



Title: Electrical system simulation of an aircraft through ANSYS Electronics Desktop

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Editorial label ECORFAN: 607-8695

BCIERMMI Control Number: 2022-01

BCIERMMI Classification (2022): 261022-0001

Pages: 24

RNA: 03-2010-032610115700-14

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Introduction

Aeronautic industry and the relationship with the simulations, causes:

- Time and cost reduction
- More safety in the test
- More tests

More Electric Aircraft is:

- Electric system – Pneumatic, Hydraulic and Mechanic systems.

Introduction

In the next diagram, you can see the differences between an aircraft with MEA and a conventional aircraft.

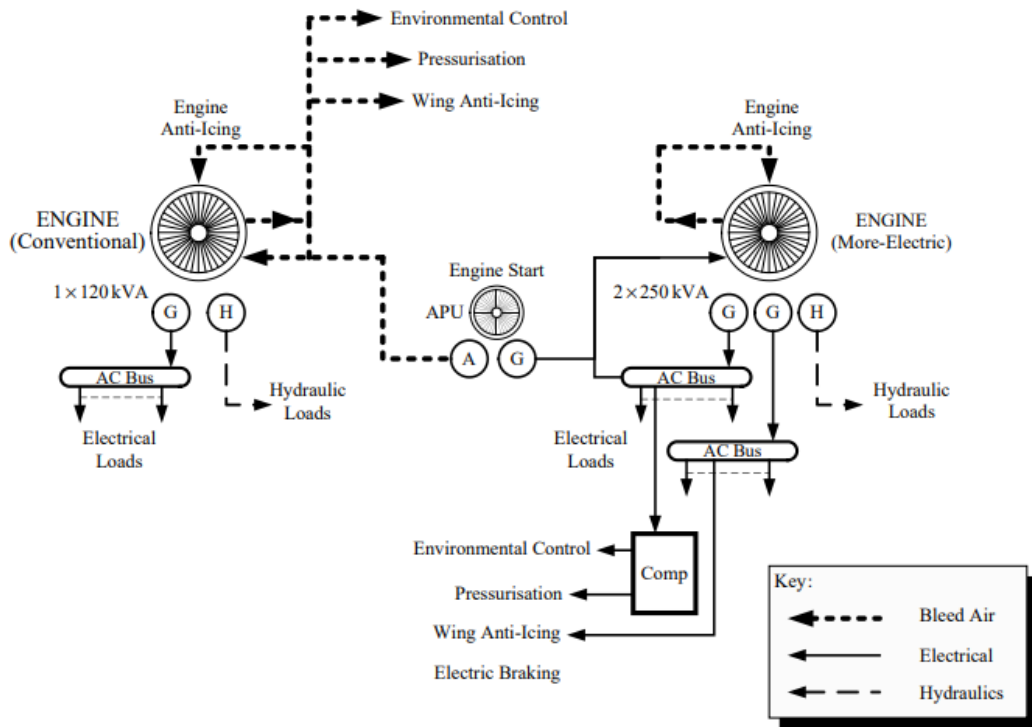


Figure 1 Electrical system of a conventional aircraft. *Aircraft System: Mechanical, electrical, and avionics subsystems integration. Moir, Ian (2008)*

