

# TAILWINDS



**EAA CHAPTER  
974  
NEWSLETTER  
DECEMBER 2015**



Butler County Regional Airport  
Hamilton, Ohio

## CHRISTMAS BANQUET

BY ALL MEASURES THE 2015 CHRISTMAS BANQUET WAS A BIG SUCCESS. WE FILLED THE PARTY ROOM AT THE HOUSTON INN WITH 43 IN ATTENDANCE. THAT WAS MY COUNT SO I COULD BE OFF A LITTLE, BUT THE CHAPTER WAS WELL REPRESENTED. THANKS TO BOB BURKHARDT WHO MADE THE RESERVATION AND SECURED A NICE ROOM FOR US. A GREAT TIME WAS HAD BY ALL. THE PICTURES WILL SPEAK FOR THEMSELVES. ALL PHOTOS BOB DOMBEK, EDITOR, UNLESS OTHERWISE NOTED.



# CHRISTMAS BANQUET CONTINUED



**MARK AND BRIAN PASS THE GAVEL FOR 2016**



**NEW CHAPTER OFFICERS FOR 2016**



**SOME CHAPTER CO-PILOTS ENJOYING THE FUN!**



**LOTS OF LOOT FOR DOOR PRIZES AND GIFT EXCHANGE**

## **THE PREZ SEZ.....**

*Holiday greetings to all. I hope everyone enjoyed the Christmas Party. Kudos to Bob Burkhardt for the menu arrangement that he worked out with the Houston Inn. Food and service was quite good.*

*I hope to continue the momentum that Brian created during his year as President. There are several projects that we have already discussed, the garage door opener for the back of the Chapter hanger, more work benches and shelving in the project areas of the hanger, and a thorough but kind cleanup of the library.*

*We have quite a few aircraft projects underway at various stages and also a number of new members with projects.*

*Al and I will strive to have programs for each meeting and continue the occasional cookouts. Please think about the type of programs that you might want. During the January meeting we will open the floor for requests and ideas for different types of programs or speakers. Please bring your ideas.*

*Happy Holidays,  
Mark Wyss*



## **CHAPTER MEETING NOTICE**

**Important Notice about the January chapter meeting.  
It will take place on 2nd Sunday Jan 10 instead of 1st Sunday, Jan 3  
Meeting place: FBO if wx is cold—chapter hangar if wx is warm**

## **CHAPTER CONTACTS**

[officers@eaa974.org](mailto:officers@eaa974.org) will reach president, vice president, treasurer, secretary as a group

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## **HOW TO LOSE 18.1 POUNDS IN 1 DAY**

### **EARTH X BATTERY INSTALLATION**

#### **BY HOWARD PLEVYAK**

My GlaStar has a Superior O-360 engine, Whirlwind GA200 propeller, heavy instrument panel, and leather interior so I stayed on the safe side and positioned my battery 6 inches behind bulkhead A in the tail cone. I sized my needs for Endurance Mode flight and chose an Odyssey PC680 battery. The battery has served me quite well all through ground and avionics systems testing. Engine starting however was a challenge. It was "OK" starting the O-360, as long as I didn't run the voltage down doing avionics system test or training for any length of time. If the battery voltage dropped from the standard 12.4V typical for lead acid battery, to lower than 12.1V....it just wasn't enough to swing the prop through the new O-360 engine compression. So during flight test I always ensured the battery was topped off the night before, and the engine started.

After flight test I started looking for a better solution, especially thinking of Winter temps. I investigated Lithium battery options due to their light weight, and much greater cranking AMPs. For those that want to comment or warn of impending death, fires, and explosions with Lithium technology....well...do your research first on the new Lithium Iron Phosphate (LiFePO4) batteries. This chemistry combined with a smart Battery Management System (BMS) is the way to go. See my links below for plenty of articles and threads on this. Folks are flying with these today with good success! Yes, they are about 3.5 times the cost (Odyssey PC680 \$100 -vs- \$379 EarthX ETX680)....but they also have a much longer service life (approx. 2-3 times) if taken care of...compared to SLA batteries, and they yield at least 40% more cranking Amps! Note EarthX had an Oshkosh show special for \$350...so look for this at SunNFun 2016.

I researched various options and decided to go with a battery that was designed for aircraft, had a BMS, and was already in use by a number of other experimental builders. EarthX became my choice. I had a tight space left open on the firewall for a battery....so I sized the space for the ETX680 and it just fit! The ETX680 case size is 6.5" x 3.1" x 6.6" (166mm x 79mm x 168mm). It was designed as a DROP IN replacement for the Odyssey PC680. It has a well thought out BMS, and LED Warning indicator both on the battery itself, as well as an output wire for installing an LED on your panel. I installed the BMS LED Warning Indicator (chose a blue LED) on my panel directly in front of me.

