MAAP™v1.1GettingStartedGuide

The MAAP™ Getting Started Guide provides a description of the MAAP™ software as well as references and tutorials to help the user learn how to effectively use MAAP™.

This document can be opened from the command line using the function:

```
openMAAPGettingStarted();
```

Other useful documentation can be found here:

- MAAP™ Getting Started Guide
- MAAP™ API Reference
- MAAP™ Overview Tutorial

Table of Contents

What is MAAP™?

Overview

The LaunchPoint EPS **Modeling Advanced Aircraft Propulsion (MAAP™)** software allows aircraft & electric propulsion designers to quickly run trade studies to understand how a bespoke electric propulsion system – motor and controller and associated subsystems – will improve their vehicles performance and mission capabilities. It will also allow them to make difficult trades between rotor speed, motor and drive mass, subsystem efficiency, power margin, and reliability and component life. MAAP™ derives this information from first principles physics models of all the components. This knowledge is unobtainable any other way as there does not yet exist a database of existing designs to

draw from to derive these kinds of trade studies. MAAP™ can also provide insight into how much potential performance is being “left on the table” by using COTS instead of bespoke to quantitatively inform a “make versus buy” decision.

Optimization

The MAAP™ software can be used to optimize motors, drives and motor-drive combinations at the system level. MAAP™ uses top-level requirements of an electric propulsion system such as power, shaft speed, air or liquid coolant temperature, efficiency constraints, and bus voltage etc as inputs and then performs numerical optimization to produce an optimal (e.g. minimum mass or maximum efficiency) motor, drive or motor-drive design that meets the requirements. In addition to top-level specifications, the designer can choose to specify many physical parameters such as magnet strength, winding fill factor, shaft strength, insulation temperature rating, switching loss characteristic of transistors, and peak transistor junction temperature.

Off-Design

MAAP™ can also run a more detailed off-design analysis of a motor, drive, or motor-drive design point. The off-design analysis shows how motors and drives will perform over a range of operating conditions which are outside of the operating conditions used to optimize the motor & drive. The off-design analysis can be performed using a MAAP™ optimized design or on a custom design specified by the user.

Trade Studies

MAAP™ readily performs system-level trade studies including requirements trades, operating point trades, and technology trades. MAAP™ will also perform simultaneous combined trade studies.

Summary

MAAP™ provides the following outputs

System performance across the operating envelope including

- Current and voltage at key system nodes
- Internal and external temperatures
- Power loss breakdown identifying sources of heat and inefficiency
- Windage and friction loss, eddy current loss, copper loss (temperature dependent) RMS and ripple
- MOSFET Switching loss, MOSFET conduction loss, capacitor resistance, emi filter inductor loss, output filter inductor loss
- Component and system efficiency
- Proximity to all operational constraints

System mass including mass breakdown to constituent parts

- MOSFET, Inductor, Capacitor, Connectors, Heat Sink, Processor, Housing, Current sensor
- Magnet, winding, shaft, bearings, structure

System and component dimensions, including electrical specifications of primary components

Virtual spec sheet

System Requirements

- MATLAB
- Optimization Toolbox
- Global Optimization Toolbox (optional)
- FEMM (Finite Element Method Magnetics) (optional)

Documentation

MAAP™ Getting Started Guide

The MAAP™ Getting Started Guide provides a description of the MAAP™ toolbox as well as references and tutorials to help the user learn how to effectively use the MAAP™ toolbox. This document is the MAAP™ Getting Started Guide.

MAAP™ API Reference

Next, it is recommended that the user familiarize themselves with the MAAP™ API Reference documentation. The MAAP™ API Reference contains detailed documentation on the important classes and methods of this toolbox.

MAAP™ Overview Tutorial

The MAAP™ Overview Tutorial should be completed first before any other tutorials. Once this is complete, proceed to the optimization and analysis tutorials. Many of the optimization and analysis tutorials are based on the motor optimization tutorial, and the drive optimization tutorial.

Tutorials

Overview

- MAAP™ Overview Tutorial (DOC I Interactive Script)

Optimization

- Motor Optimization (DOC I Interactive Script)
- Drive Optimization (DOC I Interactive Script)
- Combined Optimization (DOC I Interactive Script)
- Generator Optimization (DOC I Interactive Script)
- Mission Optimization (DOC I Interacative Script)
- Genetic Optimization (DOC I Interactive Script)

Analysis

- Off-Design Analysis (DOC I Interactive Script)
- Paramemter Sweep (DOC I Interactive Script)

Supplemental Papers

- Radial-Gap Motor
- Axial-Gap Motor
- Electronic Drive