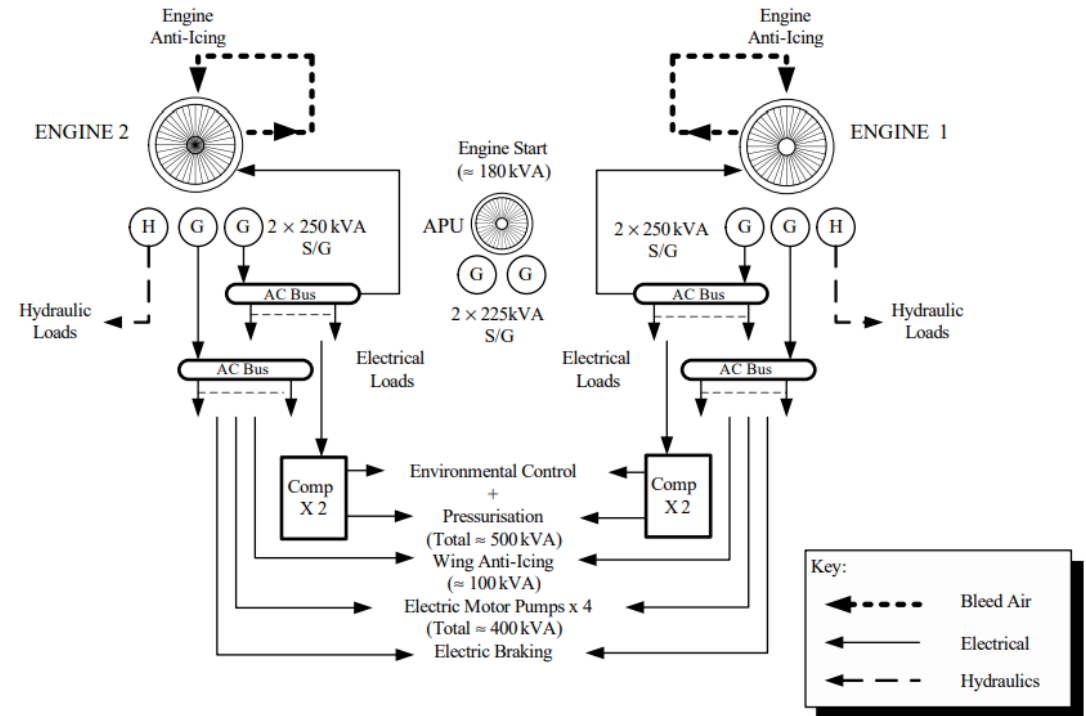
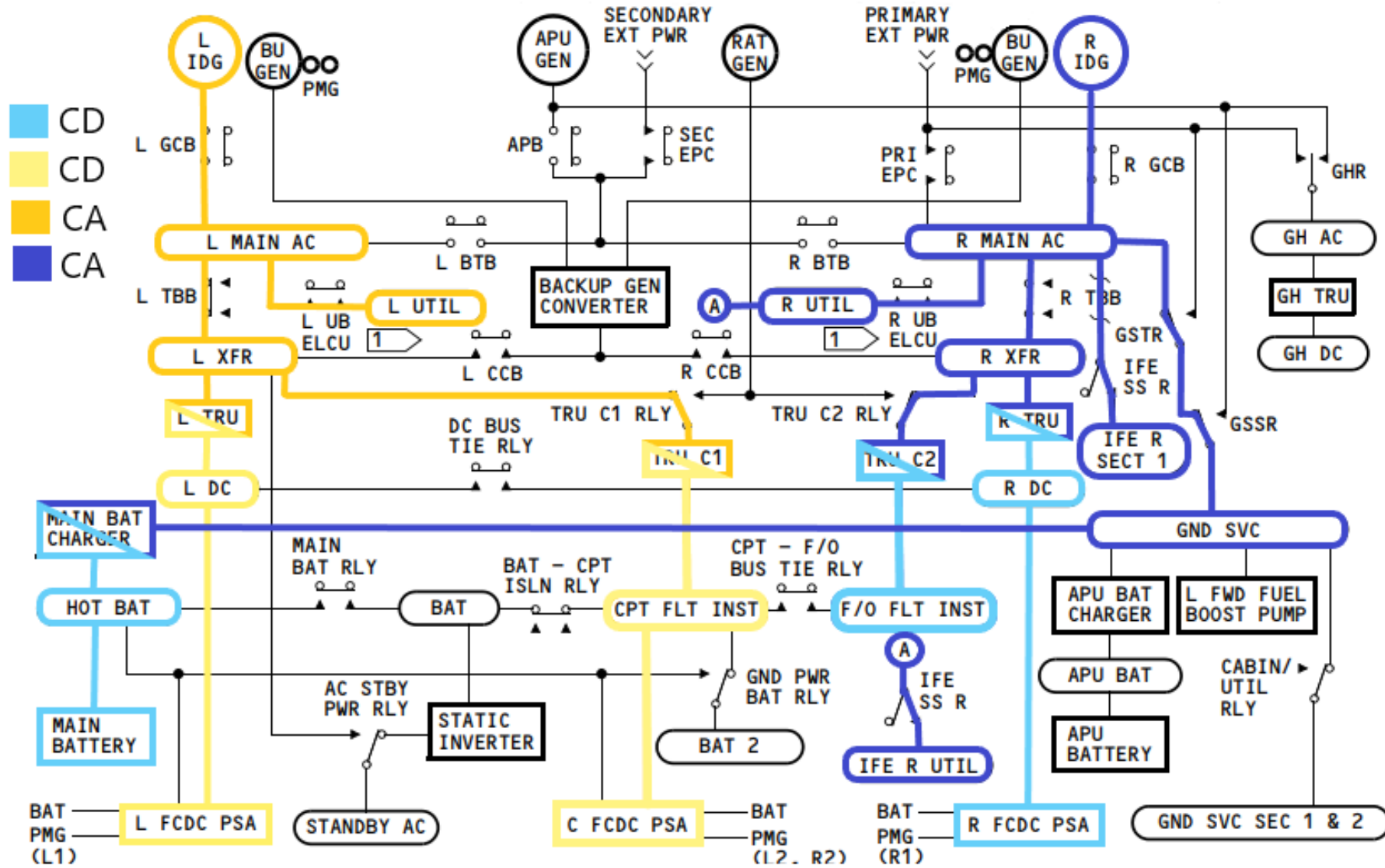


Figure 2 Electrical system of the Boeing 787 aircraft with MEA. *Aircraft System: Mechanical, electrical, and avionics subsystems integration. Moir, Ian (2008)*

Methodology

To do the simulation, the process carried out was as follows:

- **FIRST STAGE:** Analyse the electric diagram:
 - Identify which are the principal subsystems
 - How subsystems work
 - When the subsystems work
 - Input and Output of each subsystem
 - Connexions between subsystems and bars
 - Type of source AC or DC of each subsystem



Graph 1 Power flow diagram of the electrical system of the Boeing 777

Methodology

- **SECOND STAGE:** Create and simulate the circuit that represents the behaviour of each subsystem.

