Rotax Generators and External Alternator

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Introduction

The Rotax 915 iS and 916 iS are modern turbocharged aircraft engines known for their high power output (around 141–160 horsepower) and efficient design. These engines are popular in light sport and kit-built aircraft like the Sling TSi, prized for delivering strong performance at relatively low weight. A key feature of the 915/916 series is their dual alternator (or "dual generator") system built into the engine. In an era where aircraft like the Sling TSi sport full glass cockpits, GPS, autopilots, and electronic engine controls, a reliable electrical supply is vitally important. Modern aircraft engines, including the Rotax 915/916, rely on electronic engine management and fuel injection, which makes the electrical system as critical to safety as the engine's mechanical parts. This introduction provides an overview of these engines and highlights the importance of the dual alternator setup in keeping both the engine and avionics powered. In the sections that follow, we will explore how the dual alternators are arranged, how they function under various conditions, considerations for adding an external alternator, and what happens in different failure scenarios.

Architecture of the Dual Alternator System

Rotax 915 and 916 engines have two internal alternators built into a single engine-mounted system. Physically, they share one stator assembly at the back of the engine, but contain two isolated sets of coils (often referred to as generator "A" and "B") that produce electrical power independently. Each coil feeds its own rectifier-regulator unit, and together they form two separate DC power sources. In simpler terms, the engine carries a *two-in-one* alternator: one alternator (A) dedicated to engine operations and another (B) dedicated to the aircraft's electrical needs. Each has a nominal output of around 14 volts. Alternator A can supply roughly 16 amps (about 220 watts) and alternator B about 30 amps (420 watts) at normal operating temperatures .

