RAA
RECREATIONAL AIRCRAFT ASSOCIATION
RÉSEAU AÉRONEFS AMATEUR CANADA

The Leading Edge

Monthly Newsletter of the Kitchener-Waterloo RAA

- February 2017 -

C-FVEP is an air ambulance in BC. It landed in the parking lot at Big White while I was skiing in the Westridge area. Apparently, there were two medical emergencies on the mountain that afternoon… Luckily, I wasn't one of them!

President's Message

Hello from Big White Ski Resort!

By the time you read this, February will be half over, which means spring is only 5 weeks away! Before you know it we will be back at building, maintaining and flying our amateur-built aircraft. For anyone who has been flying all winter, it probably just means no more worries about pre-heating the engine and not having to carry winter survival gear. Either way, I bet we are all looking forward to winter being over in Ontario.

Thanks again to Fred Grootarz for doing the recurrent training session to keep everyone's bi-annual requirement satisfied… well almost everyone… I still have to find a way to meet mine, but I will figure something out. Hopefully I can find another one somewhere or complete the COPA magazine version.

In this month's issue you will find a couple of articles I wrote about lithium batteries for aircraft use. Other than going on a diet for a month or more, this is likely the easiest and least expensive way to shave 10 to 15 pounds off the weight of your plane.

The first article describes the most common chemistries used, why not all lithium batteries are the same and which one is best for use in aircraft.

The second article describes a circuit that I am using to protect my Aerovoltz lithium battery from over-discharge in my Highlander aircraft and why that is so important to consider when choosing a lithium battery to use in a plane.

Also note that 3 of the KWRAA fly-ins this summer have confirmed dates now, so put them on your calendar and we'll see you there!

2017 is going to be a great year for KWRAA!

- Dan Oldridge

Lithium Batteries for Amateur-built Aircraft

If you are saying to yourself, “No way I’m using a lithium battery… I don’t want my plane going up (or down) in flames!”, please read on. First let me say that not all lithium batteries are the same. Under no conditions should you use a lithium ion battery in your plane; but there are other battery chemistry options that make lithium one of the best choices for any aircraft.

Lithium-based batteries are quickly becoming the best modern option for the 150 year old technology of lead-acid batteries. Because weight is a major consideration in aircraft, lithium batteries are among the best options available. But lithium batteries are available in several chemistries; Lithium-Ion, Lithium Iron Phosphate, Lithium Polymer, Lithium Sulphur and a few more exotic variations.

The most energy dense lithium batteries are Lithium-Ion and Lithium Polymer batteries, but they have been cited in numerous fires as the source of the fire due to overheating, over-charging and over-current discharging; the most notable case being the 787 Dreamliner.

Inexpensive lithium battery pack from a laptop

The most common type of Lithium-Ion is LiCoO2, or Lithium Cobalt Oxide. These are the batteries you find in laptops, cell phones and other inexpensive consumer electronics because of their high energy-to-weight ratios, lack of memory effect, and slow self-discharge when not in use. In this chemistry, the oxygen is not strongly bonded to the cobalt, so when the battery heats up, such as in rapid charging or discharging, or just heavy use, the battery can catch fire. To help counteract this problem, devices that use Lithium-Ion and Lithium Polymer batteries may require extremely sensitive and often an expensive battery management system to monitor them.

A battery management system (BMS) is an electronic regulator that monitors and controls the charging and discharging of rechargeable batteries. Battery management systems may be as simple as electronics to measure voltage and stop charging when the desired voltage is reached or even monitor the temperature of a battery pack to “disconnect” when the battery temperature is too high while charging or discharging. Cobalt is a hazardous substance, raising health concerns and environmental disposal costs for lithium ion batteries.

The projected life of a lithium ion battery is approximately 3 years. Although initially energy dense, lithium ion batteries lose their capacity over time. After one year of use the capacity of the lithium ion will have fallen so much that the LiFePO4 will have the same energy density, and after two years LiFePO4 will have significantly greater energy density.

With all of the negative attributes of lithium ion, you can see why it is not really well suited for aviation applications, but there are other chemistries that are well suited. The LiFePO4 chemistry mentioned above offers some serious advantages over other lithium technologies and is the current chemistry of choice for aircraft battery manufacturers.