#### Old Battery Configuration:

- Odyssey PC680 (SLA) battery (15.4 lbs), 16 Amp-Hr Capacity, 170 CCA ([http://www.odysseybattery.com/extreme\\_battery\\_specs.aspx](http://www.odysseybattery.com/extreme_battery_specs.aspx))
- Odyssey Mount Box (2 lbs) including bolts, nuts, washer mount hardware. Battery mounted 6 inches AFT of Bulkhead A.
- 24 feet of #2AWG cable (6 lbs). Voltage loss at starter due to cable length is 4.5 Volts.
- Total Weight = 23.4 lbs.

#### New Battery Configuration:

- EarthX ETX680 battery (4.1 lbs), 12.4 Amp-Hr Capacity @ a 1C rate, 320 CCA (<http://earthxmotorsports.com/product-category/experimental-aircraft>)
- Standard Charge Voltage = 13.9 to 14.6V. Maximum Charge Voltage = 15V. Operating Temp = -30 to 60C, -22 to 140F
- EarthX Mount Box (.5 lbs) including bolts, washers, and rivets. Battery mounted on copilot HOT side of firewall.
- 3 feet of #2AWG cable (.75 lbs). 4.5 Volts increase at starter due to reduction in cable length run!
- Total Weight = 5.35 lbs.

Weight Reduction = 23.4 - 5.35 lbs = 18 lbs.

A few other points I considered when installing an EarthX Lithium battery....after my research:

1) Bus Voltage may need reset to maximize lithium battery service life.

A nominal Sealed Valve Lead Acid battery (SVLA) bus voltage of 14.2 translates to a charging voltage of 3.6V per cell ( $14.2V / 4 = 3.55V$  per cell). I have a B&C Specialty LR3C Voltage Regulator. It comes pre-set at  $14.4V / 4 = 3.6V$  per cell. So I reset my LR3C to  $14.5V / 4 = 3.625V$  per cell. This was recommended as the SET POINT by Bob Knuckolls in the AeroElectric Connection forum.

Per Knuckoll's: While this is gentle on the battery in terms of service life, this bus voltage set-point may charge the battery to only 70-80% of rated capacity. **THIS CRITICAL POINT MUST BE CONSIDERED WHEN DOING YOUR BATTERY-ONLY ENDURANCE CALCULATIONS.**

2) Manufacturer claims of Amp Hour (Lead Acid Equivalent) — a.k.a. Warning! Ground test your Amp Hours to ensure you have enough juice to keep your Avionics running!

AmpHrs quoted for a Lithium battery -vs- lead acid are apples and oranges. So test your battery true Amp Hour capacity by turning on all your avionics needed in the event of Alternator Out Ops, and see how long it takes before systems start shutting down. Size the battery to meet your needs. If you have an IFR airplane, consider an SD-8 Backup Alternator, and Endurance Bus configuration as shown in the AeroElectric Connection Book (Z13/8 configuration).

3) EarthX battery temperature must be kept under 140F (60C). So consider installing an OAT sensor just above my battery. I did this and set a Warning Limit to 130F on my Grand Rapids EIS4000 engine monitor. After a few HOT flights this Summer, I installed a 1.5 inch duct cooling hose to help keep the battery cool. I also make a point of popping open the Oil Cooler door to let out the cowling heat after shut down. I found the temperature above the battery is always hottest right after shutdown and just sitting on the ramp. If I were to choose a firewall location for a battery in my next experimental...I'd choose low on the firewall and someplace to maximize cooling.

So how's this compare to a Lead Acid Battery? Well the Odyssey Battery Operating temperature range is: -40°C (-40°F) to 45°C (113°F). The optimum operating temperature for the lead-acid battery is 25°C (77°F). Elevated temperature reduces longevity. As a guideline, every 8°C (15°F) rise in temperature cuts the battery life in half.

(Reference: [http://batteryuniversity.com/learn/article/can\\_the\\_lead\\_acid\\_battery\\_compete\\_in\\_modern\\_times](http://batteryuniversity.com/learn/article/can_the_lead_acid_battery_compete_in_modern_times))

4) Battery Management System (BMS) is a must for Lithium technology.

ETX Battery consists of 4 Lithium Iron Phosphate (LiFePO<sub>4</sub>) cells in series and one or more in parallel with built in electronics to protect the battery from:

- Over-Discharge and Over-Charge
- Balance the individual cell's charge level
- Short Circuit protection
- Temperature protection to prevent overheating

Battery Management System (BMS) functions:

1. In event of charging system failure where voltage increases to above 15.2V, the resistance to charging current increases, and above 16V the charging current is completely blocked. The BMS design offers protection up to 19.8V as per RTCA performance spec. DO-311. **THE DISCHARGE CURRENT (CURRENT OUT OF BATTERY) IS UNAFFECTED IN THIS SITUATION.**

2. BMS monitors all failure modes and reports failure with built-in LED indicator and discrete output. LED flashing (5 second cycle time) = abnormal condition with batteries lithium cells such as one or more cells are over-discharged (>80% depth of discharge) or OVER-CHARGED or cell voltage imbalance. LED Solid = indicates a BMS hardware failure (e.g., the BMS micro-controller fails)

3. BMS circuitry will disconnect the battery from load/charging system of aircraft if voltage exceeds 15.5V (an overcharge condition).

