Chapter 1
Introduction

Abstract

This present project deals with practical design and implementation of a power supply for CubeSat satellite. The satellite is entirely developed by the students at the Aalborg University.

The first chapter, the introduction, presents a background of the project as well as some general guidelines about the work enclosed in the project.

1.1. Background of the project

The development of a student satellite is about to be initiated at Aalborg University. It should be finished by May 2002. The object of the project is to involve project groups in development of an AAU satellite across different departments of the Faculty of Engineering and Science.

The electronic functions on board and the choice of the materials are totally up to the CubeSat groups. The only restrictions deal with weight, space environment, launching requirements and international regulations. The satellite will be located in a Low Earth Orbit (LEO) at a height of approximately 600 kilometers from the surface of the Earth.

The satellite is designed, developed, implemented, tested and operated by students. A number of student groups are established within the participating fields and subsystems.

1.2. Aims of the project

The aim of the project is to design and realize the power subsystem for the CubeSat satellite. It is considered an optimized design, therefore some considerations about redundancy, operational thermal domain, reliability and efficiency of the power supply must be taken into account. It is a requirement that the efficiency is as high as possible, considering thermal problems caused by waste heat as no kind of convection is available. All power dissipation from the satellite is done by radiation. At the same time, high efficiency will result in savings of the solar cells.

1.3. System description

In figure 1.1 is presented a general description of the satellite architecture. The flow of power is illustrated, in order to offer an overview of the general power problem.

The mission of the satellite is to take snapshots of the Danish landscape. In order to achieve this task, a few separate subsystems must be implemented. The payload consists in a 5 V supplied CCD camera, 1.3 mil. pixels.

Orientation of the satellite is provided by the Attitude Control System (ACS) by means of interaction of 3-axis coils magnetic field with Earth's magnetism. Communication Module (COM)

ensures the link with the ground control station, situated in Aalborg. It is also the task of the COM to downlink the pictures and information about each subsystem. Optional, the COM may incorporate a beacon module.

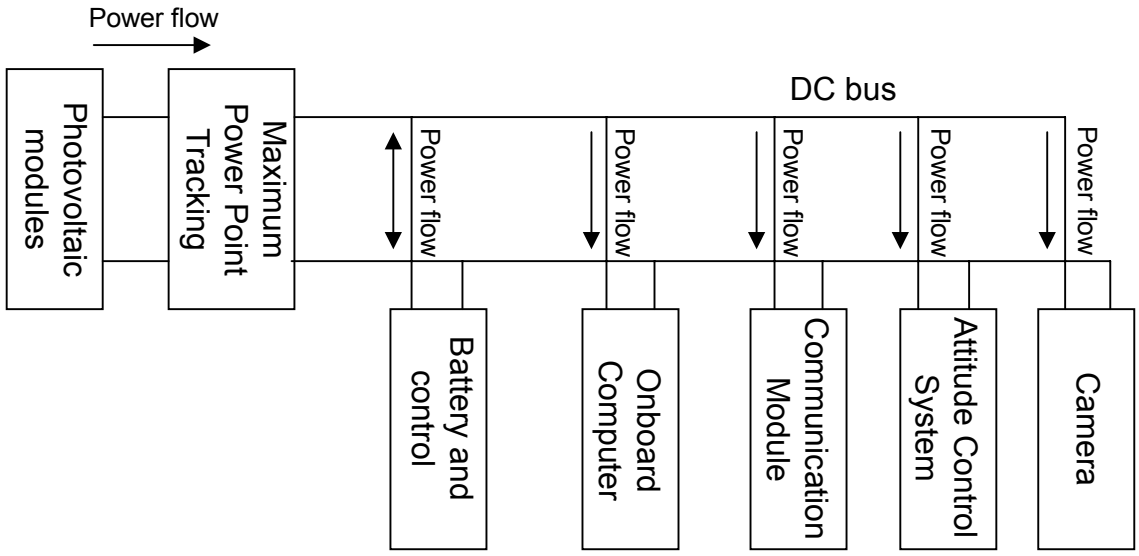

Figure 1.1 Overview of the simplified satellite system

Supervision of the well-behavior of all subsystems is done by the Onboard Computer (OBC), which will also decide in critical situations.

All subsystems will be supplied with proper voltages by the Power Supply Unit (PSU). The PSU contains Photovoltaic module (PV), Maximum Power Point Tracking (MPPT) and Battery Unit (BAT).

1.4. Strategy for achieving the aims

The strategy for achieving the aims is stated as follows:

- Analysis of entire structure of the satellite, revealing the most important aspects concerning the power subsystem.
- After the analysis is performed, the best solution for practical implementation of the different parts of the power supply is chosen, considering also the specifications for the system.
- Solution chosen is verified through simulation.
- The thermal regime is studied for a better positioning of the components of the power supply. This will provide a feedback for a more accurate analysis of the system.

- Finally, chosen topology is practical implemented.
- Measurements are performed on the real model of the power supply and efficiency is evaluated.
- Based on the results, final conclusion about the design is drawn.

1.5. Content of the project

The main goal of the present project is to realize an optimized design for a power supply used in CubeSat satellite.

The main part of the project consists of seven chapters, defining the demands for the application in which the power supply is to be used, and the power subsystem itself.

Based on the comparison between simulations and measurements, conclusions will be drawn, considering the chosen topology in respect with the application.

In the first chapter, the problem dealt in the project is stated and the goal of the project is defined, as well as the strategy for achieving the aims. A general scheme is shown and a description of the power subsystem is made.

The second chapter presents the specifications for the system.

In the third chapter, an analysis of the system is performed. Several ways to connect the solar cells and topologies for the power supply are presented and the best solution, in respect with the demands of the application, is chosen.

In the fourth chapter, the design is definitivated and the final analysis is performed using as a feedback the experience gained in the previous chapter. The protection circuits are designed and preliminary considerations about the temperature range inside the satellite are stated. The implementation of the power supply final design is also presented.

The fifth chapter deals mainly with problems related to EMC considerations and with the thermal analysis.

The sixth chapter is dedicated to experimental measurements. The experimental setup is presented and the methods used for measurements are presented. On the basis of the data obtained in this chapter, a conclusion is drawn in the final chapter, the seventh.