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Wichita state university [Electron wranglers]

Textron Cooling Fan Project documents

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# Project Proposal

**Electron Wranglers**

**Project Proposal**

Product Title:

“Cooling Fan Monitor Circuit Board”

Product Description:

This device has two main parts to its operation. First, a circuit board that will monitor the tachometer output of a brushless DC cooling fan. Second, the control of a discrete output that will indicate the status of function of the fan.

Primary Application Proposal:

This project is to develop a small circuit board for Textron Aviation that will monitor the tachometer output of a brushless DC cooling fan, and then control a discrete (ground/open) output to indicate if the cooling fan is functioning as intended. The intent is for the circuit board to be small enough that it can be installed in the aircraft wire bundle with zip ties to support aftermarket and late point definition installations with minimal impact to the aircraft and/or maintenance crew.

Requirements:

1. The design must operate reliably with the power input ranging from 10 Vdc to 80 Vdc.
2. The design must utilize only one electrical ground.
3. The tachometer signal frequency and voltage range will vary from one application to another; however, this input should be easily configurable (e.g., resistor value changes) to accept either a 0-5 Vdc square wave or a 0-28 Vdc square wave. This input should be able to accept frequencies between 0 kHz and 1 kHz.
4. This output should be a discrete output that will provide a ground whenever the cooling fan’s RPM is above the defined threshold; otherwise, this output should provide an open (high impedance) output. This output should be capable of sinking 1 A continuously when it is providing ground.
5. The design package envelope must be less than or equal to 0.5 inches x 0.5 inches x 1.5 inches.
6. The design must operate in a temperature environment ranging from -55°C to 85°C. The design must operate at altitudes ranging from -1000ft to 55000ft. The design must be able to pass the DO-160G section 8 Vibration category S curve L test. The design must be capable of operating in a humid environment as defined by DO-160 section 6 category B. The design must be capable of passing the Indirect Effects of Lighting DO-160G section 22 test to category A3J3L3.
7. The design should not contain any programmable devices (e.g., microcontrollers, FPGAs, PLDs, etc.).

Goal:

The main goal of this project is to create a well-researched and designed product package that Textron Aviation can evaluate and design in order to run tests to ensure it’s in compliance with FAA regulations. If the product complies, they plan to install them on numerous airplanes in production to help with flight tests.

# Updated Project Proposal (Semester 2)

Electron Wranglers

Project Proposal

Product Title:

“Cooling Fan Monitor Circuit Board”

Product Description:

This device has two main parts to its operation. First, a circuit board that will monitor the tachometer output of a brushless DC cooling fan. Second, the control of a discrete output that will indicate the status of function of the fan.

Primary Application Proposal:

This project is to develop a small circuit board for Textron Aviation that will monitor the tachometer output of a brushless DC cooling fan, and then control a discrete (ground/open) output to indicate if the cooling fan is functioning as intended. The intent is for the circuit board to be small enough that it can be installed in the aircraft wire bundle with zip ties to support aftermarket and late point definition installations with minimal impact to the aircraft and/or maintenance crew.

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1. The design must operate reliably with the power input ranging from 10 Vdc to 80 Vdc.

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4. This output should be a discrete output that will provide a ground whenever the cooling fan’s RPM is above the defined threshold; otherwise, this output should provide an open (high impedance) output. This output should be capable of sinking 1 A continuously when it is providing ground.

5. The design package envelope must be less than or equal to 0.5 inches x 0.5 inches x 1.5 inches.

6. The design must operate in a temperature environment ranging from -55°C to 85°C. The design must operate at altitudes ranging from -1000ft to 55000ft. The design must be able to pass the DO-160G section 8 Vibration category S curve L test. The design must be capable of operating in a humid environment as defined by DO-160 section 6 category B. The design must be capable of passing the Indirect Effects of Lighting DO-160G section 22 test to category A3J3L3.

7. The design should not contain any programmable devices (e.g., microcontrollers, FPGAs, PLDs, etc.).

Goal:

The main goal of this project is to create a well-researched and designed product package that Textron Aviation can evaluate and design to run tests to ensure it’s in compliance with FAA regulations. If the product complies, they plan to install them on numerous airplanes in production to help with flight tests.

Update:

Expansion of the summary including the differences between sem1 and now, or new or additional features added to complete end product.