4. BMS disconnects battery from the load if it is drained to less than 5% remaining charge (AN OVER-DISCHARGE CONDITION).

An over discharged battery typically has a voltage less than 11.5V.

If the BMS disconnects the battery, the voltage reading of the battery will be zero volts.

#### 5. Engine Starting Considerations

Excessive cranking protection logic includes temperature monitoring to limit "high current use" (engine cranking) to 10-30 seconds in any 60 second period.

6. If a low impedance load is connected to the battery, which causes the battery volts to instantaneously dip below 6V, the battery will disconnect from the load to protect the cells and BMS from damage (short circuit protection). ETX series is designed for short circuit protection > 1000 amps.

#### 5) Jump Starting a LiFePO4 battery from a car battery?

NO. It is not a good idea to "jump" motorsport LiFePO4 battery from a car or truck battery. It is much better to re-charge it if at all possible. On the top of each battery is a label that will specify the maximum amount of charging amps to use and a "jump" start from an automobile is about 150X more amperage than maximum amperage recommended, if not more. This can cause the cells to rupture and even catch on fire. This is true for all batteries, lithium or lead acid, if you must jump start the battery, do it from a like sized battery. A lead acid is much more tolerant than a lithium battery as they absorb the charge completely different. It is perfectly fine to jump start the EarthX battery from another motorcycle sized battery or use a jump pack.

The manual warns to NEVER jump start your battery from a car Battery. If you're worried about being able to jump start your aircraft....EarthX has a Jump Pack for this. Serves as a great iPhone charger, and bright LED flashlight as well. I'll be buying one of these for Xmas! Checkout: <http://earthxmotorsports.com/shop/earthx-jump-pack>

#### Lithium Battery Technology Links of Interest:

1) AeroElectric Connection Forum thread: <http://forums.matronics.com/viewtopic.php?t=105728&postdays=0&postorder=asc&highlight=earthx&start=0>

2) Kitplanes Article series "Practical Electrical" by Bob Knuckolls. See the series of articles starting September 2014. This series alone is well worth the price of buying your Kitplanes Subscription!!!

3) Battery University: <http://batteryuniversity.com/learn/>

4) VanForce.Net thread ((<http://www.vansairforce.com/community/showthread.php?t=127942>). Search for EarthX, and Lithium and you'll find many more!

5) EarthX Battery FAQs: <http://earthxmotorsports.com/faqs>

I have about 45 flight hours on the battery....and so far I'm extremely pleased with it's performance. Before I had sluggish starts, now it feels like a racehorse kick starting the O-360. Now just need to drop another 15 lbs. myself to make room for the paint job I plan to put on my GlaStar January 2016!

FAQs:

Q: How close to the actual amp-hour rating did you come in testing on your aircraft? More importantly, how many minutes of sustainment did the EarthX battery achieve with an IFR load?

A: The ETX680 is rated at 12.4 Amp-Hrs at a 1C rate. So what the heck is a 1C rate?

In the late 1700s, Charles-Augustin de Coulomb ruled that a battery receiving a charge current of one ampere (1A) passes one coulomb (1C) of charge per second. On discharge, the process reverses. Today, the battery industry uses C-rate to scale the charge and discharge current of a battery.

C-rate is a measure that governs at what current a battery is charged and discharged. A 1C charges a battery that is rated at, say, 1,000mAh at 1,000mA; a 1C discharge loads the battery at that same rate. The Ah rating is normally marked on the battery.

The capacity of a rechargeable battery is commonly rated at 1C, meaning that a 1,000mAh battery should provide a current of 1,000mA for one hour. The same battery discharging at 0.5C would provide 500mA for two hours, and at 2C, the 1,000mAh battery would deliver 2,000mA for 30 minutes. 1C is also known as a one-hour discharge; a 0.5C is a two-hour, and a 2C is a half-hour discharge.

Reference: Battery University

This is theoretically interesting, but as you said what's more important is how long did I get the Avionics to run with an IFR load?

I ran a test and was able to run "my Endurance Bus" for 63 minutes on the ETX680 battery alone. Your mileage will vary!

I ended the test when the EarthX Battery Warning Light (my blue LED) came on. One of the trip points for the light coming on is to signify that "One or more cells is over discharged (> 80% depth of discharge).

