THE ELECTRIC BIKE: ALTERNATIVE TRANSPORTATION?

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FACTORS I CONSIDER

1. Load capacity: How much can the bicycle frame carry?
2. How much motor power do I need?
3. Safety and signaling: headlight, tail light, brake light, and blinkers
4. How and where will I charge the batteries?

E-BIKE VERSION 1.0

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Specifications:

- Two 60VDC (nominal 52VDC) lithium-ion battery packs with 20Ah capacity (total capacity: 40Ah)
- 1400W front hub motor with regenerative braking
- Average full-throttle speed with no pedaling: 16mph

E-BIKE VERSION 2.0

E-BIKE VERSION 2.0 (NIGHT RIDE)

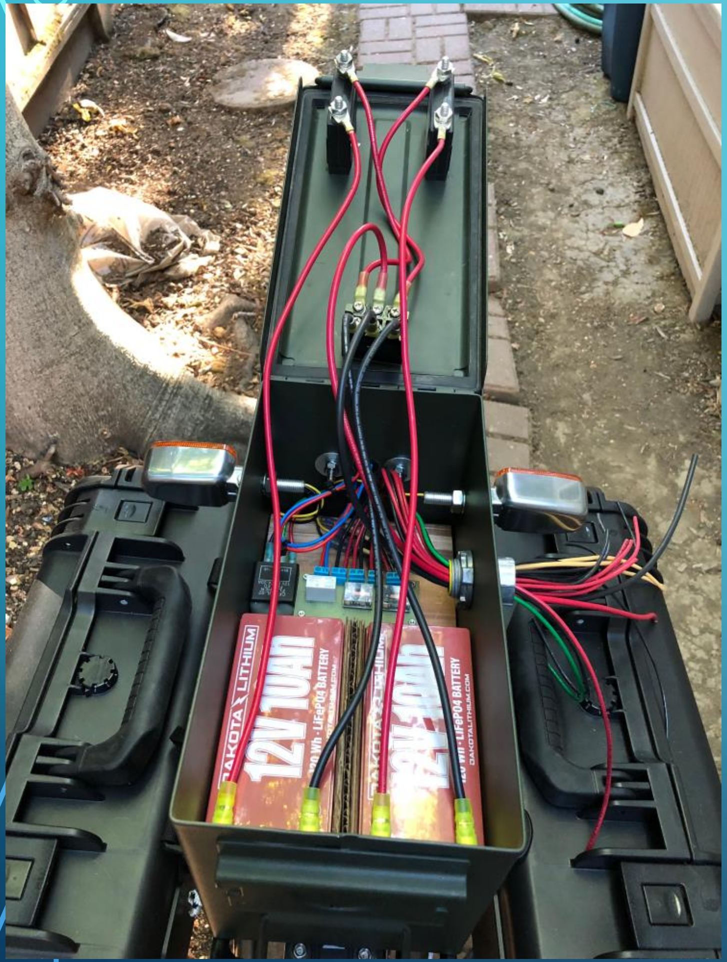
E-BIKE VERSION 2.0

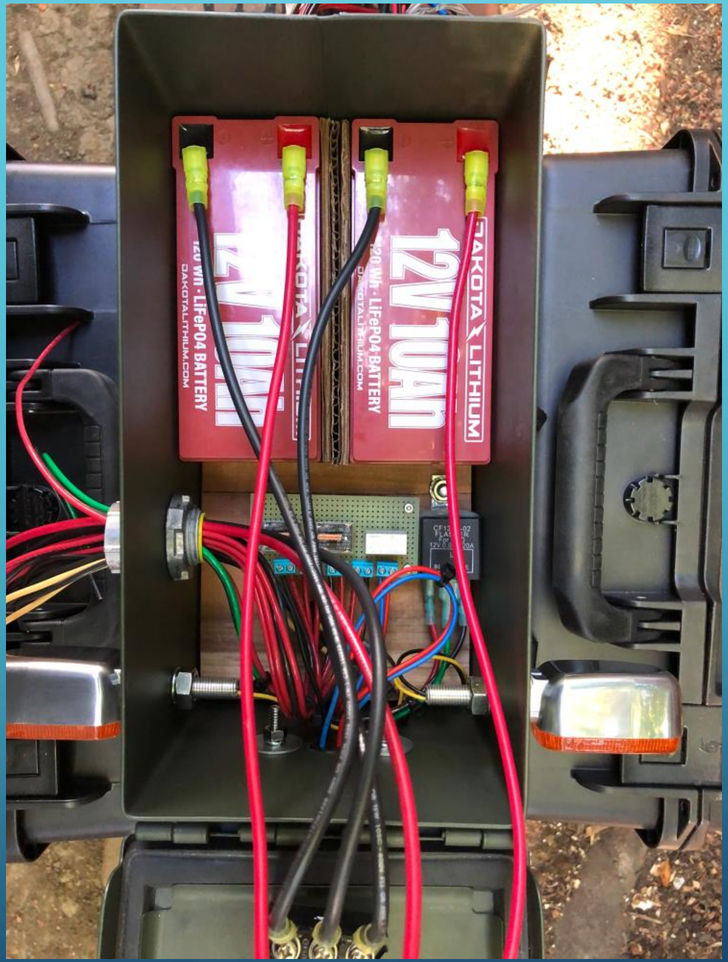
Specifications:

- Two 14VDC (nominal 12VDC) lithium iron phosphate battery packs with 10Ah capacity (total capacity: 20Ah):
  - Powers front and rear turn signals
  - Powers front LED headlight
  - Powers rear LED tail light and brake light
  - Powers horn
  - Powers USB charger for mobile phones and other devices.
- Two 84VDC (nominal 72VDC) lithium-ion battery packs with 24Ah capacity (total capacity: 48Ah):
  - Powers 300W front hub motor with regenerative braking
  - Powers 1800W rear hub motor with regenerative braking
- Two independent throttles (left and right)
- Average speed with front and rear full-throttle speed with no pedaling: at least 32mph

E-BIKE VERSION 2.0: 12V POWER AND BRAKE CIRCUIT

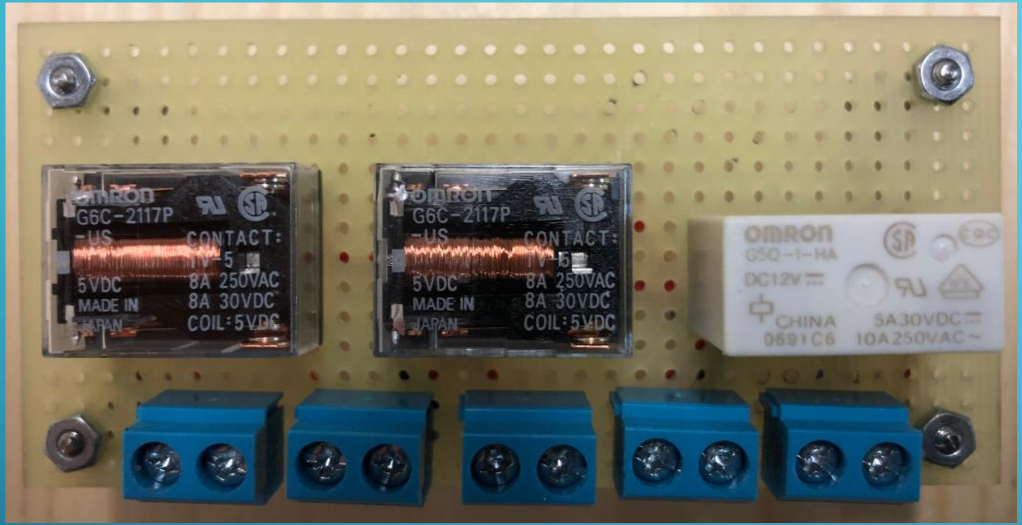
E-BIKE VERSION 2.0: 12V POWER AND BRAKE CIRCUIT

