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## Master's Thesis : XRF instrument power supply

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**Title: XRF instrument power supply**

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## Abstract

This thesis brings a complete redesign to the power supply of an X-Ray fluorescence (XRF) spectrometer.

XRF is the phenomenon in which an atom absorbs an X-radiation with a certain energy level and release another X-radiation with another energy level. Indeed, if the excitation source has enough energy, ionization can occur in the material and the atoms become unstable. To restore equilibrium, electrons from higher orbitals can fall to fill the gap by releasing energy (in the form of a photon) equal to the difference between the 2 orbitals involved. In an energy-dispersive spectrometer (EDXRF), the number and the energy of the incoming X-rays are measured and then sorted. A complete spectrum of the target can be obtained, and the atomic composition of the target determined.

The ALEXIS instrument is basically composed of 6 excitation sources, 1 detector and signal processing electronics. The excitation sources are pyroelectric crystals which are thermally cycled in order to have a continuous flux of X-Rays. The detector is a Silicon Drift Detector (SDD) which the actual state of art in EDXRF analysis. This technology needs to be cooled down by a Peltier element and must be polarized by a high negative voltage to drift the electron-hole pairs produced by the X-Rays impact to the collection electrode.

The first part of the thesis is dedicated to the design of a controller for a current source driving the Peltier cooler. The goal is to obtain a stable cold temperature of the detector chip during the measurements. In space applications, due to radiations, analog electronics is preferred to digital. That is why an analog PID controller has been implemented based on the temperature feedback coming from the SDD. The finality of this part is a series of simulations to tune PID parameters.

The second part of the work is the implementation of the thermal cycle of the sources. Two temperature thresholds determine if the source must be powered up or not and the 6 sources must work independently. In order to achieve this, an analog Schmitt trigger was designed on each source with a digitally controlled gain attenuator to control the output voltage. Final simulations give results very close to the real lab tests.

The last part of the project described the method to design a DCM Flyback converter. The goal is to generate negative high voltage from the rover power supply (28V) in order to generate the drift electric field in the SDD. A spreadsheet was created. It automatically computes the circuit parameters according to the input/output requirements. The conclusion is open-loop simulations performed to show the influence of the parameters. Future closed-loop design is just discussed.

**Keywords:** EDXRF, ALEXIS project, power supply, Peltier cooling, analog PID controller, Schmitt trigger, DCM Flyback converter.