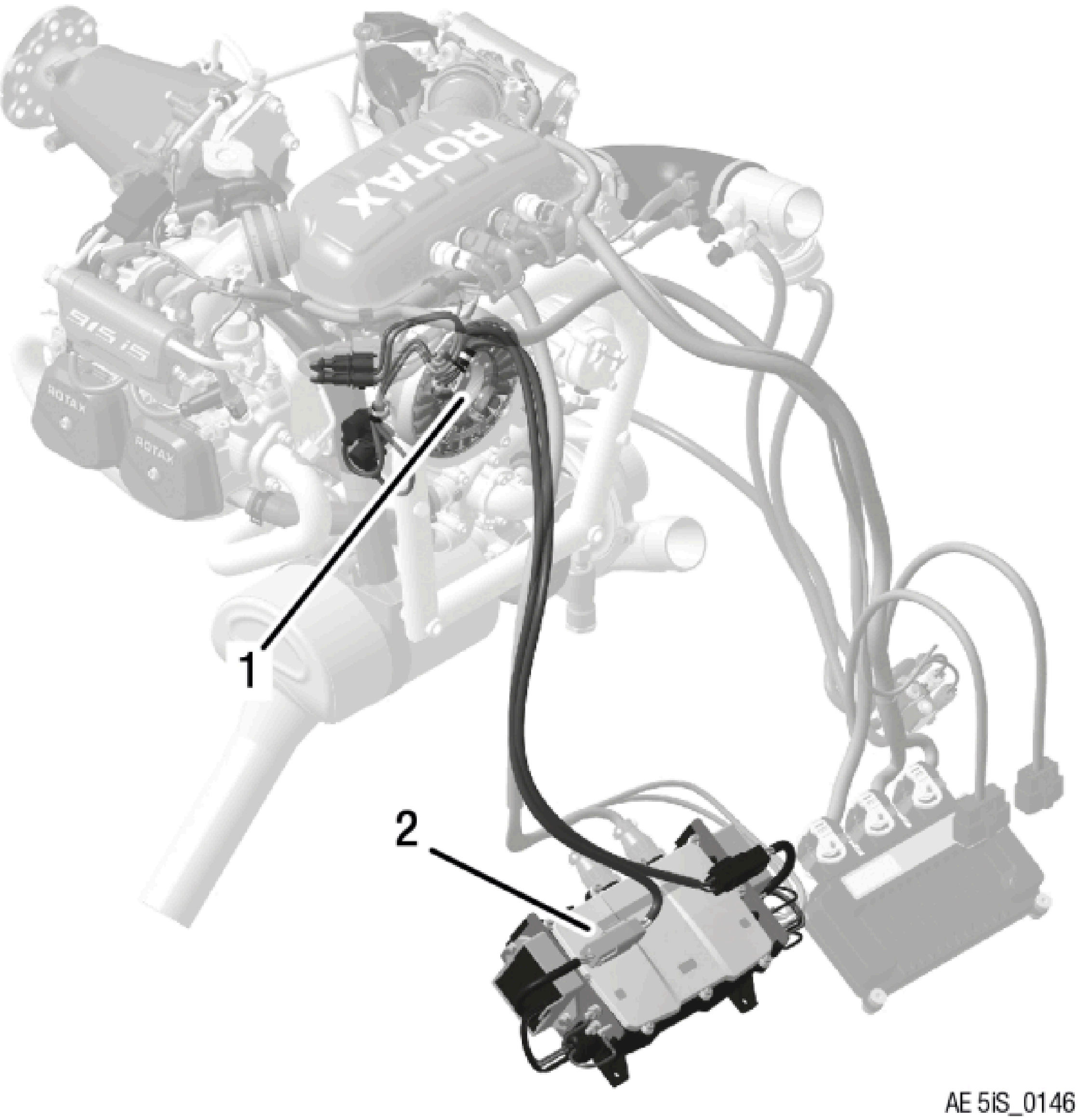

Figure 9: Internal power supply

1 Stator *2 Fusebox*

Figure: Rotax 915iS internal electrical system – The engine's stator (label 1) and fusebox (label 2) containing dual rectifier/regulators. This built-in system provides two independent power sources: one for the Engine Management System and another for aircraft electronics. Source: Rotax 915is Operators Manual

In the Sling TSi and similar installations, alternator A's output is dedicated to running the Engine Management System (EMS) and critical engine accessories. This includes the electronic control unit (ECU), ignition system, fuel injectors, and fuel pumps. For safety, the output of alternator A is **not** directly tied into the aircraft's main electrical bus; it is essentially reserved for engine use only. Alternator B, on the other hand, is connected to the aircraft's main electrical bus (sometimes called the "house" or airframe bus). It powers the avionics, instrument displays, lights, radios, and other electrical equipment in the cockpit. Alternator B also charges the aircraft's main battery during flight. The two alternators are mounted within the engine's top-mounted fusebox assembly (made by Ducati Energia) which contains the rectifier/regulators for each side . By converting the alternators' AC output to DC and regulating it to about 14.2 volts, the system ensures both the engine electronics and aircraft systems have a steady supply of voltage. This dual architecture provides inherent redundancy: either alternator alone can run the engine in a pinch, which is a fundamental safety feature of the Rotax 915/916 design.

Functionality of the Alternators

Under normal operating conditions, the two internal alternators work in a coordinated manner to supply power to different loads. When starting the engine, the aircraft's battery initially provides all electrical power. The starter motor cranks the engine and the battery powers the ECU, fuel pumps, and ignition until the engine fires up. Once the engine reaches about 2500 RPM, alternator B comes online and begins to supply the engine's EMS with power . At this stage (just after startup), alternator B essentially takes over from the battery in keeping the engine running. After a brief engine self-check process, the system automatically transitions power supply for the engine from alternator B to alternator A . In other words, a short time after startup, alternator A becomes the primary source powering the engine's electronics. At that point, alternator B is freed up to do what it normally does in flight: supply the rest of the aircraft's electrical consumers and recharge the battery . This automatic switching is managed by the engine's electronic control unit and a power switching module (via relays) to ensure the engine always has at least one dedicated power source.

Once the aircraft is in cruise with the engine running, alternator A continuously powers the engine systems, while alternator B powers the avionics and other equipment. The design prioritizes critical systems (the engine's EMS) on alternator A, which has no other duties. Alternator B's energy is split among charging the battery and running everything from flight instruments to lights. In practice, alternator B's 30 A capacity is sufficient for typical VFR avionics and lighting, but it can be approached or exceeded if the aircraft is equipped with a lot of electronics (for example, multiple glass cockpit screens, autopilot, radios, plus high-draw items like pitot heat and powerful LED lights). Pilots should be mindful of the electrical load – if too many devices run at once, the total draw could exceed what alternator B can supply (30 amps). In such cases, the electrical system will begin to draw from the battery to make up the deficit, and the bus voltage may start to drop below its normal ~14 volts. Pilots can monitor this via the voltmeter or ammeter on the panel. A declining voltage (or a battery discharge indication on an ammeter) during flight is a sign that either the alternator B has failed or the power demand is exceeding its capacity. The Garmin G3X or similar engine monitoring systems installed in aircraft like the Sling TSi can provide alerts if the main bus is drawing from the battery unexpectedly, warning the pilot of a potential alternator issue.