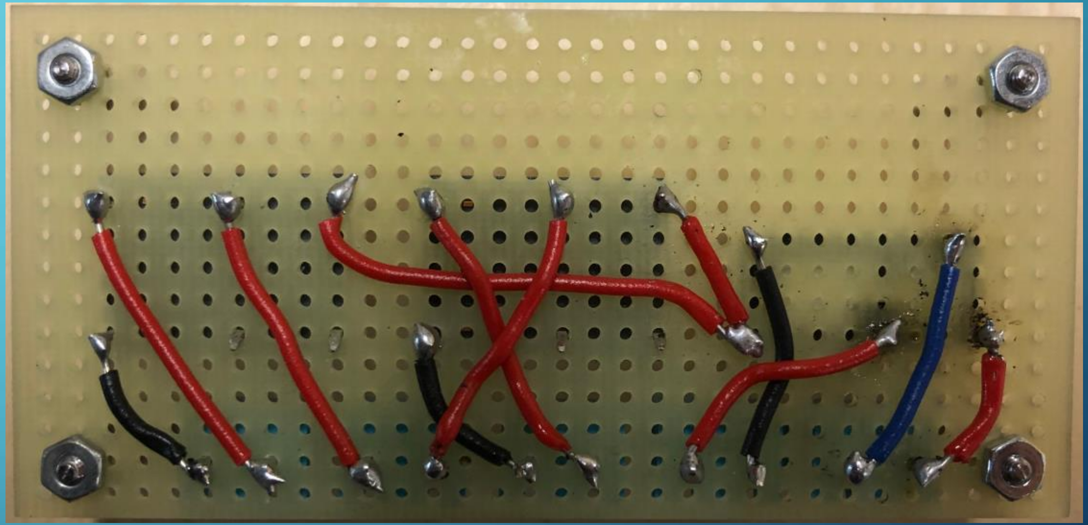




E-BIKE VERSION 2.0: HEADLIGHT, TAILIGHT, BLINKERS

E-BIKE VERSION 2.0: BRAKE CIRCUIT VERSION 1.0

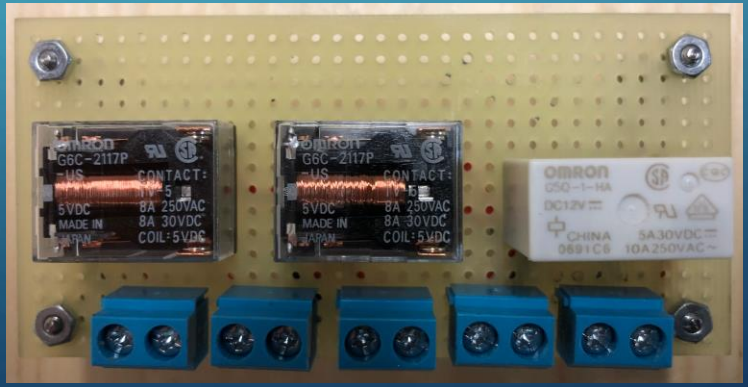




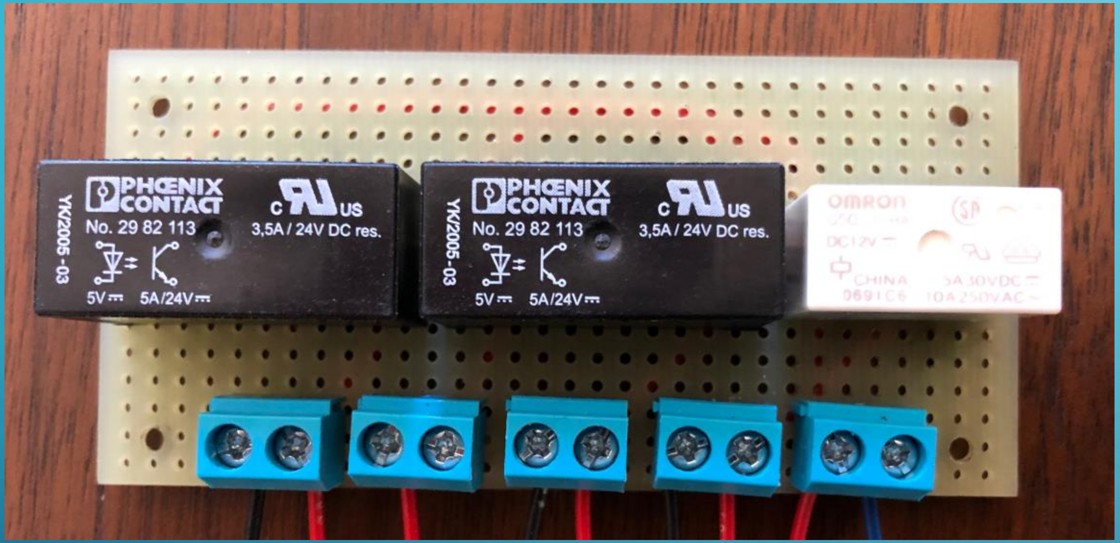
E-BIKE VERSION 2.0: BRAKE CIRCUIT VERSION 1.0

