Waterloo Rocketry Team

General Electrical Advice

Stuff that just didn't fit in the standard

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1 Preamble/Beginning Ramble

This section is going to be a bit of back story and an explanation of why this document exists. It's a bit rambly, so you really don't have to read this section if you don't want.

This document exists as an offshoot of the "Electrical Design and Assembly Standards" document (which will usually be referred to as "The Standard"). The Standard began as a collection of handwritten notes at IREC 2017. We suffered a lot of failures with our electrical gear at that competition, many of which could have prevented us from flying (a cat5 sensor cable broke an hour before dark the day before we planned to launch first thing), and a great deal of hacky solutions were MacGyvered together last minute, and it just barely worked.

Electrical gear is becoming a bigger part of our team. And more and more systems that are required for us to launch safely are becoming dependent on student made (read sketchy AF) electrical gear. We've already had one competition at which we failed to launch because of a failure with one minor system (IREC 2016), and the thought of having a repeat of that because of a piece of electrical gear is unthinkable. As such, we wrote list of things that you either should or should not do when designing or assembling mission critical electrical gear. After all the profanity was removed from that list, it became The Standard.

The Standard is intended as a list of things to either do or not do. Ideally, it would work as a pass fail checklist for any designs or gear that we have. However, there were a lot of items in that list that didn't fit well into this model, and worked more as general advice more so than a pass or fail checklist. These items were still of value, but they didn't fit in that document. To that end, we created this document (which I'm going to call "The Advice", for symmetry), which will be filled with whatever advice that should be imparted with all members of the electrical team, but we can't put in the Standard.

Most members of the electronics team started with Rocketry before knowing anything about electrics. Everything we know, we learned here, and we learned mostly by fucking things up. The Advice is here to try to spare you some of these mistakes that we made. That being said, we still don't know everything (or even most things. Or, to a linear approximation, anything). There is a great deal of valuable advice that isn't in this document, and some of the stuff in here may be wrong. If you want to change anything in here, you're free to. Either write notes into the margin, or submit a pull request to `https://github.com/akmorrison/waterloo_rocketry_electrical_standard`. If you are changing anything though, write in a reason, and sign your name on the title page.

2 PCB Advice

Here's my advice if you're deciding to get PCB's made. I've only ever had 2 designs manufactured, neither of which had very exacting requirements, so take

things with a grain of salt, feel free to add any advice that you feel fits.

- EEVBlog has a great (albeit long) introduction to PCB layout/design: `https://www.youtube.com/watch?v=JrH_itjMDjo`. It's like an hour and a half long, but well worth watching.
- Given the choice, please draft your schematics and board layouts in KiCad. It's free (GPLv3), used by the rest of the team, and runs on all platforms. `http://kicad-pcb.org/`
- The cheapest board that can be purchased in small quantities is a 2 sided 1oz 5cm by 10cm 10/10 (10 mil (.254mm) min clearance and min trace width) 0.4mm smallest drill size board. If at all possible, try to make your design fit that requirement.
- On the subject of price, go to `https://www.pcbshopper.com` to get quotes for boards. It's a great crawler for dozens of PCB fabs, so you're likely to get the best price here. There's search parameters for board size, type, copper weight, solder mask color, etc. It's a really great site.

2.1 Specific to PCB assembly

- Solder the smallest components on your board first; Usually the surface mount resistors. You'll have more dexterity on your soldering iron, and you're less likely to burn a bigger, more expensive/less heat tolerant plastic component like a relay or a connector.
- Use flux. It makes surface mount soldering orders of magnitude cheaper. 10ml syringes are less than $20 at Sayal, and should last for a while.
- Watch this video `https://www.youtube.com/watch?v=J5Sb21qbpEQ` (EEVblog soldering tutorial) and its sequels.

3 On Standardization

Standardization is a broad issue that applies to a few different sections that could exist, but it's a big enough issue that we should take some space to talk about it here. Standardization, broadly, is using the same parameter (whether that be electrical component, or pin spacing, or software, etc) whenever possible in a design or across many designs. The advantages for hardware standardization are hotswappability (if you used the same connector in 12 spots, and 1 breaks, you can swap in another one easily) and parts in stock (we have a bunch of M3 standoffs and bolts in the bay, for example). The advantage to standardizing software is easier collaboration with the other electrical people on the team. It would be much harder to work together on stuff if we were split between using Word, Docs, text files, and stone tablets.

Here's a list of what we are currently making an effort to standardize on (note, this absolutely does not mean that designs are *required* to follow these, if

there exists a decent reason for your project not to follow these rules, then by all means disregard them). This list is, as all lists, incomplete. If there's something you want to add, please pencil it in or submit a pull request for discussion.

- M3 mounting hardware: for pcb mounting and other small fastener related tasks. We have plenty of standoffs and bolts and nuts in the bay, and if we have need of more, it's easy to buy this type of hardware in bulk on Aliexpress for much cheaper than we can get here (albeit with significantly longer lead times).

- 10mil pin pitches (2.54mm for you metric apologists): We have an entire box of 10mil dupont connectors (and the required ratcheted crimper to use them) in the bay, and again, we could get way more on Aliexpress. By using 10mil pin pitches on all connectors, we can use those components to kluge together a more robust temporary or development solution for a connector. In addition, this also lets us standardize on jumpers and pin headers, which we could also buy in bulk.

- KiCAD (schematic capture and pcb layout software): The current electrical team members all use KiCAD, which makes collaborating really easy (we don't need to send around PDFs of every revision). It's a free, open source program, and while there are complaints of learning curve and lack of polish, it's better than any other free software we've found for the task.