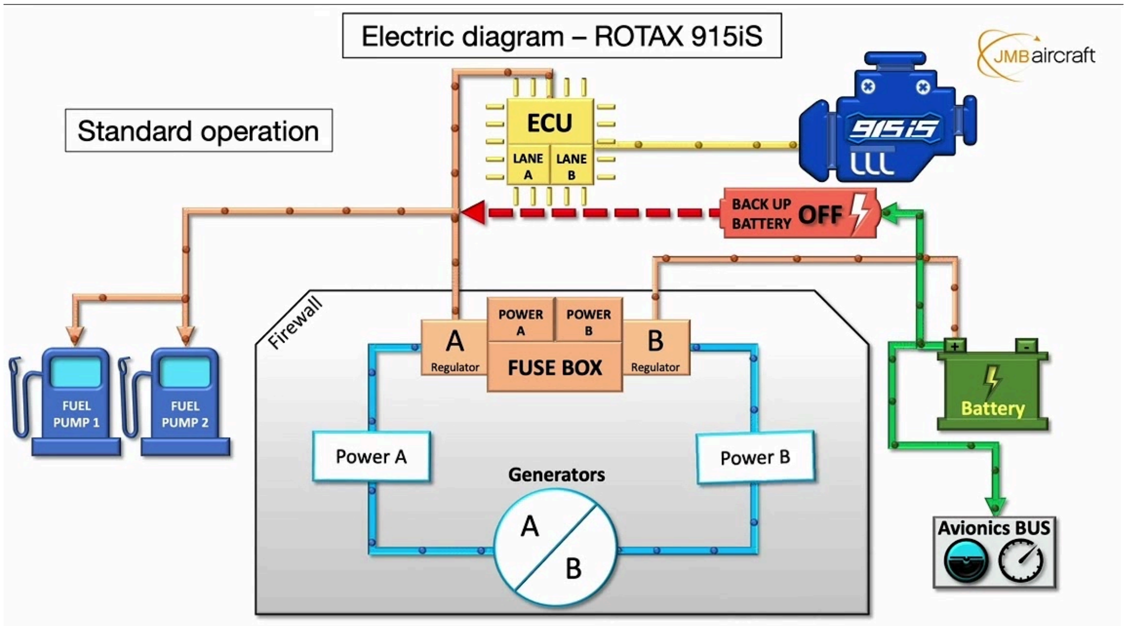

*Figure: Conceptual Architecture of the Rotax 915/916iS electrical system. Source: [JMB Aircraft Youtube video](). *

To manage loads, there is an order of priority: critical equipment (like the engine ECU or electronic ignition) always has top priority and is kept powered by alternator A at all times. Non-critical or high-draw items (such as cabin lights, seat heaters, or pitot heat) should be turned off first if the pilot needs to shed load. For example, in IFR conditions a pilot might use the heated pitot tube and full avionics, which pushes close to the alternator's limit; if the alternator is struggling, the pilot could turn off non-essential lights or other accessories to reduce the load. Under normal operation, however, the two alternators together provide a healthy margin of power for both engine and avionics. The system is engineered such that alternator B can even temporarily power both the engine and aircraft if needed – for instance, during the few seconds of switchover in startup or if alternator A hasn't yet taken over – without a noticeable drop in bus voltage. In summary, in everyday flying the pilot doesn't have to actively manage which alternator powers what; the system automatically dedicates alternator A to the engine, and uses alternator B for everything else. The pilot's main task is to monitor the electrical system status (voltage and current) and be prepared to react if an alternator falls offline or if the electrical load becomes too high for the system.