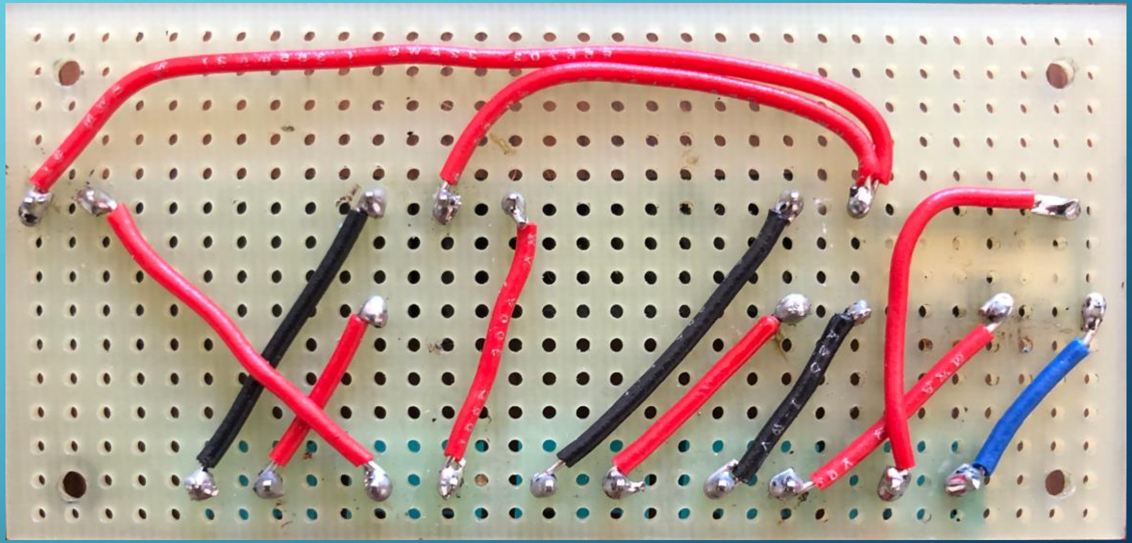
Why did this brake circuit fail?

- The 5V relays each required 40mA (to generate a magnetic field in the coil windings).
- My 5V power source could only put out 10mA! ☹