LiFePO4 (also known as Lithium Iron Phosphate) life expectancy is approximately 5-7 years. LiFePO4 batteries are the safest type of lithium batteries as they will not overheat, and will not catch on fire, even if punctured.

The chemistry of LiFePO4 batteries is very stable because the oxygen is tightly bonded to the molecule, so there is no danger of the battery erupting into flames like there is with lithium ion. LiFePO4 batteries will accept a charge from a lead-acid battery charger although balanced-cell charging is recommended occasionally to extend life. This makes LiFePO4 batteries ideally suited as a replacement for lead acid batteries in aircraft.

The small size and light weight of LiFePO4 lithium batteries make them an ideal choice for any amateur-built aircraft.

The cathode material in LiFePO4 batteries is not hazardous, so there are no negative health concerns or environmental hazards on disposal.

Although LiFePO4 batteries do not perform well below about 0 degrees Celsius, when capacity, weight, size, long term costs and other factors are considered, LiFePO4 batteries are quickly becoming an industry standard for replacement of lead acid.

So what are the current options for LiFePO4 in aircraft today? I have prepared a chart, which should allow you to determine the best choice for your plane based on which factors are most important to you.

LiFePO4 lithium batteries are so safe now that some manufacturers are just covering the cells in shrink wrap.

As a guide, 135 to 200 cold cranking amps is adequate for ultralight aircraft, 250 to 400 CCA is adequate for Rotax 912 and similar sized engines, while 6 cylinder engines require upwards of 400 CCA and 8 cylinders 500 to 800 CCA. Check with the manufacturer of the engine and battery for exact matches of battery capacity to engine starting requirements.

If you aren't currently using a lithium battery in your aircraft look seriously at the weight savings and consider switching out your old lead acid battery for lithium next time it fails. Make the right battery choice and you will likely be very glad you switched, but be sure to read the next article before deciding!

Brand	Capacity CCA	Weight (pounds)	BMS	Case	Price (CAD as of Feb/17)
Aero Lithium 4.5	240	2.2	Included	Shrink Wrap	$229 (approx.)*
Aero Lithium 8	400	3.5	Included	Shrink Wrap	$360 (approx.)
Aero Lithium 8	400	4.9	Included	Aluminum	$392 (approx.)
Aero Lithium 16	800	6.6	Included	Shrink Wrap	$720 (approx.)
Aero Lithium 16	800	8.2	Included	Aluminium	$752 (approx.)
Aerovoltz AV-04	135	0.9	Extra	Plastic	$157.75
Aerovoltz AV-08	275	1.81	Extra	Plastic	$238.95
Aerovoltz AV-12	410	2.5	Extra	Plastic	$316.00
Aerovoltz AV-16	500	3.0	Extra	Plastic	$388.00
Earth-X ETX-12B	135	1.3	Included	Plastic	$235 (approx.)
Earth-X ETX-18B	230	2.2	Included	Plastic	$300 (approx.)
Earth-X ETX680C	320	3.9	Included	Plastic	$514 (approx.)
Lithium Pro	400 (est.)	4.5	Included	Plastic	$690 (approx.)

* Approx. prices are converted to CAD from USD on Feb. 12/17

Lithium Battery Protection

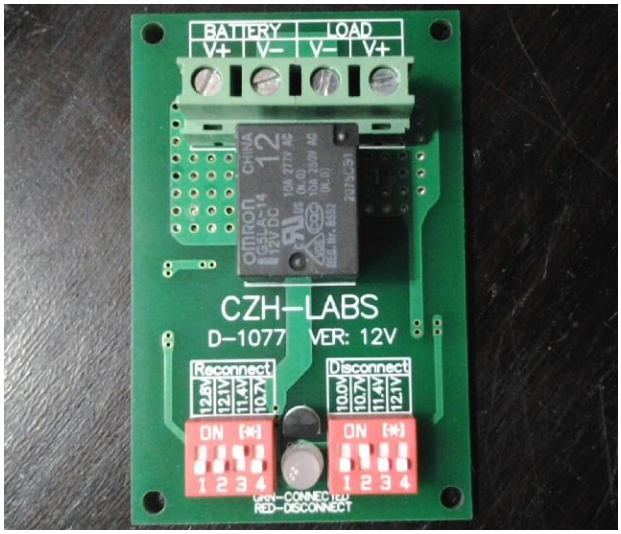
Modern Lithium Iron Phosphate (LiFePO4) batteries are not only much safer than their older Lithium Ion predecessors, properly installed and maintained; they can be a fraction of the overall long term cost of many other battery choices. They are smaller, much lighter and more energy dense than most other options for aircraft use. They are an excellent choice for any amateur-built aircraft.

