TEXTRON COOLING FAN PRODUCT SPECIFICATION SHEET

Ayham Sabra, Cody White, Melvin St.John

ELECTRON WRANGLERS Wichita State University

General Product Description

This is an ad hoc project to develop a small circuit board that will monitor the tachometer output of brushless DC cooling fan and control a discrete output to indicate if the fan is functioning with established parameters. This PCB will be small enough to be installed in an aircraft wire bundle with zip ties to support aftermarket and late point definition installations with minimal impact to the aircraft and/or maintenance crew.

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).
    - 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.)
    - 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 -55˚C to 85˚C.
    - 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
    - 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
    - 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:

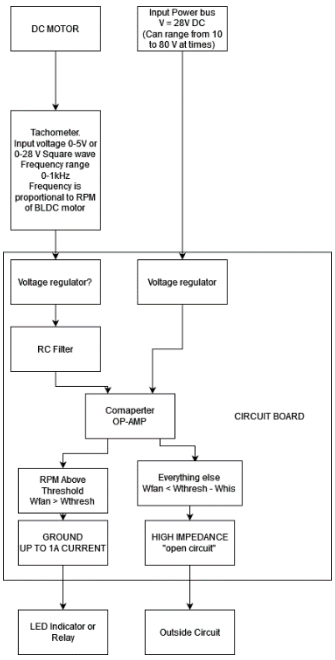
- The following is the documentation required by Textron:
    - PCB schematics
    - PCB layout
    - Package design
    - A report
        - Function description
        - Detail on hysteresis effect
        - Results of testing to prove design
        - What and how to change values to get configurability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

Alternatives



- On the left is our basic circuit.
  - Some alternatives we thought about are:
  - Comparator was debated between OP-AMP voltage comparator circuit and frequency-based comparator circuit.
    - Frequency-based circuit was decided against because it would necessitate the use of memory.
  - RC filter circuit: active or passive, was debated. We intend to use a passive filter element in the design because size constraints and there was no identifiable need for the active filtering.
  - Because the circuit is supplied by a 28v bus, there is a need for regulation to support the lower voltage fan usage (5v). We looked at two different possible designs for voltage regulators, a simple Zener diode setup, or a transistor shunt or series pass design. The design we choose will be affected by the voltage ratings that the Zener diode we pick has ratings for. Since the power bus could supply up to 80 V, we may have to use a diode with a large voltage drop which will directly affect the output voltage at this stage of the circuit. If this drop voltage is too high, then we can counter act it with the aforementioned series pass design.

Signature:

I have read the entire report and it meets my personal quality standards

Date: 10/24/2021 10/24/21

Sign:

Citation:

Clinton, T. (2021). Avionics and Electrical System. *Project Proposal*.

RTCA. (2010, December 8). *Product details*. Product - Community Hub. Retrieved October 22, 2021, from https://my.rtca.org/NC__Product?id=a1B36000001IcnSEAS.