E-BIKE VERSION 2.0: BRAKE CIRCUIT VERSION 2.0



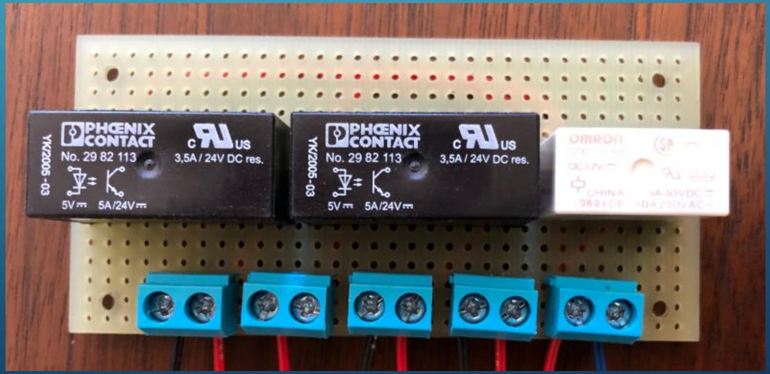


E-BIKE VERSION 2.0: BRAKE CIRCUIT VERSION 2.0

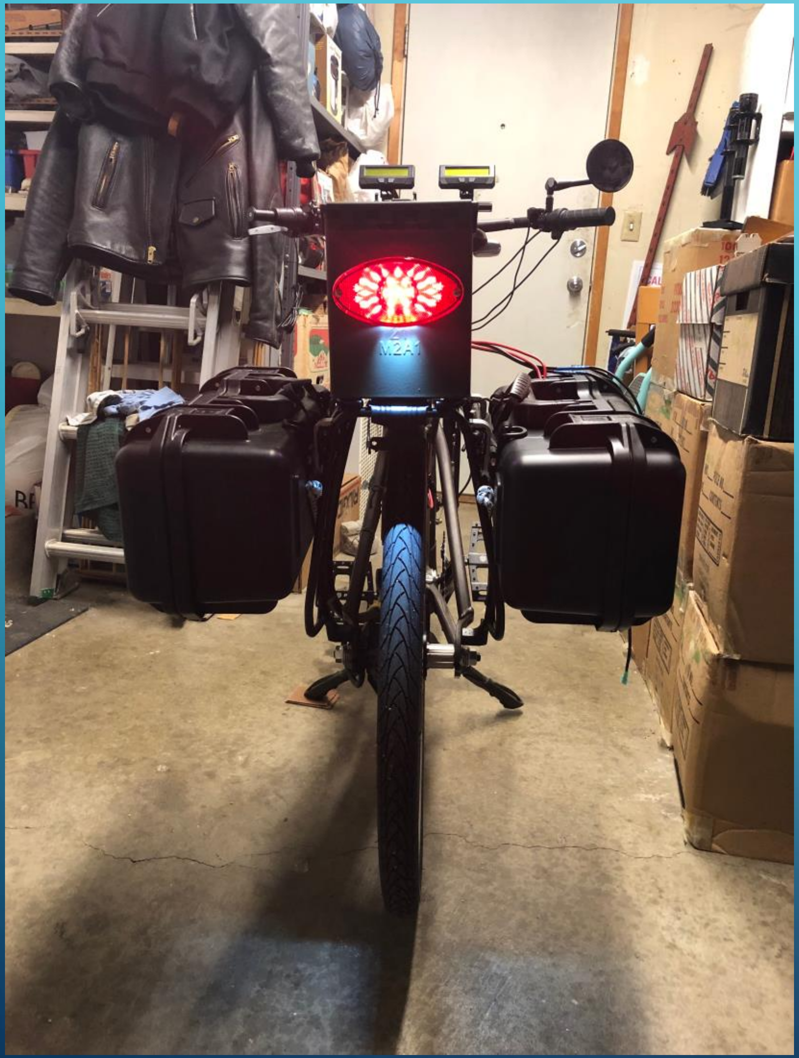
Why did this brake circuit succeed?

- The black 5V relays are solid-state relays that only needed 10mA to operate!

Brake light engaged when I pulled either or both brake levers! ☺



E-BIKE VERSION 2.0: BRAKE CIRCUIT VERSION 2.0



E-BIKE VERSION 3.0

E-BIKE VERSION 3.0: THE NEXT STEPS…

- Replacing front fork with Surly Dinner Fork (high-strength, rigid chromoly steel and capable of handling 203mm disc rotors).
- Replacing headset with Chris King Inset 5 sealed bearings
- Upgrading front and rear stock hydraulic disc brakes with hydraulic, four-piston Magura MT5E disc brakes.
- Upgrading front and rear stock disc brake rotors with 203mm rotors.

WHY REPLACE THE FRONT FORK?

Source: https://endless-sphere.com/forums/viewtopic.php?f=3&t=40902

WHY REPLACE THE FRONT FORK?

"I realise a lot of people will chime in with comments about using such a large rotor (I started with a small rotor, but ended up moving to a 203mm) on rigid forks like this, but I thought I would post this up for the possible safety of others.

Luckily I was not going fast when this happened, but whilst braking (not suddenly or heavily), **the forks on my Yuba collapsed and I crashed**. As I said, I wasn't going fast so was only bruised, but if I had been going downhill it could have been possibly fatal.

As I said, I can already hear the comments about using such a large rotor, but to be honest the forks felt like they flexed slightly even with the 185mm rotor.

By way of background I weigh 95kg, and I was carrying nothing other than the ammo cans bolted to the bike and 40ah of Lipo on board, so well within weight spec."