I had a voltmeter on the battery bus with battery bus voltage at 13.2V at beginning of test, and 12.87V at the end of test...when the Blue LED Warning light came on my panel.

The LOAD on the battery was 7.4 Amps with the following equipment ON.

1. EFIS 1 + AHRS 1 @ 1.5 amps
2. EFIS 2 + AHRS 2 @ 1.5 amps
3. GTN650 (Comm/Nav) @ 2.2amps (Note...I did not do any transmitting during the test, only AWOS reception).
4. Trig Avionics TT22 Transponder @ .34 amps
5. EIS4000 Engine Monitor @ .2 amps
6. ADSB (SkyRadar DX) @ .31 amps
7. ELT 406MHz GPS position reporting @ .040 amps

## 8. Ignition #2 (Lightspeed) @ 1.3 amps

Note: I'm following Bob Knuckoll's AeroElectric Connection Architecture for Z13-8, with a Battery Bus, Main Bus, and Endurance Bus. I have a 60 Amp B&C Alternator, an SD-8 Backup alternator, and the ETX680 for electric power. If I lose my Primary Alternator, I flip a couple of switches to go to E-Bus mode shedding loads, and running what I need off the SD-8 alternator. See Knuckoll's AeroElectric Connection book for the E-Bus and how it works.

Q: I'm curious to know your thoughts on the EarthX battery box. They built the battery as a direct replacement for the PC680 but it isn't the same size. Is it worthwhile to purchase the EarthX box?

A: I really like the aluminum box...it's super light weight (7oz / 198 gram), and allows one to pop out the battery from the top without unbolting the entire mount. In my case however, since my space was tight firewall forward I didn't allow for the slide UP space needed to pull out the battery....but it's just four quick bolts to loosen, and the battery comes off the firewall. If you already have the Odyssey box...you could save a few bucks and not get the Aluminum box.

Q. Can the battery be removed without removing the battery case?

A: Yes, using the EarthX mounting case you pull back the clip and can slide it out. Just plan for this in your location. However in my case due to limited firewall space it's too close to the top. So I'll have to unbolt 4 bolts.

Q. I have concerns with the BMS. If it fails, are you grounded? Could a BMS failure in flight cause a battery fire? Maybe a BMS failure is not a big issue? Not being to jump start from "standard" batteries could leave you stranded. Carrying a JumpPack adds more cost and weight. The overall weight savings are certainly compelling however...

A. The BMS functions are what happens are detailed in the ETX680 installation & operations manual here [http://earthxmotorsports.com/wp-content/uploads/2015/07/ETX\\_Manual\\_111017\\_K.pdf](http://earthxmotorsports.com/wp-content/uploads/2015/07/ETX_Manual_111017_K.pdf)

If you search for Lithium battery fires, you'll find plenty on the web. But you'll find it tough finding one on EarthX and even less on fires using LiFePO4 (Lithium Iron Phosphate technology). I did find one from July 2014 on the AvidFox flyers forum. The guy used an EarthX...but I'm almost positive this was BEFORE EarthX put a BMS on the battery. The LiFePO4 chemistry used by EarthX with a BMS is much safer and more stable than the old LiPo stuff.

BTW...Google the web for Sealed Lead Acid battery fire as well...and you'll find some real entertaining videos!

My rules for installing the battery after doing the research were:

- 1) Plan for the worst...and put the battery on the firewall. <Hey...it's still new technology, so CYA for the unknown, unknown).
- 2) LiFePO4 is the best chemistry out there right now. But don't buy one without a BMS.
- 3) Use forced cooling to keep the battery cool during HOT summer days, and monitor with an Outside Air Temperature (OAT) sensor. This is more for battery life span and longevity.

On the JUMP Battery....EarthX's Jump battery pack system weighs 1.4lbs for the entire pack. So if I drained the main battery down due to a hard start scenario....this is cheap insurance to



carry around. It also will serve to re-charge my iPhone, iPad, and as my emergency LED flashlight! So it's on my Xmas Santa Wish list.

I do have DUAL Lightspeed Engineering Electronic Ignition systems however, so the engine starts within 1-2 maximum rotations every time! Gotta love the Lightspeeds!

Q. How much did it cost and where can I get one?

A. The ETX680 cost \$379. You purchase through EarthX (<http://earthxmotorsports.com>) or search Google, Amazon, etc. to find a deal.

One last point to keep the lawyers away! I have no connection to EarthX companies nor any Lithium technology sellers. I'm just a simple experimental builder trying to improve my personal flying carpet. Please use the above information AT YOUR OWN RISK! If you're not sure about changing out your electrical system components...talk to an A&P first!

Howard

Howard Plevyak, N19HL (Kit #5615)...now have 102 hrs on her!

