University of Alabama
Department of Physics and Astronomy

PH 126 LeClair Fall 2011

RPM sensor project

1 Goals

1. Devise a scheme to generate an electrical signal every time a small fan completes one rotation
2. Filter and amplify this signal to give a known number of 5 V pulses per rotation of the fan.
3. The occurrence of 5 V pulses should not depend sensitively on the amplitude of the signal (which itself depends on the rotation speed), but trigger so long as the input pulses exceed a defined and adjustable threshold.
4. Use the Arduino microcontroller to count these pulses and display the rotations per minute on the serial monitor

2 Details

1. A fixed coil of wire and a magnet glued to a fan blade will produce a signal that looks something like one period of a sine wave for each rotation
2. You should eliminate the negative voltage portion of the pulse, and amplify and integrate the positive portion.
3. The integration time should be comparable to the rotation period, simply for "smoothing" the signal.
4. After filtering and amplification, a threshold detector (pulse height discriminator) will produce the requisite 5 V pulses.
5. These pulses will be fed into a Arduino digital input, and edge detection will be used to count the number of pulses per second.

3 Guaranteed Supplies

1. Arduino Uno microcontroller
2. protoboard with various power supplies and function generator
3. oscilloscope
4. PC
5. dc fan
6. NdFeB "button" magnet
7. various passive components (resistors, capacitors, diodes) and wires
8. op amp (741) and comparator (LM311)

9. pre-wound coil

Other supplies available at your request.

4 Deliverables

1. Diagram of the mechanical arrangement of fan, magnet, and coil which produces an electrical RPM signal, including a sketch of the expected signal on the coil
2. Complete circuit diagram which produces a fixed number of 5 V pulses per rotation, including the expected signal at various points in the circuit (pre/post- amplification, pre-post digitizing, etc.)
3. A plot of your measured RPMs versus the dc fan supply voltage.
4. Arduino code which counts said pulses and prints the RPMs to the serial monitor.
5. A memo describing the above.

Each of these items (except the memo) should be turned in separately as a brief report as you generate them, a hard copy or electronic submission is fine. The memo should be turned in at the completion of the project. Only one of each report is necessary per group.

5 Expected Duration

It is anticipated that the project will take at least two weeks, but it will continue until each group has achieved satisfactory performance. Groups finishing early will be given the option of additional extra credit projects.

6 Reporting

Suggested length: 3-5 pages; hard limit of 5 pages in maximum. A *concise* memorandum summarizing the results of the build and experiment. The memorandum is a sort of "role-playing" exercise: you play the role of an outside contractor, specializing in custom control circuitry, who has been hired by a technology firm to perform this task. You are writing this memorandum for a very busy manager at a technology firm who has little time for (or interest in) esoteric details: you must get to the point quickly, without sacrificing critical information. A template will be provided. *Creativity is encouraged*, and the format will vary with your solution to the problem and your own tastes. A suggested outline is:

1. Background: what is the problem addressed?
2. Theory: a very short (~2 paragraph) outline of the physics and electronics
3. Circuits designed and calculations
4. Results and Discussion; include measured RPMs versus fan supply voltage.

5. Conclusions: did you solve the problem? To what degree?
6. Appendices: important, but secondary information (such as your Arduino code)

The grading of memos will follow the template below, with brevity and precision playing a large overall role.

- Theory and motivation, 10%
- Description of problem, 20%
- Description of experiment and design, 30%
- Analysis of data, results, and uncertainties, 20%
- Relevance of results to the stated problem, 10%
- Style and quality of written English, 10%