Integrated Drive Generator

Parts:

Turbine – Gear box , Constant Speed Driver – Generator – General Control Unit

Function:

Supply the main AC bar left and right

Variables:

Output voltage and current: 115 VRMS AC 3 ϕ – 900 A

Frequency: 400 Hz

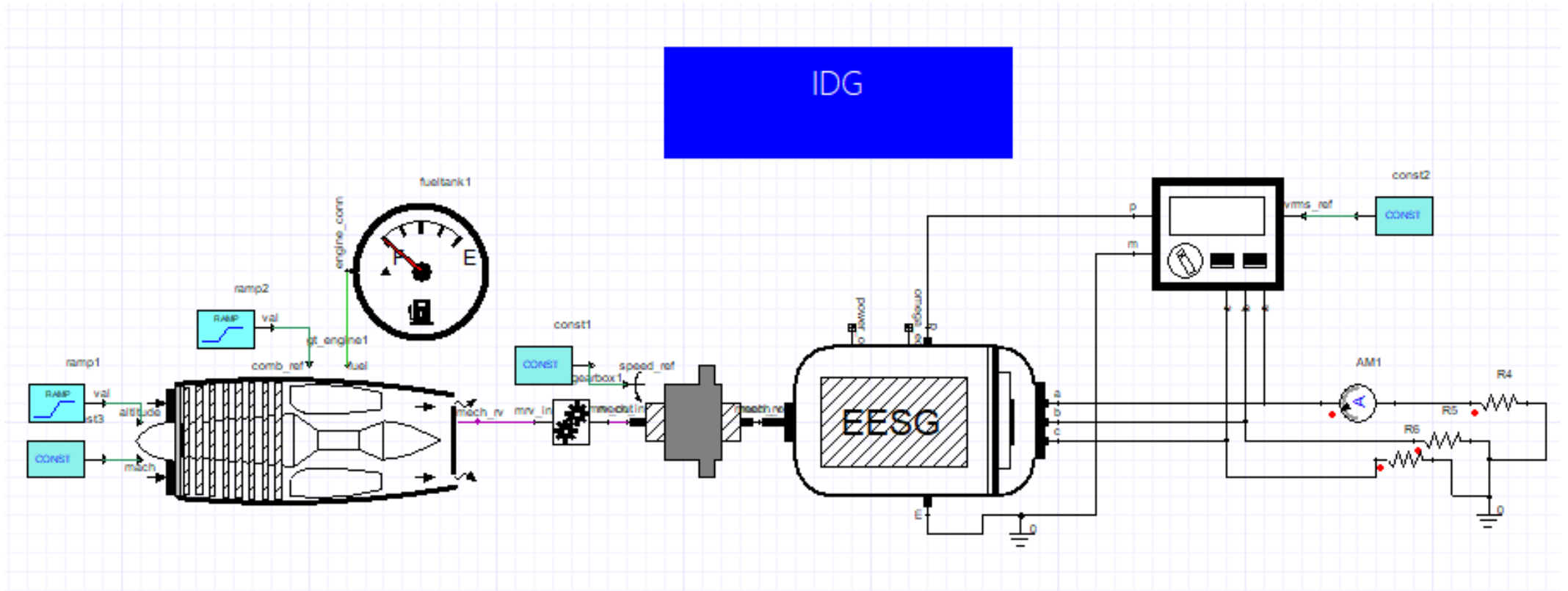


Figure 3 IDG Simulation.

Methodology

Transformer Rectifier Unit

Parts:

3 ϕ Transformer – Bridge full rectifier

Function:

Convert AC voltage to DC voltage

Variables:

Input voltage: 115 VRMS AC 3 ϕ

Frequency: 400 Hz

Output voltage: 28 VDC

Output current: 250 – 300 A

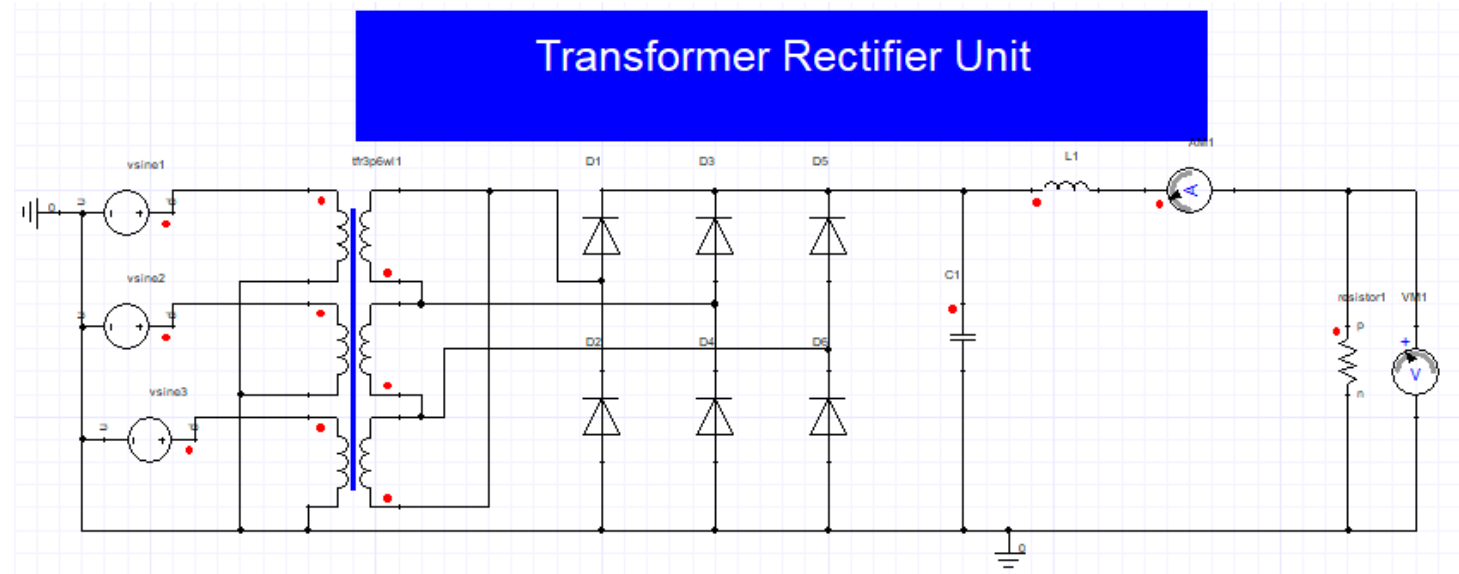


Figure 4 TRU Simulation.