Unfortunately, there is one dirty little secret that many of us find out the hard way… lithium LiFePO4 batteries need to be protected from over-discharge (under-voltage conditions) or they can be discharged beyond the point of no return. Typically, a 12 volt lithium LiFePO4 cannot drop below 9 volts without damaging it permanently. Some of the lithium LiFePO4 batteries on the market have built-in protection circuits; other less expensive batteries do not.

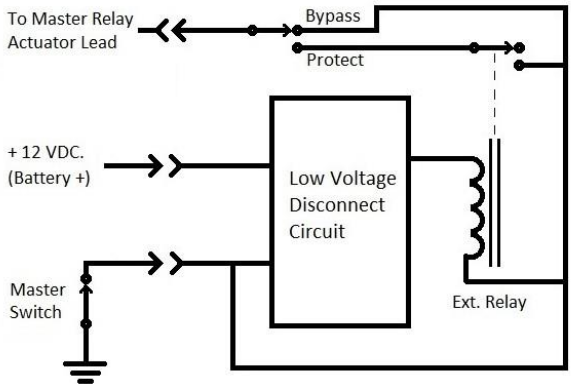
Having bought mine a few years ago, there were fewer options available and the lithium battery sold locally by Aircraft Spruce was the Aerovoltz, which I purchased. Less than one year later, I was doing some minor maintenance on the plane and left the master switch on one day for a few hours, only to realize that the battery relay coil had drained the battery way below the 9 volt threshold. Needless to say, I had to replace a $300 battery because of an oversight caused by a small distraction that kept me from flipping the master switch off.

For the last couple of years, I have been very diligent in monitoring whether the master switch is off when I leave the cockpit for any length of time, but I have been looking for a way to prevent another unnecessary and costly replacement of the lithium battery.

Recently, I came across a circuit that promised to protect lithium batteries from an under-voltage condition. One interesting feature of this circuit is that both the cut-out and reset voltages can be set by micro-switches at the desired voltages.

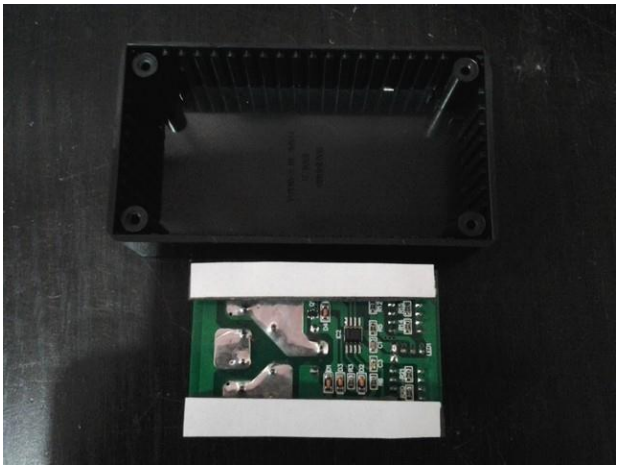


The circuit ($13 on ebay) is designed to be inserted in-line with the load, which presents a small problem when employing it in an aircraft battery (master) relay circuit that is operated by taking the relay actuator lead to ground through the master switch. The problem is easily solved by adding another small relay. The coil of the second relay becomes the load and the contacts can be used to switch the actuator lead of the battery (master) relay to ground when the relay is activated.