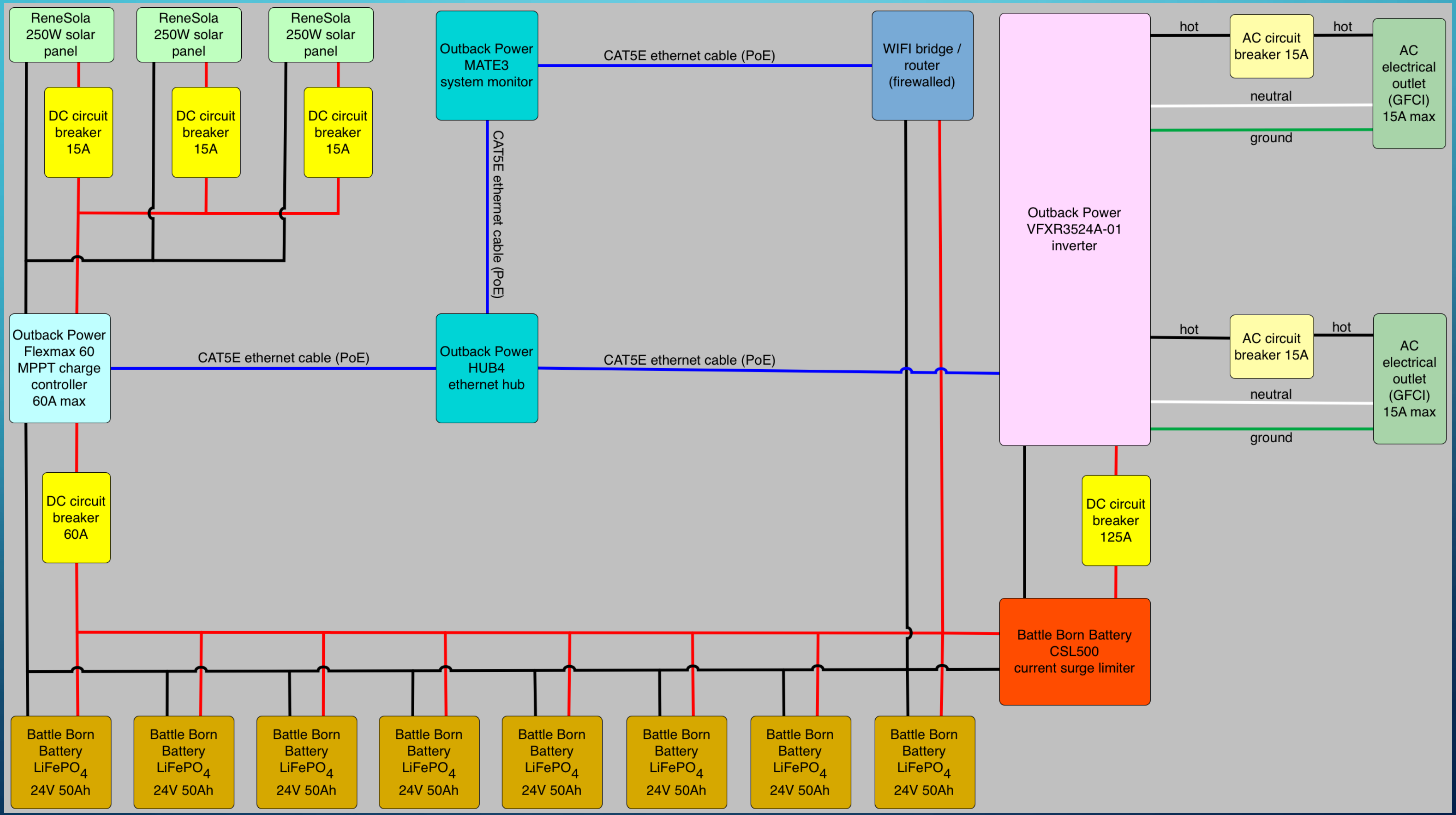
Source:
https://endless-sphere.com/forums/viewtopic.php?f=3&t=40902

E-BIKE CHARGING INFRASTRUCTURE VERSION 1.0

E-BIKE CHARGING INFRASTRUCTURE VERSION 2.0

E-BIKE CHARGING INFRASTRUCTURE VERSION 2.0

E-BIKE CHARGING INFRASTRUCTURE VERSION 2.0



ARE E-BIKES FEASIBLE?