Adding an External Alternator

Given the 915/916's built-in alternator B is limited to about 30 amps continuous output, some pilots and builders (especially those who fly aircraft like the Sling TSi under instrument flight rules or with many electrical accessories) consider adding an **external alternator** for extra power. The Rotax 915/916 series has provisions for an optional belt-driven alternator that mounts on the propeller gearbox flange. This is essentially a third alternator, added to the front of the engine, that can significantly increase available electrical power. Rotax offers an official external alternator kit (approximately 40 A output), and there are aftermarket solutions as well. For example, one popular kit provides a 40-amp alternator that outputs 14.2 V and weighs about 3 kg (6.6 lbs) . There are even higher-capacity aftermarket kits (RS Flight Systems offers up to dual 150 A alternators), though those are beyond the needs of most light aircraft and come with weight and cost penalties.

Installing an external alternator is generally feasible on the Sling TSi's Rotax 915 iS engine and is an option offered by the kit manufacturer. The installation typically involves bolting the alternator to the engine's accessory pad or prop flange and adding a drive belt. The alternator's output is wired through a regulator (often built into the unit) and then to the aircraft's main bus or battery via a circuit breaker switch . Usually, the external alternator is controlled by the pilot through a switch or breaker – this allows the pilot to turn it on only when needed, such as during high load operations or in the event the main alternator B cannot handle the load. In normal practice, many builders will wire the external alternator so it remains off under most conditions and is activated manually if the primary alternator B fails or if the electrical load is consistently above about 75-80% of alternator B's capacity. This strategy prevents the external unit from "fighting" the internal alternators. Due to slight differences in regulator set points, if both alternator B and an external alternator are active, the one with the slightly higher voltage will carry more of the load . By using one alternator at a time (or designating one as primary and the other as a backup), the system avoids complex load-sharing issues.

Benefits

Adding an external alternator can roughly double (or more) the available electrical power for the aircraft's systems. This is especially useful for pilots who fly at night or in IFR conditions with multiple avionics screens, pitot heat, de-icing equipment, and other accessories that draw significant power. It provides peace of mind that the alternator won't be overloaded – for instance, one can cruise with all avionics and lights on and have ample amps to spare, rather than running the main alternator at its limit. Another big benefit is improved redundancy. With an external alternator installed, you effectively have a third source of power. In the event alternator B fails, the external unit can be brought online to power the avionics and charge the battery, rather than relying solely on the battery. Even if alternator A (engine alternator) were to fail, an external alternator could potentially be used to feed the engine's electrical system through the battery or backup circuits (more on that in the failure scenarios section). Some Sling TSi owners also report a **center-of-gravity advantage**: the external alternator's weight at the front of the engine helps offset the Sling's tendency toward an aft CG when loaded with passengers and luggage. In essence, the alternator serves as a small forward ballast, which can improve the CG envelope of the airplane (this is a unique side benefit and specific to aircraft like the Sling that might be tail-heavy).

Drawbacks and Considerations

The trade-offs for an external alternator include added weight and complexity. An extra 3 kg on the nose isn't a huge penalty in a four-seat aircraft, but every bit of weight and drag can slightly reduce useful load and performance. The installation requires a mounting bracket and drive belt, which introduce additional potential failure points (e.g., belt tension and wear must be checked). There is also the cost of the alternator kit and the effort to integrate it into the electrical system. Pilots must be trained on how to operate it – usually, procedures are added to the checklist to periodically check the external alternator or to manage it in abnormal situations. Another consideration is that an external alternator running at full capacity will put an extra load on the engine (on the order of a few horsepower drain when producing max power). However, in normal operations this load is minor and only incurred when the alternator is actually producing a lot of current. Overall, the external alternator option is a popular upgrade for owners of the Rotax 915/916, especially those who want full IFR capability or extra redundancy. It is feasible to install and offers significant benefits in electrical system capacity, so long as one is aware of the weight, cost, and complexity implications.

Failure Scenarios and Impact on Electrical Systems

While the dual internal alternators of the Rotax 915/916 provide redundancy, pilots should understand what happens in various failure scenarios – and how an external alternator could help in those cases. The engine's electronic control system is designed to automatically handle single alternator failures with minimal pilot intervention, but a double failure is more serious. Below we outline a few scenarios:

1. Failure of Alternator A (Engine Alternator)

If alternator A (the 16 A engine-dedicated alternator) fails in flight, the engine will not immediately quit. In this situation, the engine's ECU will automatically switch over to draw power from alternator B, essentially using B as the backup source for the engine . This happens through an internal switching mechanism (relays that isolate alternator A's circuit and allow alternator B to feed the EMS). From the pilot's perspective, there may be a warning light (often the "Lane B" light in Rotax installations) indicating alternator A is offline, but the engine continues to run normally now powered by alternator B. However, because alternator B is now diverted to the engine, it will **stop feeding the aircraft's main bus**. All your avionics, lights, and other non-engine systems will automatically fall back to battery power in this scenario . The aircraft's battery will no longer be getting charge from alternator B either, since B's priority becomes sustaining the engine. The immediate impact is that while the engine keeps running, the clock starts ticking on your battery endurance for avionics. Pilots should **shed non-essential loads** to conserve battery life if this occurs (for example, turn off cabin lights or secondary radios) and prepare to land if the battery capacity is limited. In practice, alternator A failures are rare, but it's important to recognize that a failed engine alternator means your only source of power for avionics is the battery (unless you have an external alternator). An external alternator in this scenario could greatly mitigate the impact: if the airplane is equipped with one, the pilot could activate the external alternator to take over powering the main bus, thereby keeping the avionics and other systems running without draining the battery. The engine would be on alternator B and everything else on the external alternator – a comfortable situation given the circumstances.

2. Failure of Alternator B (Aircraft Alternator)

If alternator B fails, the situation is somewhat the mirror image of the above. The engine will continue running on alternator A power without interruption . The pilot will likely get an alert (such as a "Lane A" warning light or a low voltage alarm) because the bus voltage will drop when alternator B stops functioning. With B out, the aircraft's electrical bus and battery charging system are lost; alternator A is *only* wired to the engine's own circuits and cannot recharge the battery or directly power the avionics bus. Therefore, all the aircraft systems will immediately switch to battery power in this scenario as well. The battery will no longer be charging , and as it supplies current to run the avionics, its voltage will gradually start to drop. The pilot should again shed loads and plan to land if the alternator B cannot be recovered, because the battery alone might sustain the avionics for perhaps tens of minutes (depending on its capacity and the load) . In many installations, a warning light or EFIS message will specifically indicate "Generator B" failure. The POH for the Sling TSi notes that the engine will continue to run after an alternator failure, but the pilot should manage the electrical load and consider the battery life remaining . If an external alternator is installed, it can be a game-changer in this scenario: the pilot can turn on the external unit, which will then provide power to the main bus and keep the avionics and lights on *and* recharge the battery (depending on how it is wired) . Essentially, the external alternator can step in to do the job that alternator B was doing – preventing a total electrical loss on the airframe side. This greatly reduces urgency, allowing the flight to continue to a safe landing with all systems operational, rather than racing against a draining battery.

3. Failure of Both Internal Alternators (Dual Failure)

This is an unlikely but critical scenario – a double alternator failure will result in a complete loss of engine power *unless* immediate action is taken. If both alternator A and B cease to produce power (for example, due to a common failure like a short in the stator or dual regulator failure), the engine's EMS has no electrical source and the engine will stop. The Rotax 915/916 installation includes a feature called a **backup battery switch** for this worst-case scenario . Activating the backup battery switch connects the aircraft's main battery directly to the engine's EMS power inputs, essentially allowing the battery to take over as the emergency power source for the ECU and fuel pumps . The pilot's operating handbook emergency checklist will have steps for a double generator failure – typically it instructs to turn on the backup battery or ECU backup switch, verify the engine is receiving power, and attempt to restart if the engine had died. With the backup switch on, the engine can be restarted (since the battery powers the ignition and fuel system) and will run as long as battery power remains . However, in this state the battery is the *only* source of power for both the engine and all avionics. Endurance is very limited – roughly 20 to 30 minutes of flight at best, and likely less since both the engine EMS and the instruments are drawing power . Pilots are advised to **land as soon as possible** in the event of a double alternator failure, since once the battery is depleted you will have neither engine nor instruments. Non-essential equipment should be immediately switched off to conserve power (for instance, shut off lights, cabin fans, even turn off one of the EFIS screens if you have multiple) . In a Sling TSi, one might even switch off the second fuel pump if not needed, to save power (using only one fuel pump can extend battery life in this emergency). If an external alternator is on the aircraft, could it save the day here? If the engine is windmilling (turning) and the external alternator is functional, it might still be producing some power – but remember that a dual *internal* alternator failure often implies the engine has stopped, so the external alternator would also not be spinning anymore. The sequence in such a case would be: engine dies, pilot enables backup battery to power the engine, and attempts restart. If the engine comes back to life (now running on battery), the external alternator belt-driven from the engine will start turning again too. The external alternator could then begin supplying power to the system and charging the battery, effectively taking over for the failed internals. This could greatly extend how long the engine can run and the instruments stay on, potentially turning a 15-minute emergency into a more controlled situation. It's important to note, however, that this only works if the external alternator was installed and either came on automatically or was switched on by the pilot after the failure. Some modern installations have automatic backup batteries or even backup alternators, but in most kit aircraft the pilot must manually manage these. With an external alternator in play, a double internal failure no longer means total electrical loss – it becomes analogous to the "alternator B failed" scenario (with engine on alternator A or battery, and external powering the bus). Still, due to complexity, it's not guaranteed unless properly wired for that contingency. **Weight and balance** impacts of adding an external alternator are generally minor but worth noting here: the Sling TSi's POH and builders have observed that the extra weight on the nose can be beneficial for balance, and from a failure scenario perspective, there is no negative effect – the alternator either works or it doesn't; if it fails or the belt breaks, you're no worse off than without it. The only consideration is ensuring any added alternator is properly secured and its electrical connections are robust to handle the current in failure cases.

