly closely together, making battery charging and maintenance easy to track. You should use packs of the same type and capacity to get the most of this technique. The balanced current levels occur when the programmed voltages are matched, provided that you do not add excessive extra lengths of extension wiring to one regulator. If one supply lead is much longer than the other (about 50% or more longer), the additional voltage drop along the extra wire length can cause the balanced system to be "out of trim", so to speak. Everything will still work, but one battery may habitually deliver more current to the servo load than the other will.

It is recommended that you monitor battery voltage for each pack prior to each flight, which is a good recommendation in any configuration. Besides assuring that everything ready for flight, this also lets you track the change in battery voltage as they discharge, especially when using LiPo or LiIon batteries. Jotting these values down during each flying session will let you easily see how things are performing throughout the flying season and even year-to-year.

The Balanced Redundant Supply: What if a battery fails?

As with most things, there is a compromise involved with any redundant supply setup. Although we have provided a safe backup if a failure occurs, we have also added some complexity, i.e., there are more parts that can potentially fail. Similar principles are involved here as with a multi-engine airplane. More engines = more chance of an engine failure, but if the airplane is flown within its limits; you also have more options to save yourself than a single engine design allows. Fortunately, if a single failure does occur with a Tech-Aero redundant configuration, the fault is seamlessly handled.

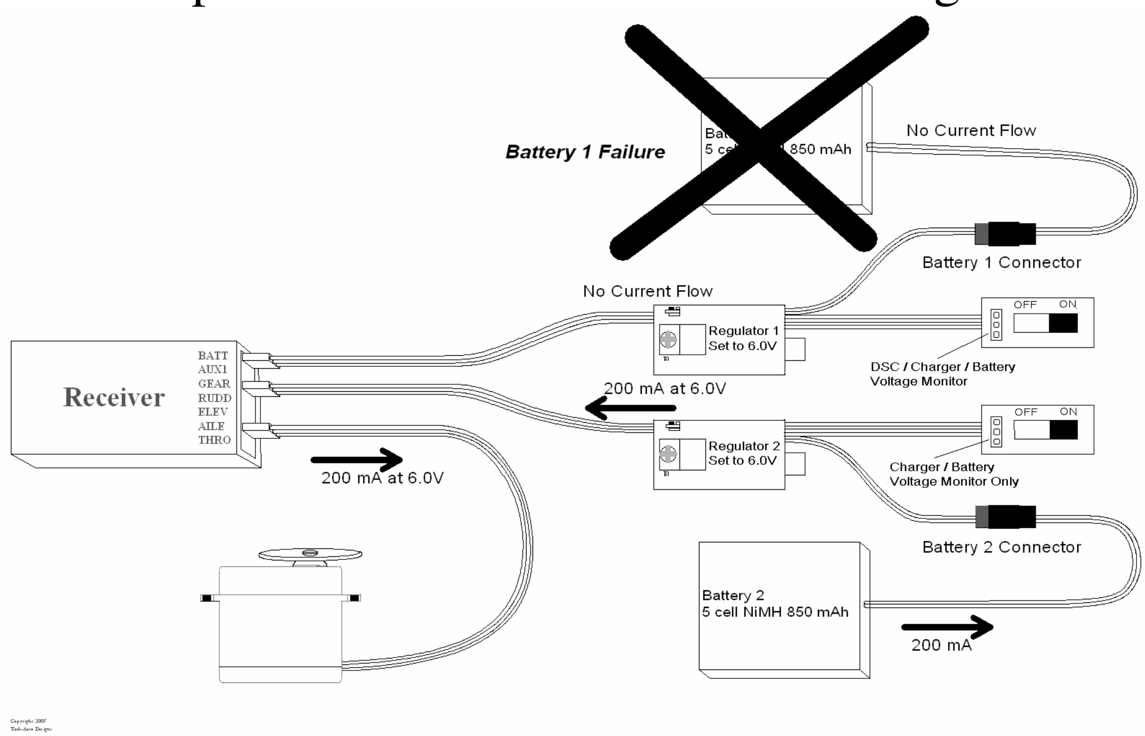

Figure 2 - Balanced Redundant Supply handling a failed battery situation

Refer to figure 2 and note that battery 1 has failed for some reason. Because of this, regulator 1 can no longer contribute to the power needs of the full system and Regulator 2 instantly picks up the slack. No reverse current can ever flow back through Regulator 1 and into the failed or discharged battery, so in case a failure does happen, the good battery will not expend any of its capacity trying to "charge" the bad battery pack. The same exact scenario holds if the failure were with the other battery; #1 would take over for #2 in that case. In either case, the same regulated voltage level will be delivered to the receiver and servos. The same holds true if a wire breaks or even in the unlikely event that a regulator fails.