# Product Specification Sheet

**General Product Description**

**Regulations**

* DO-160G
* Avoiding DO-178 or/and DO-254 by:
  + Using nonprogrammable parts
  + These regulations can take years to test, while DO-160 can be done with 6 months or less
* Regulations on wire bundle and tachometer input are handled by Textron

Constraints

**Input**:

* **Tachometer input from the fan:** This input will have a 0-5V or 0-28V square wave based on which system/fan it is installed in. The PCB must operate reliably within the frequencies of 0 kHz to 1 kHz.
  + Tachometer input must be filtered to reduce noise in the signal and prevent unnecessary peri- signal triggering.
* **Bus input from wire bundle:** The bus will provide a nominal 28Vdc. The bus will sometimes fluctuate as low as 10 Vdc and as high as 80 Vdc (when turning on the engine and other aircraft functions).

**Output**:

* The output will be based on an established upper and lower threshold frequency which will include a 5 Hz hysteresis within a 70 Hz range (approximately 7%).
* The output will be grounded if our frequency is above the threshold.
  + The ground must be able to sink 1 Amp continuously.
  + The overall design must utilize only one electrical ground.
  + This output must be discrete.
* The output will be open (high impedance) if the frequency is below threshold values.
  + Output switches from ground to open once below threshold minus hysteresis

**Design:**

* The design must be easily re- configurable by changing values of components (i.e., resistor values). This configurability is for:
  + Change in tachometer input voltage based on system voltage (i.e., 5v fan or 28v fan).
  + Change in threshold frequency (to accommodate the variability of systems/environments).
  + Change in hysteresis values (to accommodate different systems). o For prototyping we can start with 0-5V, 70Hz, 5Hz hysteresis
* The Physical size of this design must be within 0.5 x .05 x 1.5 inches
* The design must operate with NO programable devices (i.e., microprocessor, memory, etc.) o This will trigger DO-178 or/and DO-254
* Components must be generic and reliably sourced with minimal risk of becoming obsolete.

**Environmental:**

* This product must be able to operate within:

A temperature range of -55ﹾC to 85ﹾC.

* + An altitude range of -1,000 to 55,000 ft
* This product must be able to handle Vibration, Humidity, and indirect effects of lightning.
  + Vibration must pass DO-160G section 8 category S curve L test o Humidity must pass DO-160G section 6 category B
  + Indirect effects of lightning must pass DO-160G section 22 tests up to category A3J3L3
* This product will be zip tied to a wire bundle in an airplane o No sharp edges to reduce risk of damage to wire bundle.
* The Physical size of this design must be within 0.5 x .05 x 1.5 inches.

**Documentation:**

* The following is the documentation required by Textron:
  + PCB schematics o PCB layout o Package design
  + A report
    - * Function description
      * Detail on hysteresis effect
      * Results of testing to prove design
      * What and how to change values to get configurability listed above

**Real world constraints:**

* Package must have no sharp edges as listed above.
  + This will avoid the cause of any damages to the wire bundle.
* To be cost effective, we will be testing and prototyping using lower grade parts Once implemented, it will use more precise and higher rated parts (military grade)

# Project Planning Document

**Project Planning**

Project: Textron Cooling Fan Circuit

Team: Electron Wranglers

21 September 2021

**Summary:**

This project is to develop a small circuit board that will monitor the tachometer output of a brushless DC cooling fan, and then control a discrete (ground/open) output to indicate if the cooling fan is functioning as intended. The intent is for the circuit board to be small enough that it can be installed in the aircraft wire bundle with zip ties to support aftermarket and late point definition installations with minimal impact to the aircraft and/or maintenance crew.

**Scope:**

**Interface Requirements**

**Power Input**

The design will be powered from a nominal 28 Vdc power bus; however, the design must operate reliably with the power input ranging from 10 Vdc to 80 Vdc.

The design must utilize only one electrical ground

**Tachometer Input**

The tachometer input will be a square wave that’s frequency will be proportional to the cooling fan’s RPM. The tachometer signal frequency and voltage range will vary from one application to another; however, this input should be easily configurable (e.g., resistor value changes) to accept either a 0-5 Vdc square wave or a 0-28 Vdc square wave. This input should be able to accept frequencies between 0 kHz and 1 kHz.

**Indication Output**

This output should be a discrete output that will provide a ground whenever the cooling fan’s RPM is above the defined threshold; otherwise, this output should provide an open (high impedance) output. This output should be capable of sinking 1 A continuously when it is providing a ground.