In summary, the dual internal alternators give the Rotax 915/916-equipped aircraft a high degree of safety. A single failure (A or B) results in loss of redundancy but the flight can typically continue for some time using the remaining alternator and battery . A dual failure is an emergency, mitigated by the backup battery switch to keep the engine running for a short duration . Adding an external alternator significantly improves the redundancy: it can supply the aircraft systems if either internal alternator fails, and in theory can even keep the engine running through a dual internal failure if managed correctly. Pilots should be familiar with the electrical schematics of their aircraft – understanding which components are on which alternator – and follow the emergency checklists provided (for example, the Sling TSi checklist that covers alternator failures and the use of the backup ECU battery). By practicing scenarios in simulation or training, a pilot can react promptly to an alternator warning light by shedding loads, activating backups, or starting the external alternator as needed.

Conclusion

The Sling TSi and similar aircraft benefit greatly from the Rotax 915 and 916 engines' dual alternator system, which provides a robust and redundant electrical power setup. We have seen that **Alternator A** is dedicated to keeping the engine's electronic brain and fuel system alive, while **Alternator B** takes care of the aircraft's avionics and recharges the battery. This architecture means that even if one alternator fails, the other can carry the essential load – an important safety net for any modern aircraft dependent on electronics. The functionality of the system is largely automatic and behind-the-scenes, ensuring that during normal operations pilots don't have to manually manage power source selection. Nevertheless, pilots must remain vigilant, monitoring their voltmeters and ammeters for signs of trouble and being prepared to act (turning off non-essentials or switching on backups) in the event of an alternator failure .

For pilots and aircraft owners who are not mechanics, it's reassuring to know that the Rotax's dual alternators are **built-in guardians** of your electrical supply. They prioritize critical engine power needs and intelligently share the workload to keep your battery charged and your avionics running. The addition of an **external alternator** is an option worth considering for those flying with heavy electrical loads or who desire an extra layer of redundancy. It can provide additional amperage for power-hungry systems and serve as a backup generator in case one of the internal alternators fails. However, with that upgrade comes added complexity and weight, so the decision should be based on individual mission needs. A Sling TSi being equipped for IFR cross-country flights with dual glass panels, radar transponder, autopilot, and anti-ice might strongly benefit from the external alternator, whereas a daytime VFR flyer with minimal electronics might find the stock dual alternators perfectly sufficient.

In conclusion, the dual alternator system of the Rotax 915/916 exemplifies the modern approach to aircraft engine design – providing redundancy and reliability for an electronically dependent engine. Pilots and owners should take the time to understand their electrical system layout (diagrams and schematics can be a big help in visualizing which component is powered by which source) and ensure they adhere to proper maintenance of the alternators and battery. With proper knowledge and perhaps the boost of an external alternator, one can significantly reduce the risks associated with electrical failure. The result is a safer flying experience, knowing that the lights will stay on and the engine will keep running thanks to those twin alternators humming under the cowl.