Methodology

Main Battery – Main Battery Charger

Parts:

Charger: 3 ϕ Transformer – Bridge full rectifier

Main Battery: battery

Function:

Supply DC voltage and charge the battery

Variables:

Battery: 24 VDC

Charger: 14.25 kW, 24 VDC, 600 A

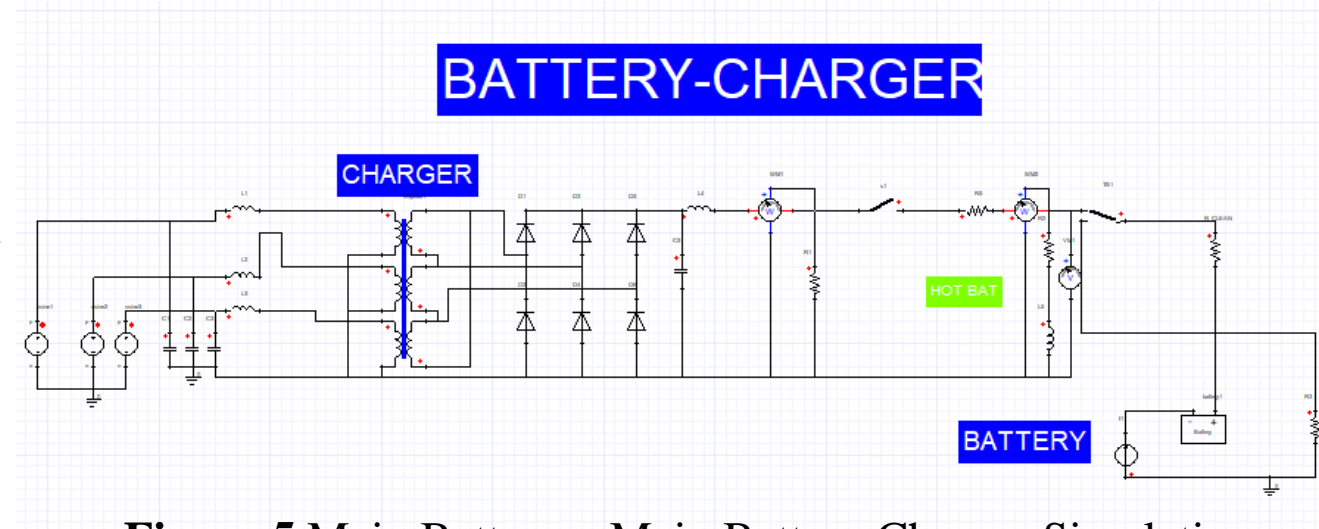


Figure 5 Main Battery – Main Battery Charger Simulation.

Methodology

Flight Control Direct Current

Parts:

Represented by electrical resistors

Function:

Flight controllers help maneuver the aircraft

THIRD STAGE: Join each subsystem according to the Graph 1 divided in two parts, left and right lane and simulated.

Results

PER SUBSYSTEM:

Integrated Drive Generator

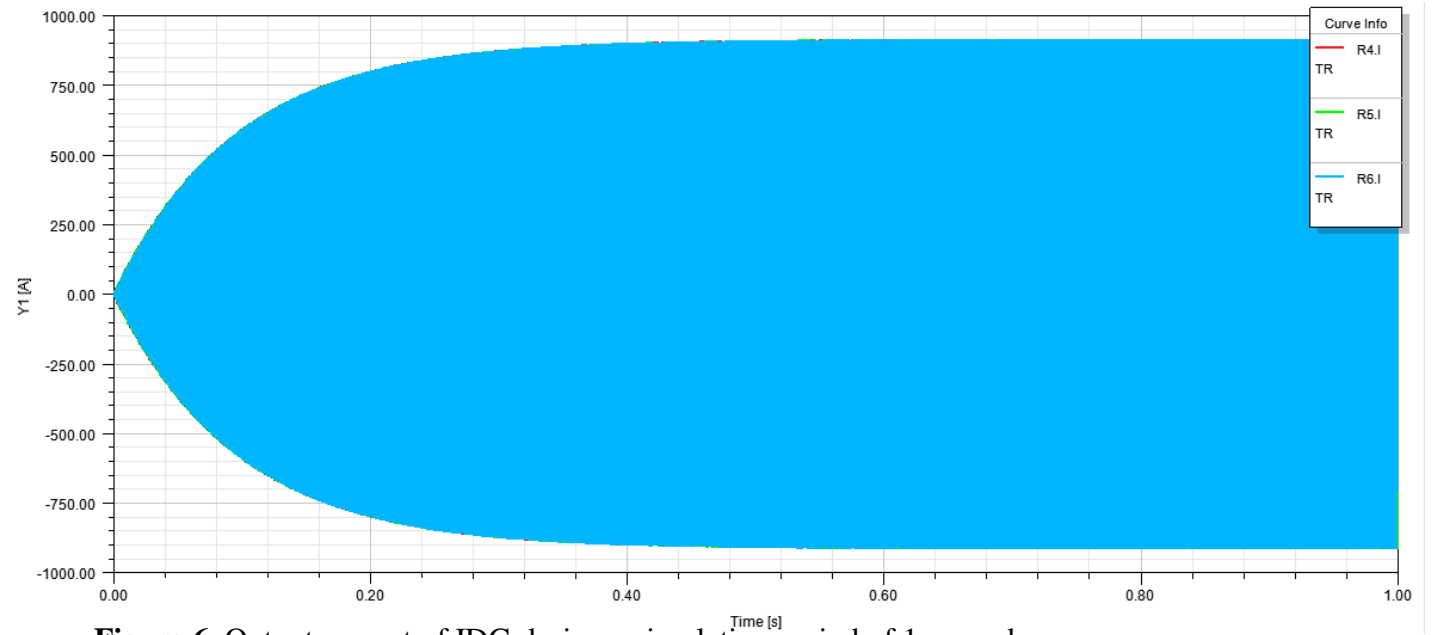


Figure 6 Output current of IDG during a simulation period of 1 second.