**Functional Requirements**

Indication Output Assert

The design shall set the Indication Output to ground if the tachometer input frequency is greater than the defined threshold.

Indication Output De-Assert

The design shall set the Indication Output to open if the tachometer input frequency is less than the defined threshold minus a hysteresis value; the intent of the hysteresis is to unsure the Indication Output does not oscillate whenever the tachometer input frequency is operating at, or near, the defined threshold value.

Threshold and Hysteresis Definitions

The tachometer frequency threshold at which the Indication Output should trip currently is not a known value because testing must be completed to determine this threshold; in addition, the hysteresis value for the indication output currently isn’t known because testing must be completed to define this parameter as well. Furthermore, the frequency threshold and hysteresis are values that could change from one application to another as such these two parameters must be easily configurable on the design without the need for significant re-design. For example, one acceptable means to configure these parameters would be to change resistor values on the design. A practical starting point for the design would be to set the frequency threshold to 70 Hz and the hysteresis parameter to 5 Hz.

Tachometer Input Filtering

Filtering must be implemented on the tachometer input to ensure the design does not respond to double tachometer clock edges.

**Environmental Requirements**

The design must operate in a temperature environment ranging from -55°C to 85°C. The design must operate at altitudes ranging from -1000ft to 55000ft. The design must be able to pass the DO-160G section 8 Vibration category S curve L test. The design must be capable of operating in a humid environment as defined by DO-160 section 6 category B. The design must be capable of passing the Indirect Effects of Lighting DO-160G section 22 test to category A3J3L3.

**Documentation**

* PCB Schematic Files
* PCB Layout Files
* Package Design Files
* A Report That Contains the Following Information for the Design:
  + Detailed Functional Description
  + Detailed Description of How to Set the Frequency Threshold and Hysteresis Parameters
  + Results From Any Testing that Was Accomplished to Prove Out Design

**Design Reviews**

We will hold design reviews with Textron Aviation throughout the design. The following are the points in the project when we will hold said design reviews:

* Schematic Review after proof-of-concept testing is complete and prior to layout of PCB
* PCB Layout Review after layout is complete and prior to ordering boards
* Packaging Review after package is designed and prior to ordering material

**Team Skills Assessment:**

* **Negative impact to project:**

1. Limited exposure to engineering research
2. Limited exposure to researching Do regulations
3. Limited experience in project management
4. No experience with PCB design/layout

* **Positive Impact to project:**

1. Team has varied experience with testing equipment
2. Team has experience with bread board layout of circuits for simulation and testing.
3. Multiple team members have experience with soldering/de-soldering.
4. All team members are motivated and willing to learn whatever is needed.

**Legal and Ethical Analysis:**

There are no known legal or ethical issues associated with this project except from an individual perspective. As this is a monitoring circuit for a cooling fan on an aircraft, our legal/ethical responsibility is to ensure that it operates as it is intended and within the given parameters.

**Tasks and Deliverables:**

This section will identify the major features, tasks, requirements, and deliverables for the final product. The tasks and deliverables are broken down into two sections project planning/management and construction/implementation/testing. Each phase has its own tasks and deliverables. The successful completion of this SOW requires that all deliverables and tasks in each sub-section have been completed/submitted.

**Section 1: Project Planning/Management**

|  |  |  |
| --- | --- | --- |
| **Task or Deliverable** | **Description of Requirement** | **Date to be Completed** |
| Weekly reports | These will include:  • A brief description of the team accomplishments for the week. The description should include decisions made by the team because of the team discussions.    • A brief description of the individual contributions made by each team member for the past week. Assignments and activities are to be tracked until task has been completed.  • A brief description of the team plans to accomplish over the next week. Assignments for each team member should be added to the running task list with an expected due date for completion.  • A brief description of issues the team has encountered, and potential resolutions for the issues. If the team would like staff to help with the issues, this is the appropriate place to request assistance. | Weekly |
| Do 160 Regulation research | We need to find what specific requirements pertain to this project. The actual testing for these regulations will be performed by Textron but we must still ensure that our circuit is operational within these regulations before handing it over. | 29 Oct 2021 |
| Technical research | Research will be conducted into the technical aspect of this type of circuit and what supplies and parts will need to go into the creation of this device | 05 Nov 2021 |

