Shaker Generator Project

Design a DC low voltage low power vibration or shaker generator.

A local business designs, manufactures, and builds vibration conveyors. The conveyors run at about 15 Hz and have a stroke of about 3/8-in. The details are in the addendum. Users of this hardware like to be able to remotely check the status of the conveyor to determine if the system is running as planned, and the manufacturer likes to be able to check the system and make sure the customer is not overloading the system or driving it to hard (for warranty claims).

The current system has an internal accelerometer, RF transmitter, and battery mounted in a water tight plastic package. It is about the size of your fist. The current objective is to remove the battery and have the system powered by a passive energy harvesting mechanism. The size of the generator and the power supply electronics needs to fit in the space presently taken by three AA batteries. The objective is to make the actual generator fit in about the size of a AAA battery or perhaps as big as an AA battery. Erik Biesenthal is designing the box and will be supplying us with drawings/CAD data. There is a section on the class wiki with some useful links as well. Feel free to add more.

The project is to:

1) Determine the power requirements (voltage, current, power, etc.) for transmitting the information 2, 4, 6, and 8 times per hour. Estimate the average power needed for these four options. (The addendum provided by the company provides some details).

2) Design a small vibratory driven generator that can produce about twice the minimum energy needed in part 1. The energy may be temporarily stored in a capacitor to provide the power required by the electronics with its duty-cycle. It is to our advantage to make the generator not make much more energy than we need, because excess energy is turned into heat which will end up being a problem. I plan to use a Maxim MAX757 switching step up DC-DC converter somewhat similar to the way the Shakemote uses a MAX756. If your generator puts out voltages in excess of 5.6 volts, that energy will all end up as heat so you don't want to do that. The minimum peak voltage out put that will work is about 2 volts.

The specifications are as follows:

a) Provide power as specified above.
b) Must be as small as possible, but not so small as to increase the production cost due to its size. The size should be about that of an AA battery.
c) Must function within a specified vibration direction of plus or minus 5 degrees. The mounting allows very close alignment of the vibration direction of the conveyor to the generator's direction.
d) The generator must operate from zero to forty degrees Celsius ambient temperature. Assume all frictional and generated energy is dissipated in the box. Note that the electronics has a maximum operating temperature given in the data sheets. Estimate the steady state temperature of the parts.
e) The generator must be designed such that it can last 5 years.

Report the following:

1) Assumed average constant power produced is? And show the assumptions to arrive at this power.
2) Provide a drawing/sketch of the final generator mechanical design, sufficient that it may be made and tested from your drawing/sketch.
3) Provide a electromechanical model of the generator, to include such things as friction force between sliding parts, magnetic force between moving parts, end-of-generator forces due to vibration. Include a magnetic circuit model of the generator.
4) All calculations necessary to demonstrate the generator is functional at the required specifications.
5) A parts list necessary to build a prototype, with costs and suppliers.
6) A summary of your work with a recommendation of any superior idea you can think of to perform this task beyond the details of what you have done.

Prototypes:

This design could be done entirely experimentally, however, better designs generally come about by doing calculations first, and prototypes next. You will submit a preliminary report with the five items above to the instructor by not later than class time, Friday, February 19. Your design will be reviewed, and either submitted back to you for refinement, or your parts will be ordered so you can build and test a prototype of your design.

Teamwork:

The project will be done in teams of two. I recommend having at least one ME on your team, because there are some significant fatigue and thermal issues to be solved in addition to the electromechanical energy conversion. The project will replace up to one hour of exams. (You can specify which problems to apply it to on future exams, including the final, if you are happy with your Exam 1 score.) If an EE wants to design the power conditioning, that is fine. For anyone who needs it, the instructor will provide a design of that part.