The Hot Standby Redundant Supply: Normal Operation

The Hot Standby Redundant Supply configuration has many similarities to the Balanced Redundant Supply already described. Refer to figure 3 and note that they are physically wired the same way. The diagram depicts a lower capacity (but the same voltage rating) battery for the backup as a weight savings method, but you can use any capacity that you find suitable, as long as it is enough to fully power your model for at least an entire flight, with some safety margin. Tech-Aero recommends backup battery capacity margin of safety of at least 2X the capacity needed for one full flight, so if you would normally use about 200 mAh capacity in a flight, a 450 mAh pack would be a good idea.

The only real difference between the Balanced Redundant Supply and the Hot Standby Redundant Supply is that you simply program one regulator to be a little bit higher in output voltage than the other. The regulator with the higher voltage setting and its corresponding battery becomes “the primary”. The other one becomes the Hot Standby, i.e. “the backup”. Because the primary is set higher, it begins to deliver more of a share of the full servo load current than the one at the lower setting. If you continue to step adjust the primary just high enough (or set the back up just low enough – either way), it will handle the entire load.

To achieve a “zero load” backup, it usually won’t take much of a difference between the two output voltage levels. About 0.1V difference is a good starting point to try out, but systems with 6 or 7 high torque digital servos may place enough load demand to cause the backup to deliver some current at peak times, even though everything is working well. You can experiment to find the optimal setting for your model and you might find that you settle on a value around 0.2V lower for the backup. Note that there is never really “zero load” on the backup while operating, since the regulator circuitry uses a few mA for its own operation even when idling, but this is a negligible amount. However you should still check and occasionally recharge the backup to assure that it’s full capacity is there when you are ready to go flying.

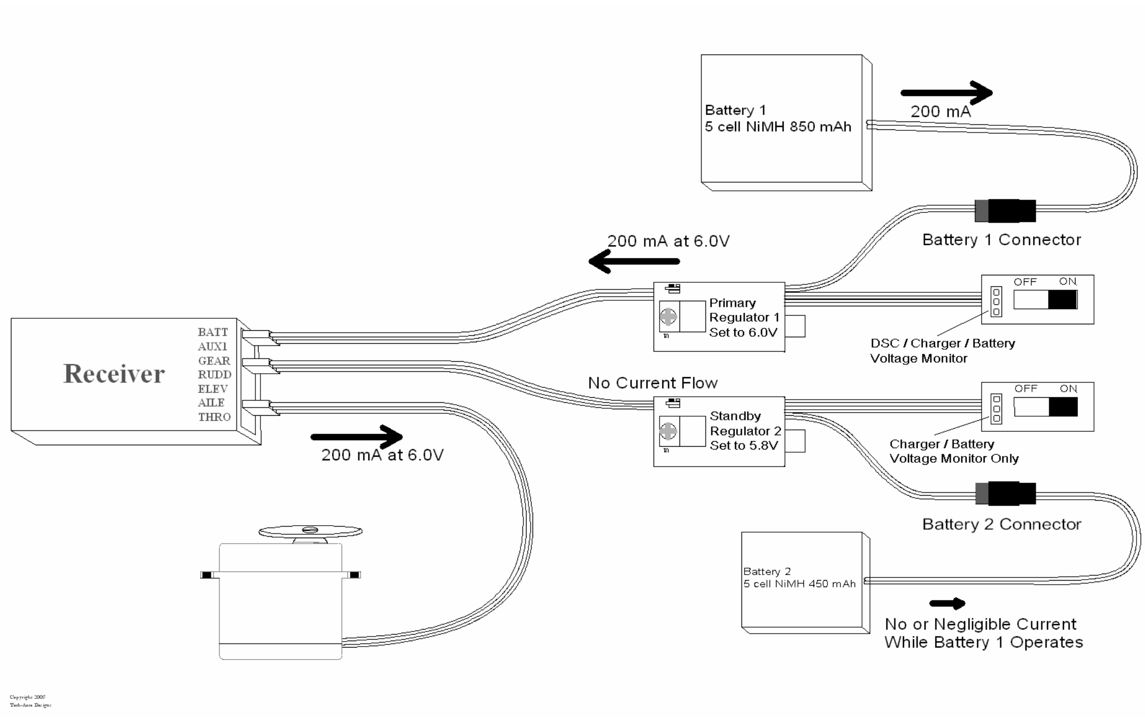

Figure 3 - Hot Standby Redundant Supply with everything operating normally

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The Hot Standby Redundant Supply: Normal Operation

