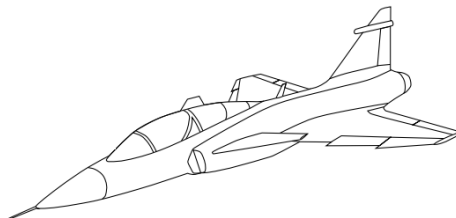


# Test Plan Future Aircraft Energy Management Systems

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Course name:	Reglerteknisk projektkurs	E-mail:	emibo804@student.liu.se
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## Project Identity

**Group E-mail:** emibo804@student.liu.se  
**Homepage:** <https://gitlab.liu.se/chrre97/student-project-energy-management>  
**Orderer:** Alessandro Dell'Amico, Saab Aeronautics  
**Phone:** +46 ordernr, **E-mail:** alessandro.dellamico@liu.se  
**Customer:** Alessandro Dell'Amico, Linköping University, IEI.  
**Phone:** +46 customernr , **E-mail:** alessandro.dellamico@liu.se  
**Course Responsible:** Anders Hansson, Linköping University  
**Phone:** +46 13 281681, **E-mail:** hansson@isy.liu.se  
**Project Manager:** Emil Boström  
**Supervisor:** Kristoffer Ekberg, Linköping University, ISY.  
**Phone:** +46 advisornr , **E-mail:** kristoffer.ekberg@liu.se

## Group Members

Name	Responsibility	E-mail (@student.liu.se)
Emil Boström	Project Leader	emibo804
Petrus Eriksson	Hardware Manager	peter792
Hugo Lundeberg	Document Manager	huglu683
Erik Börjesson	Test Leader	eribo610
Robin Helsing	Design Manager	robhe093
Emil Brunberg	Software & Integration Manager	emibr702

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# 1 Introduction

The testing will be established as straightforward as possible and broken down into easy to follow steps.

## 1.1 Goal

The end goal for the following test plan is to establish connection with all Keysight components, Speedgoat and Simulink. And run a real-time simulation of the entire Digital Twin (DT) for different mission profiles and failure modes.

# 2 Initial hardware test plans

The test plan will be presented in the following sections. Where PSU stands for **Power supply unit**, PCU **Power consumption unit**. The two different units will first be tested separately where connection between PC and the units will be established. Further on, the PSU and PCU will be connected and connection to the PC will via switch will be established.

## 2.1 Test Plan for establishing communication with PSU

**Test number: 1 Req. tested: -**

1. Power PSU on. Familiarize with PSU control panel.
2. Change voltage and max power output level via the PSU control panel.
3. Find IP-adress of one PSU.
4. Read voltage level from PSU via ethernet cable and Simulink interface. While changing voltage level on the PSU control panel.
5. Change PSU voltage level via Simulink.
6. Repeat step 1-5 for a second PSU separately.
7. Connect both (L and R system) PSUs to PC via a switch.
8. Read voltage level from both PSUs via ethernet cable and Simulink interface. While changing voltage levels on the PSUs control panel.
9. Change PSUs voltage levels via Simulink.

## 2.2 Test plan for establishing communication with PCU.

**Test number: 2 Req. tested: -**

1. Power PCU on. Familiarize with PCU control panel.
2. Change consumption setting.
3. Find IP-adress of one PCU.



4. Read consumption level from PCU via ethernet cable and Simulink interface. While changing consumption level on the PCU control panel.
5. Change PCU consumption level via Simulink.
6. Repeat step 1-5 for a second PCU separately.
7. Connect both (L and R system) PCUs to Simulink via a switch.
8. Read consumption levels from PSU via ethernet cable and Simulink interface. While changing consumption levels on the PCUs control panel.
9. Change PCUs levels via Simulink.