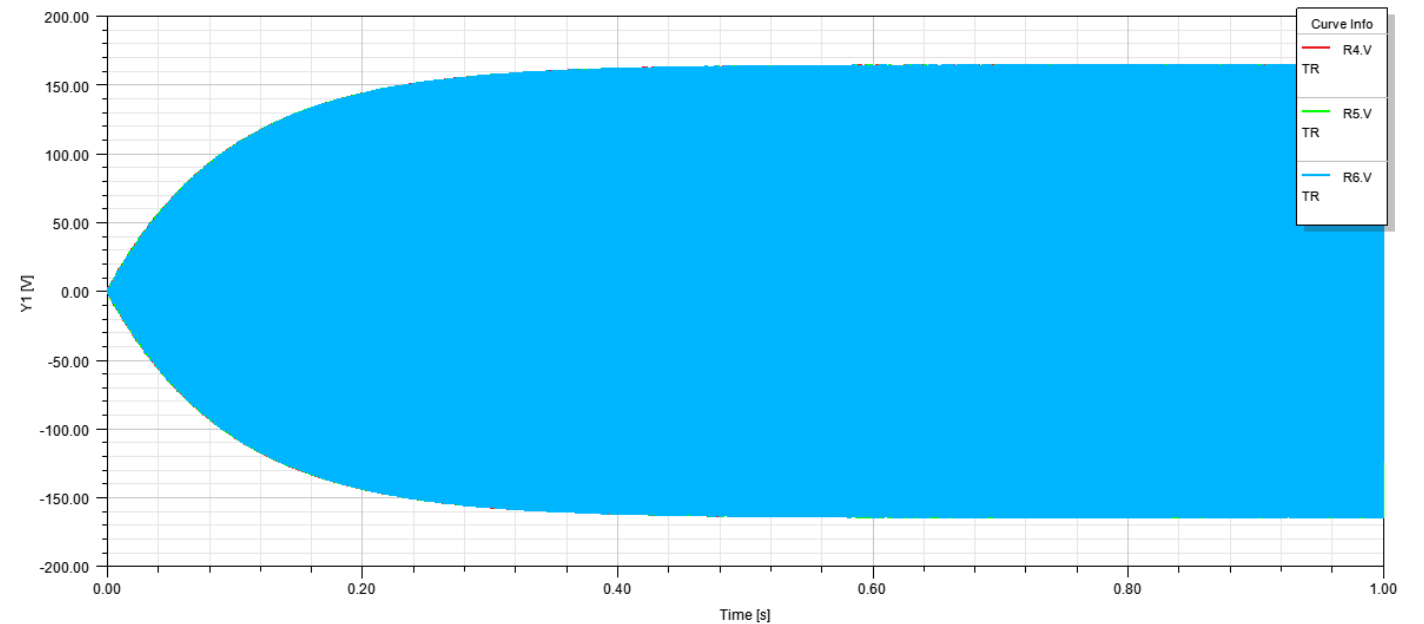


Figure 7 Output voltage of IDG during a simulation period of 1 second.