**Section 2: Construction/Implementation/Testing**

|  |  |  |
| --- | --- | --- |
| **Task or Deliverable** | **Description of Requirement** | **Date to be Completed** |
| Familiarizing with LTspice | As the team, as a whole, has limited exposure to this software, we will need to become familiar with it. | On-going thru semester 1 |
| Software simulations of the proposed circuit design | The team will be testing the circuit with software to run simulations and adjust as/where needed. | 15 Oct 2021 |
| Meeting with Textron | This meeting will be to go over our initial designs to gain feedback from their perspective and make any changes they require. | 22 Oct 2021 |
| Breadboarding | We will construct a breadboard layout of the circuit utilizing a BLDC motor, power supply, and testing equipment. | 05 Nov 2021 |

**Metrics:**

To track our project performance, we have a few measures to base off. To meet our prototype deadlines, we will need to stay diligent in our research. By being knowledgeable on the way various parts of our circuit work, the creation of a prototype will be a far smaller workload. This means we will need to do quite a bit of testing where all the members of the group can see the results and understand the ins and outs of the circuit’s process.  
 When it comes to our testing, we have many specified requirements given to us by Textron that we must meet. So, it is important that through our testing, we continue to find what components meet each of those requirements. As the requirements we must meet get smaller through successful testing, the better our project performance will be.

**Work Performance:**

**Team Schedule:**

**Week 1-2:**

Initial research into BLDC motor characteristics and gaining familiarity with parameters.

**Week 3-4**

Initial research into specific circuit requirements for voltage regulator, filter, and comparator as well as the hysteresis effect

**Week 5-6:**

Narrowing down specific components/elements of the voltage regulator and filter circuits

**Week 7-8:**

Initial layouts of the three circuits (voltage regulator, filter, and comparator) and interconnect ability.

Meet with Textron to go over circuit layout to ensure acceptability as a prototype.

Begin preliminary testing and simulation.

**Week 9-10:**

First large-scale prototype built. Initial testing begins.

**Week 11-12:**

Testing and simulation of first prototype. Also, week for evaluations to address problems that have occurred.

**Software:**

The software that will be used for simulation and testing of the circuit designs will be **LTspice** as that is the software used by Textron. It would put a hinderance on the “customer” to give them deliverables in a software that their system isn’t equipped for.

We will also use Circuitmaker, a free software based on the Altium software, which is used by Textron, to perform the PCB design. It should be compatible with their system according to our contact.

**Acquisition Schedule:**  
 Overall, our project will involve a circuit board that starts by filtering a tachometer input and regulating the voltage coming from a power bus. These 2 inputs feed into an operational amplifier that runs a comparison to check if the motor is running too fast. This output, based on the comparison, will either ground the output or send the signal out as an open high impedance signal.  
 Looking into the cost of these parts, the cost of building this will be low. Most of the components are around or less than $1, with the most expensive parts being up to $10-$15 a piece. As the enclosure is small, there will not be many components.  
 We will be doing a lot of our initial testing through LTspice, so the acquisition for the parts will not need to happen until later this semester at the middle of October. Because of this, we want to ensure that we do not have a delay in receiving these parts as it could put the completion of the prototypes into November when the holidays are in full motion. Textron has indicated that it should not be hard to get most of these parts from them, but if a part does need to be ordered, shipping delays could cause problems.

**Data Configuration Management Plan:**

When it comes to the management of software and hardware, the modelling software does not have much to configure or set. We can access Multisim through school computers in John Bardo Center or through remote connections. LTspice is free and can be accessed by any of us through a simple installation. As we are not at the part of our design where we need to layout the PCB board, we are not familiar with how this will need to be configured, or if it will need to be at all, but the software itself is free and can be accessed by any of us. As we will only order actual hardware two or three times, the parts will be kept with one of the team members or in an area that any of us can access.   
 Currently, all our files are exchanged and shared on a discord server that all our members are in. This allows us to exchange files and provide feedback immediately through text or voice chat. We make sure to add in any crucial files into the server, this may each member can access it when they need to.

**Acceptance Criteria:**

* The design should not contain any programmable devices (e.g., microcontrollers, FPGAs, PLDs, etc.) because this will add unnecessary complexity and cost to the certification efforts of the design since it will invoke DO-178 and/or DO-254 activities.
* The design should avoid using electrical components that only have a single source of supply in order to prevent part obsolescence issues. for example, if there a chip that performs a specific function and there aren’t any other manufacturers that make similar components in the same footprint, then don’t use that component because the Circuit Board will need to be re-designed if that component ever goes obsolete. In general, it is a better design practice to use more generic components (op amps, diodes, FETs, etc.) than special function chips since these generic components have many alternates and equivalents within the industry.