### 2.3 Test plan for PSU-PCU configuration

**Test number: 3 Req. tested: -**

1. Disconnect both PCU and PSU from switch/Simulink.
2. Connect power cable between one PSU and PCU.
3. Power on PSU and PCU, and set PSU voltage level and PCU consumption level.
4. Change consumption levels on PCU on PSU control panel.
5. Read consumption and voltage level from PCU and PSU via ethernet cable, switch and Simulink interface. While changing consumption level on the PCU control panel.
6. Change PCU consumption level via Simulink.
7. Repeat step 1-6 for the second PSU-PCU configuration separately.
8. Connect both (L and R system) PSU-PCU setups to Simulink.
9. Read consumption levels from (L and R system) PSU via ethernet cable and Simulink interface. While changing consumption levels on the PCUs control panel.
10. Change both (L and R system) PCUs levels via Simulink.

### 2.4 Performance testing of Keysight setup

**Test number: 4 Req. tested: -**

To move on with the initial testing more performance testing of the hardware will be carried out. The testing here will be an extension of the previous initial testing where connection between the PSU-PCU and PC has been established.

1. Establish the connection with PSU-PCU and PC via switch.
2. Through the PC make the PCU consume power from the PSU. This could for instance be interpreted as a step in Simulink via PC.
3. Since the information is send in series, a speed test of how fast the Keysight is able to handle command in series should be done.
  - Make two step responses which is performed at the same time. Step responses could for example be that the PCU should pull a set amount of power.



### 3 Test plan for Simulink models

#### 3.1 ME

**Test number:** 5 **Req. tested:** -

1. Send in a throttle angle to the model and check that an appropriate speed output is achieved.

#### 3.2 Generator

**Test number:** 6 **Req. tested:** -

1. Send in a rpm speed to the generator and check that the desired voltage is achieved

**Test number:** 7 **Req. tested:** -

1. Send in a varying speed to the generator and test that the voltage follows the variation

#### 3.3 SSPC

**Test number:** 8 **Req. tested:** 24,25

1. Set the maximum current output to a component, example the radar, and test that the voltage is set to zero when the max current is sent.

**Test number:** 9 **Req. tested:** 24,25

1. Set the maximum and dropout voltage levels and test that the output voltage is set to zero if any of the two is reached.

### 4 Test plan for entire digital twin, offline

#### 4.1 Offline simulation

**Test number:** 10 **Req. tested:** 1a, 3, 14-15

1. With the integrated Simulink file with the IEI group, run the simulation offline using a pre-defined flight mission
2. Also test that the interval of the voltage is within the standards set in requirements 14 and 15.

### 5 Test plan for entire digital twin and PSUs/PCUs

#### 5.1 Real-time testing

**Test number:** 11 **Req. tested:** 1a, 4, 14-15



1. With the integrated Simulink file with the IEI group, run the simulation in real time using a pre-defined flight mission
2. Also test that the interval of the voltage is within the standards set in requirements 14 and 15.

**Test number: 12 Req. tested: 39**

1. Send a voltage and current command to Keysight unit and receive a matching measurement of voltage and current.

**Test number: 13 Req. tested: 16**

1. Perform a step from 330 V to 280 V, this is done by replacing the reference voltage in the CSD model to previously mentioned values in the step.
2. Perform a step from 200 V to 250 V, this is done by replacing the reference voltage in the CSD model to previously mentioned values in the step.

**Test number: 14 Req. tested: 17**

1. Perform a step from 50 V to 29 V, this is done by replacing the reference voltage in the converter model to previously mentioned values in the step.
2. Perform a step from 18 V to 22 V, this is done by replacing the reference voltage in the converter model to previously mentioned values in the step.

## 5.2 Keysight power distribution

**Test number: 15 Req. tested: 37**

1. Set one Keysight unit to constant voltage and one unit to constant current and check that a current is flowing.

## 6 Energy management test

### 6.1 SSPC and VMS voltage control

**Test number: 16 Req. tested: 24, 28**

1. Make a test where the required power exceeds the maximum generator power, and test that the VMS lowers the power to non critical components, i.e the radar.
2. If needed, the SSPC should cut off the voltage to said components.

## 7 Test plan for different failure modes

### 7.1 Generator failure

**Test number: 17 Req. tested: 26, 29**

1. the generator status to off and test that the battery engages and supplies current to the consumers.