Results

Transformer Rectifier Unit

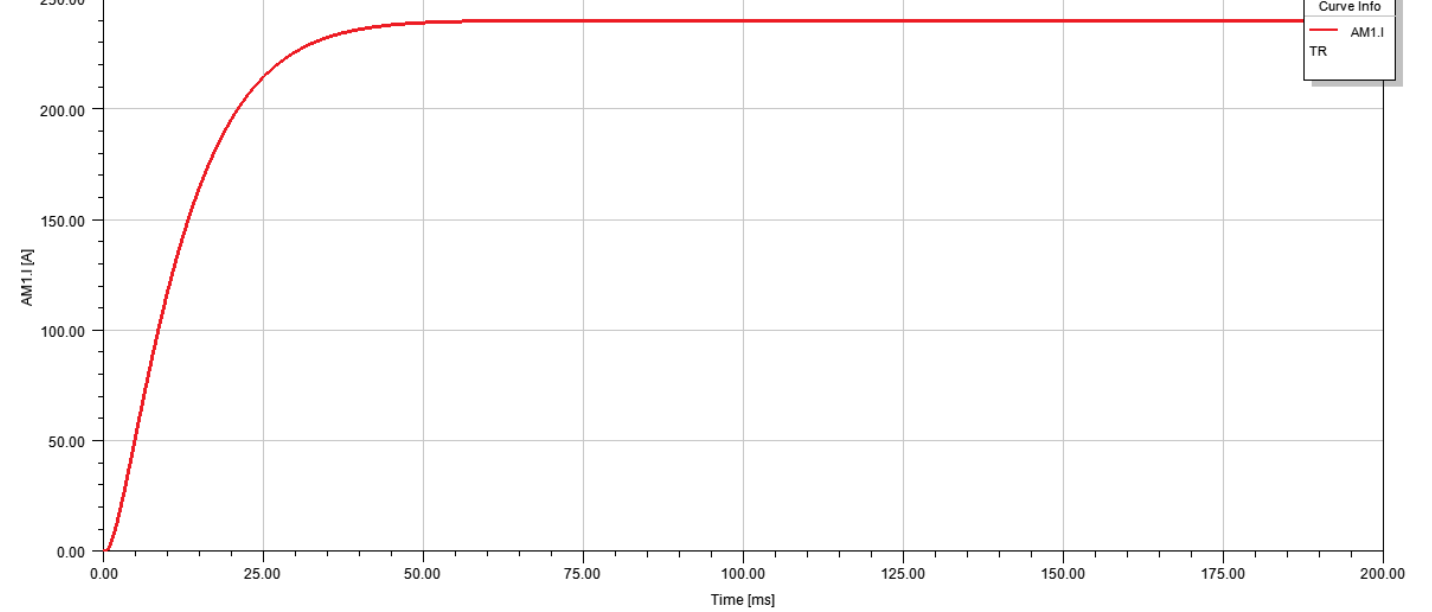


Figure 8 Output current of TRU.

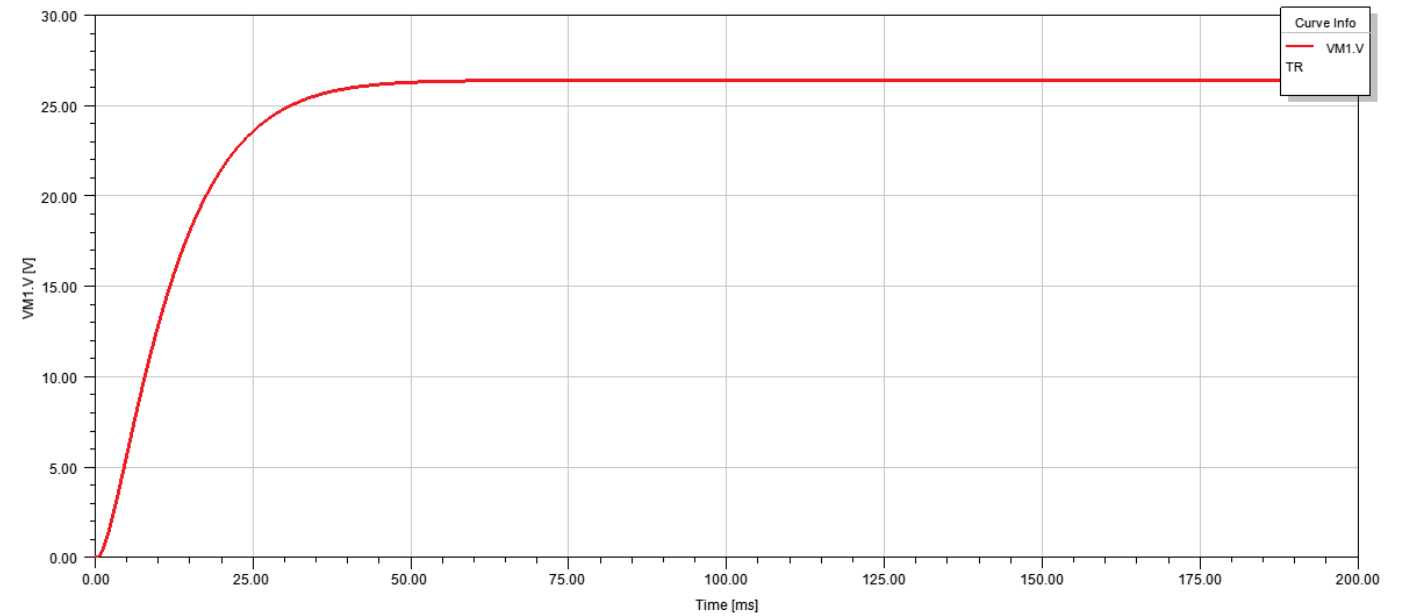


Figure 9 IDG current output during a simulation period of 1 second.