Advantages of buying a brand-new e-bike (i.e. completely working with no DIY)

1. Saves LOTS of time and MONEY!
2. Frame and motor are engineering correctly to handle the torque load of motor.
3. Battery sized appropriately for reasonable distance.

Disadvantages of buying a brand-new e-bike (i.e. completely working with no DIY)

1. Proprietary battery and/or motor that are not easily upgradeable or user-serviceable.
2. E-bikes are usually limited to 750W or lower.
3. May be difficult to upgrade components such as motor or battery.

ARE E-BIKES FEASIBLE?

Advantages of the DIY route (i.e. build your own e-bike)

1. Endless upgrade capability
2. Quality control: you hand-pick the components (motor, batteries, brakes, frame, etc.)
3. High performance! No limits on motor output.

Disadvantages of the DIY route (i.e. build your own e-bike)

1. It is very expensive.
2. It is very time consuming
3. You should have fundamental knowledge of physics, materials engineering, mechanical engineering, and electrical engineering.
4. You must have strong mechanical skills to repair and upgrade components.
5. You should have experience with lathe, mill, drill press, angle grinder, and general metalworking skills, cutting tools and metrology tooling (dial calipers are your friend). You will likely need to make custom parts!
6. You should also have experience soldiering and crimping wire. Get the proper crimping tools. High quality crimping tooling is expensive but gives fantastic results!
7. I strongly suggest learning MIG welding or stick welding to make custom bicycle frames.
8. CAD experience is highly beneficial as well especially if you have access to a traditional CNC machine, CNC plasma cutter, or CNC water jet.
9. Going the DIY route can be EXTREMELY dangerous if you do not understand how to strengthen bicycle frames for high performance motors and brakes!

TIPS IF YOU WANT TO BUILD AN E-BIKE

1. Utilize a chromoly steel bicycle frame. This frame will be stronger than aluminum frame.
2. Use at least two torque arms on rear axle motors! The torque arms should be at least ¼ inch thick from 304 stainless steel or 4130 chromium-molybdenum steel.
3. Cargo e-bikes can carry huge loads yet are easy to pedal with motor assist.
4. Cargo e-bikes require heavy duty braking! Remember: a cargo bike with large loads and high speed is going to experience high momentum (p=mv). *Hint: fully-loaded freight trains do not stop quickly!*
5. Do not underestimate the power of regenerative braking in a brushless motor. Dial it down or disable regenerative braking. *My regenerative braking on the rear wheel was putting out 160 N-m (approximately 118 foot-lbs torque). I was constantly loosening axle nuts! I reprogrammed the regenerative braking to a much tamer 15 N-m. I also used nylon-locknuts to keep the axle nuts on.*
6. Choose appropriate wire gauges depending on continuous current capacity of your motor, controller, and continuous battery discharge rate (often impacted by built-in battery management system). Charts for ampacity are well known and easy to find on the World Wide Web.
7. Use nylon locknuts EVERYWHERE! I can assure you, nuts will come loose otherwise due to vibration from riding a rigid frame on a bumpy road.
8. Use class 12.9 metric bolts and nuts. These are REALLY TOUGH bolts and nuts. I sheared several low-strength 6mm diameter bolts on my ebike frame when I hit a pothole (ouch).
9. Be very careful about installing a full front suspension on a bicycle frame designed for a rigid front fork. The front suspension will completely change the feel and handling of the bike. If you go this route, it will require a lot of trial-and-error. Also, note: high quality front suspension forks from the likes of Rockshox can cost thousands of dollars! Of course, high quality isn't cheap!

FINAL THOUGHTS

1. One must maintain a careful balance between a building a motorcycle and building an e-bike: I'm walking a fine-line with my own e-bike builds!
2. Potholes wreck havoc on hard-suspension frames!
3. Carry spare tools and parts in case of a breakdown.
4. Know the limits of your riding abilities and ride defensively!
5. Wear appropriate protective gear including a helmet.

QUESTIONS OR COMMENTS?

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