# Product Interview Reflection

**Textron Aviation Cooling Fan Project**

Introduction

This project is to develop a small circuit board that will monitor the tachometer output of a brushless DC cooling fan, and then control a discrete (ground/open) output to indicate if the cooling fan is functioning as intended. The intent is for the circuit board to be small enough that it can be installed in the aircraft wire bundle with zip ties to support aftermarket and late point definition installations with minimal impact to the aircraft and/or maintenance crew.

Body

**Interview 1:** Robert Evans

Robert is a research engineer for NIAR in the robotics laboratory and holds a bachelor’s in electrical engineering. He currently works on defense projects through NIAR. Based on his personal work experience, we picked up some interesting, new information based on his perspective. He first mentioned that we should be more specific with the types of circuits we are using (ie. If we are using a filter, specify that it is a low pass filter). This gives the reader an easier and more direct understanding of the overall circuit. He also mentioned that we should try and find out what kind of wires we will being running this circuit next to, as these wires could create more noise in our signal. While we already have filtering to counter act this, we may have to raise our values on our filters in order to add a larger cushion for error. He said it would be quite important it to label all components, including cables, inputs/outputs, and the parts on the PCB board itself, as this will make the jobs of the technicians far easier.

One of the most important points he brought up is that many aircraft circuits are “potted”, meaning that the entire PCB board with all the components soldered on is encased in a layer of epoxy. This epoxy could push our design beyond the required size constraints, and he did not seem to think that we would be able to fit that size if we are required to pot our circuit.  
 Overall, Robert was able to give us good first had knowledge on standards of aircraft parts. We should be more descriptive with our overall circuit by adding more labeling and be specific with our circuit sections. We will need to get into contact with Textron again and see if we can get more information regarding the wires we’ll be installing this bundle next to, and whether we will be potting this circuit.

**Interview 2:** Andy Stallard

Andy is a professor at Wichita State University who is currently our Senior Design I professor. He is a former aircraft-based engineer who has several years of aircraft experience. He brought up some good points regarding other parts that we can add into our circuits. Regarding our voltage regulation for the power bus, he brought up how a snubber circuit, or a metal oxide varistor could work better for our voltage regulation as they will better account for large spikes in the voltage signal. Looking into both, the metal oxide varistor seems like it would be a practical solution for us that would also be compact for our size constraints. He did say that in the case that we use a relay to transmit this information, that we may need to investigate using a free-wheeling diode for diode suppression.

Like Robert, Andy mentioned the need for labels on our circuit, and specified that this is an FAA regulation. Regarding these regulations, he also told us that it would be to our benefit to investigate FAA regulated materials for our packaging as resin, which we have investigated, is flammable and not FAA regulated.

Overall, we can take away from this interview that we need to look some more into FAA regulations on these parts and materials. We have begun to investigate MOV’s, and we think this will be a great solution to our power bus voltage regulation. It will also be important for us to reach out to Textron and get more information regarding where the output will go.

**Interview 3:** Arun Kaarthick Manoharan

Arun is a current graduate student at Wichita State University specializing in power electronics. From our interview, it seems that Arun believes our design can accomplish this task. He also recommended a snubber circuit like Andy did for voltage regulation as it will better accommodate the high spikes we might receive. He did bring up that we should consider what the output voltage is to know whether we will be able to sink the 1 A required by Textron.

An important consideration he brought up was that we need to know how the fan is controlled if we wanted to use a voltage to RPM relationship. Getting more information about both questions will greatly help us to create a relationship between the input RPM reading and what the output will/should do.

Overall, our most important take away from this interview is to find out how our fan voltage to RPM relationship isn’t as simple as we thought it would be. Having better knowledge on this subject will not only give us the relationship we mentioned, but it will also give us a better understanding of how our design works as well.

**Summary**:

One thing that we learned from our interviews was that we should stick with using the tachometer as our input signal to compare to as that would better fit our product requirements to know whether our fan is spinning less than or larger than our threshold. This is because at times our fan could have an input voltage but isn’t spinning as fast as it should be because of some fault in the motor. The tachometer would make sure that this would be addressed as its output frequency is done by measuring the spin of the rotor. We believe that our block diagram is still valid after the completing the interviews. We learned that we need to investigate MOV and snubber circuits as they could be better than a voltage regulator for our input bus. We learned that we should use non-flammable housing materials and labelling is very important as an aid to the maintenance staff , and to provide clarity as to its purpose withing the wire bundle.

