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Master Degree Course Electronics Engineering, MSc EE

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# Modelling and Simulation of Electric Propulsion System for Manned and Unmanned Light Aircraft.

## *ABSTRACT - Masterthesis*

To estimate and evaluate the performance of electrically driven manned and unmanned small aircraft ELIAS II (UltraLight class), a detailed modelling of the main components of the propulsion system is required. The main components of the propulsion system are the engine, the engine controller, the propeller and the battery system. For range extension solar cells are installed on the upper wing surfaces of the aircraft.

To increase safety by redundancy and improve the efficiency in low power cruise flight, a duplex motor is considered consisting of two single engines working on the same propeller drive shaft. To avoid a braking moment of the non-functional engine in the single engine model (intended or due to an engine failure) a free wheel clutch for each engine is proposed.

A duplex motor with and without free wheel clutch and duplex controller is modelled using Simulink ®. Duplex system without free wheel has the serious problems, such as stopping the running motor in short circuit condition. The control laws for the duplex system is designed and implemented in the model. The duplex motor is connected with two Li-Ion battery packs with battery management systems. During the duplex system operation it is assured that both battery packs are being discharged equally. The engine model is validated with data of a 58 V DC single in the 16 kW class.

In duplex system, an additional battery in the system enhances the endurance of the ELIAS II flight cycle duration. When two motors are running, efficiency of the motors is also increased. Wear and tear of the motors are decreased as load is distributed between two motors.

Propeller model in the simulation is analyzed with three different sets of propeller data. The results from the three different propeller data are compared for validation. The data measured in the wind tunnel test provided better results in comparison to the other two propeller data.

The solar cells recharge the batteries during flight operations depending on the intensity and the angle of sun light on the solar cells. Solar panels are designed with their respective controllers to suit with the battery voltage of the system in Matlab® and Simulink®. Solar panel system simulation model is compared for their results with three different solar cell types, at different geographic locations and at different seasons of the year. Solar panels are arranged on the wings of the ELIAS II ultra light aircraft. Solar panels accumulated around 1-20% of additional power supply to the battery for the functioning of propeller system.