Results

Main Battery - Main Battery Charger

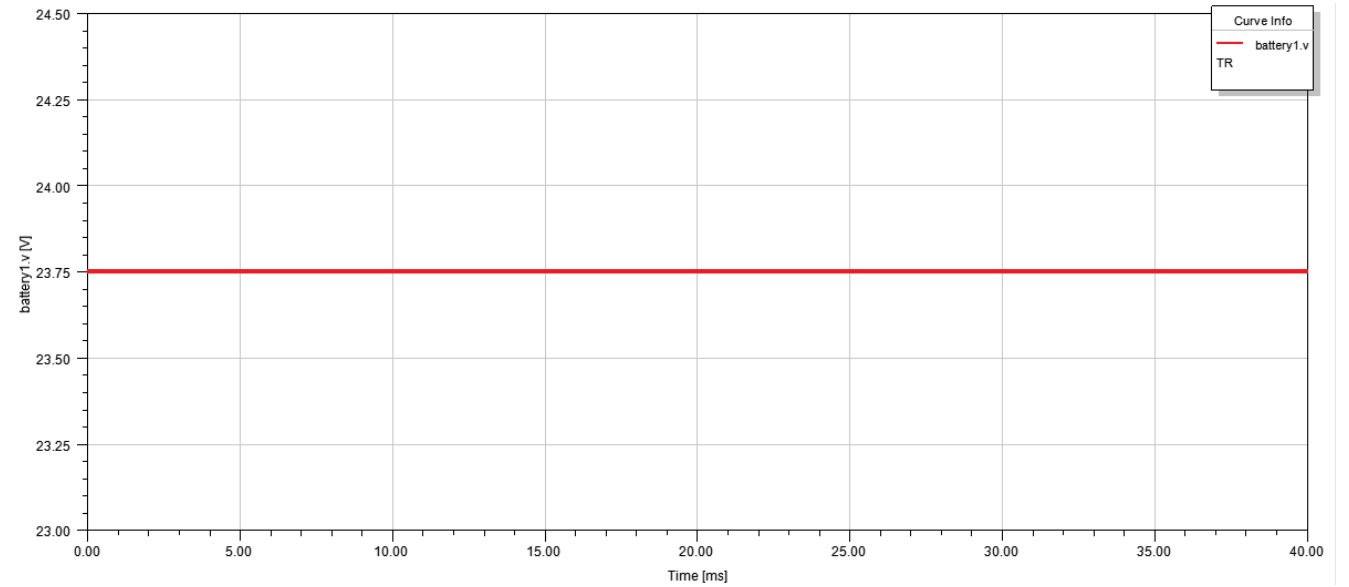


Figure 9 Output voltage of battery.

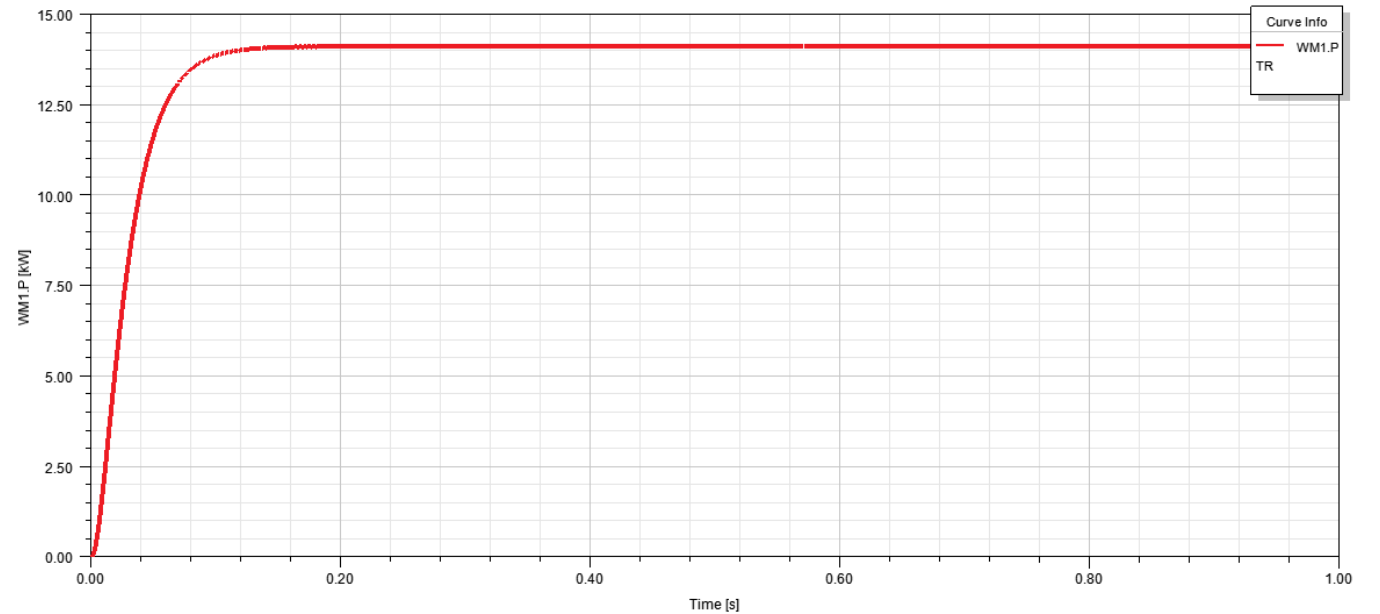


Figure 10 Output power of main battery charger.