The interview process was very educational, and the group learned a lot from this experience. As engineers, we should, and must, commit to lifelong learning. The interview process helped the team to grow and provided an insight into learning process of a practicing engineer. It also illustrated some blind spots within our original design. Interviewing people to ask them their expectations for a product is very important for the engineering profession. All engineers should ask questions to help them learn who they trying to help, and how they should do it.

# Project Work Package (Semester 1)

**Textron Cooling Fan Project Work Package**

For the Spring semester 2022, there are several items left that need to be accomplished. The major milestones are detailed below.

* Finalize the component values for the first prototype.
  + The design that we currently have is still in need of some adjustments as it relates to the specific component values. Additionally, we need to finalize the output stage in order to ensure that it is able to sink. 1-amp continuously. We had hoped to be at this point already but been delayed due to our inexperience and opposing opinions within our ‘mentor’ support system.
  + After this above steps are accomplished, we will generate a BOM to acquire the specific components needed to move on to prototype and test the circuit. These first pass materials will likely be obtained via the university so cost at this point will be minimal.
  + It would also be appropriate to set up a design review with Textron at this point before moving on.
* Breadboard and test the large-scale prototype.
  + At this stage we will require the use of a power supply, oscilloscope, the accompanying leads, etc.
  + We will perform tests on the design to ensure that we get the appropriate response in regard to frequency response, output voltage, and output current (to sink 1-amp continuously).
  + Once the performance is satisfactory, we will generate a progress and testing results report to forward to Textron.
  + Generate a BOM and acquire components that fit our value, ratings, safety requirements.
* Design the PCB that our circuit will utilize.
  + It is my understanding that in order fulfill FAA and DoD requirements, the design will be forward to Textron who will then manufacture the PCB for us and return it for testing. This will also mean a minimal cost the team.
* Design the package to enclose the PCB.
* To do this we will have to research specific material requirements with regard to aircraft. This could be anything from a plastic, 3-d printed package, to an encapsulated circuit.
* We will have to refamiliarize ourselves with Catia, or other CAD software if it is to be 3-D printed.
* Assemble the PCB and enclose within the package
* At this point there are tests to be run to ensure compliance with DO-160g. These tests will be performed by Textron will the observing.

# Updated Project Work Package (Semester 2)

**Textron Cooling Fan Project Work Package**

For the Spring semester 2022, there are several items left that need to be accomplished. The major milestones are detailed below.

* Finalize the component values for the first prototype.
  + The design that we currently have is still in need of some adjustments as it relates to the specific component values. (i.e., the component values for the Schmitt Trigger ). Additionally, we need to finalize the output stage in order to ensure that it is able to sink. 1-amp continuously. We had hoped to be at this point already but been delayed due to our inexperience and differing

opinions within our ‘mentor’ support system.

* + After the above steps are accomplished, we will generate a BOM to acquire the specific components needed to move on to prototype and test the circuit. These first pass materials will likely be obtained via the university so cost at this point will be minimal.
  + It would also be appropriate to set up a design review with Textron at this point before moving on.
* Breadboard and test the first pass prototype.
  + At this stage we will require the use of a power supply, oscilloscope, the accompanying leads, etc.
  + We will perform tests on the design to ensure that we get the appropriate response in regard to frequency response, output voltage, and output current (to sink 1-amp continuously).
  + Once the performance is satisfactory, we will generate a progress and testing results report to forward to Textron.
  + Generate a BOM and acquire components that fit our value, ratings, safety requirements.
* Design the PCB that our circuit will utilize. (This will occur concurrently with the above step.)
  + It is my understanding that in order fulfill FAA and DoD requirements, the design will be forwarded to Textron who will then manufacture the PCB for us and return it for testing. This will also mean a minimal cost the team.
* Design the package to enclose the PCB.
* To do this we will have to research specific material requirements with regard to aircraft. This could be anything from a plastic, 3-d printed package, to an encapsulated circuit.
* We will have to refamiliarize ourselves with Catia, or other CAD software if it is to be 3-D printed.
* Assemble the final PCB and enclose within the package
* At this point there are tests to be run to ensure compliance with DO-160g. These tests will be performed by Textron will the team observing.
* Assemble the deliverables and draft the final report for Textron.
* PCB Schematic files
* PCB Layout files
* Package Design files
* Final Report