In figure 3, battery 2 is the backup with its corresponding regulator set as a zero load backup, so it doesn't supply current to the servos during normal operation. All of the 200 mA load is being supplied by the primary, as shown by the current path arrows. In essence, its normal mode of operation is like the single failure mode of the Balanced Redundant Supply, since all the current flows from one battery and through one regulator. The key difference is that if that primary fails as in figure 4, the full load instantly toggles to the backup with no interruption at all, albeit at a slightly lower regulated supply voltage.

To assure that everything is ready to operate as expected in the air, checking the backup battery is a good way to confirm any suspicions you may have of improper operation of the primary during flight. For example, if your experience has shown that the backup does not normally get tapped during flight and if this situation changes, you should suspect that during flight, the primary system isn't holding up as well as it once did. This can be a valuable clue that the primary battery is getting worn out and may be due for replacement.

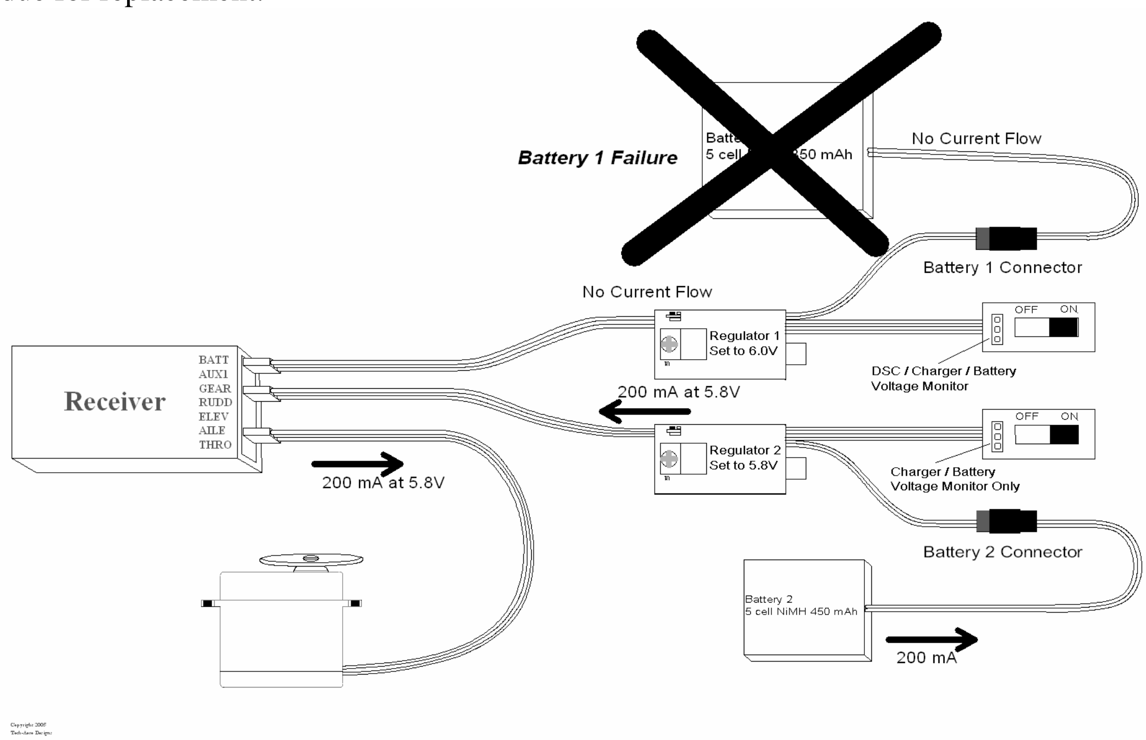

Figure 4 - Hot Standby Redundant Supply handling a failed primary battery situation

As a final note, the backup is also referred to as a "hot standby", not because it's running hot temperature-wise (it's not!), but because it's "hot and ready" electrically, meaning that it can instantly take over the full load if needed. Keeping the two regulator settings fairly close assures that if one battery fails, servo speed and power would be virtually unaffected.