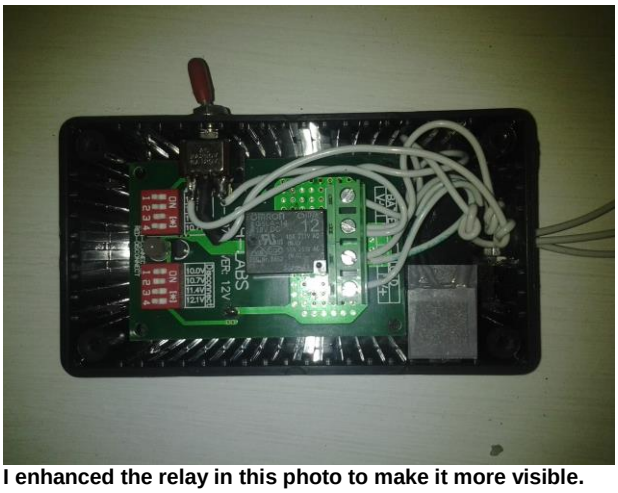


Wired as above, the circuit only becomes active when the master switch is on. If the low voltage circuit activates, the ext. relay drops out and disconnects the master relay. At this point the circuit only draws 1.5 milliamps to continue monitoring the battery voltage.

I mounted the circuit board and extra relay in a small Hammond plastic box using double sided foam tape.



I mounted a small toggle switch in the box and completed the wiring to the switch and relay using 18 gauge mil spec wire, although I likely could have used 22 gauge given the small load presented by the extra relay and actuator lead of the master relay.



I enhanced the relay in this photo to make it more visible.

Below, the box and wiring are shown complete with labels to make its purpose and connections obvious to anyone working on the plane in the future. I mounted the box behind the panel, but made the bypass switch accessible by feel in the event it becomes necessary in the future to bypass the protection circuit.

The bypass switch allows for testing and may allow me one short attempt to start the engine if the circuit has protected the battery from a “master off” memory lapse during travels to a remote location. The battery should still be in the 11 volt range if the protection circuit triggered. Also, if the alternator circuit fails, the bypass switch will also allow me to continue using the radio and other electronics to land safely or call for help by running the battery down below the set protection voltage.

I conducted a number of tests to confirm the operation of the protection circuit and it seems to operate correctly. I hope that if it ever gets tested in real life it’s not during one of my remote location flights, but if it does I will be happy I had the battery protection circuit installed. Not only will it prevent a major inconvenience, this circuit should eliminate the need to replace another costly Lithium Iron Phosphate (LiFePO4) battery in the plane.

\- Dan

Upcoming Events in 2017: (Highlighted lines are KWRAA Events*)

March 13	-	March Meeting at 7:30 in the Cadet building at CYKF
April 4-9	-	Sun-n-Fun in Lakeland Florida
April 10	-	April Meeting at 7:30 in the Cadet building at CYKF
May 8	-	May Meeting at 7:30 in the Cadet building at CYKF
June 23-24	-	COPA National Convention in Kelowna, BC
June 10	-	KWRAA Fly-In at Cam Wood's in West Montrose
July 15	-	KWRAA Fly-In at Tom Shupe's
July 24-30	-	Air Venture Oshkosh in Wisconsin
August 12	-	KWRAA Fly-In at CMZ2 – Metz/MacPat Field in Arthur
August 18-20	-	UPAC Convention – Lubitz Field, Plattsville ON
August 26	-	Aviation Fun Day at CYKF
August 27	-	KWRAA Fly-In at CPR3 in Teviotdale/Palmerston (Tentative)
Sept 2-4	-	Canadian International Air Show – CNE Grounds
September 11	-	September Meeting at 7:30 in the Cadet building at CYKF
October 16	-	October Meeting at 7:30 in the Cadet building at CYKF
November 13	-	November Meeting at 7:30 in the Cadet building at CYKF
November 24 (TBA)	-	KWRAA Christmas Party in lieu of a December meeting

* KWRAA events are fly-in and/or drive-in (Please advise the host in advance if you plan to attend whenever possible.)

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Hangar for Sale in Roseville:

- 8' high at the back, 9 '2" at the front
- 39' x 24' overall
- Asking $7000 for the hangar
- Land rent is about $400/yr

Contact: Allen Mattice at *allenjmattice@hotmail.com*

Reminder: Don't forget to bring your RAA Canada membership card when paying your 2017 KW-RAA Chapter dues. There is a bylaw on the books requiring all local members to also be a member of RAA Canada. Please pay your 2017 KWRAA annual $25 dues to Mike Thorp at the March meeting if you missed paying at the January and February meetings!

Be sure to check out the KWRAA website regularly for the latest information regarding KWRAA events and get more chapter information at: www.KWRAA.net