Results

Left lane

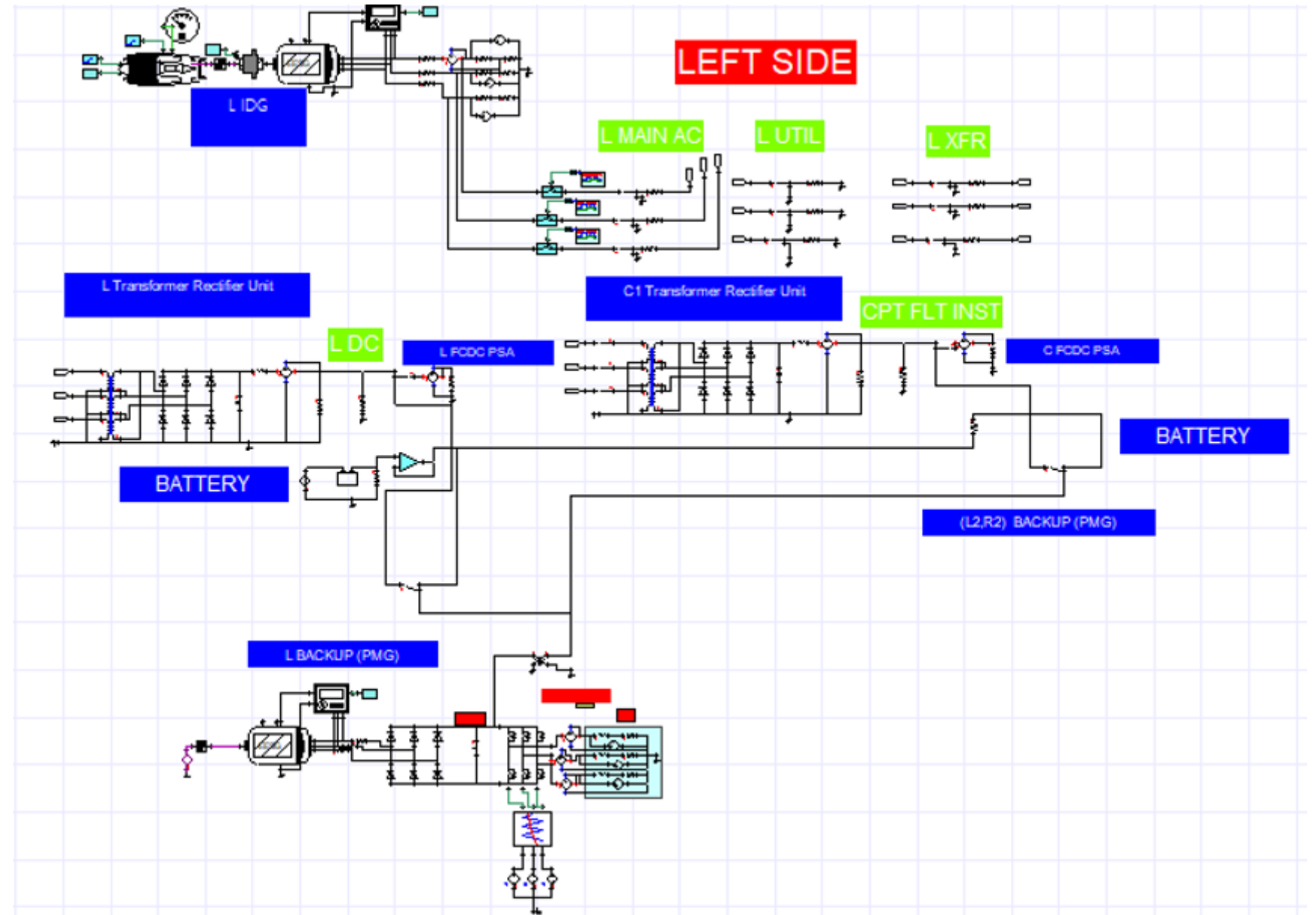


Figure 11 Simulation corresponding to the left side of the electric system.

Results

Integrated Drive Generator

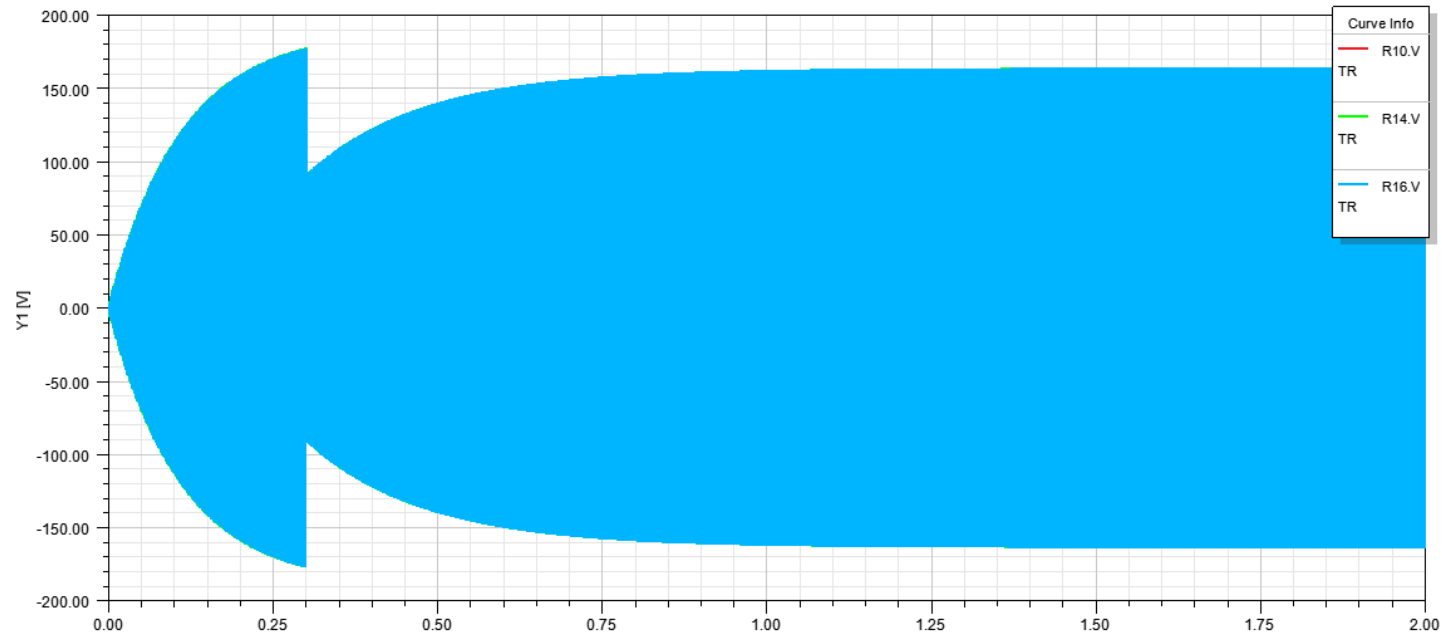


Figure 12 Output voltage of IDG.

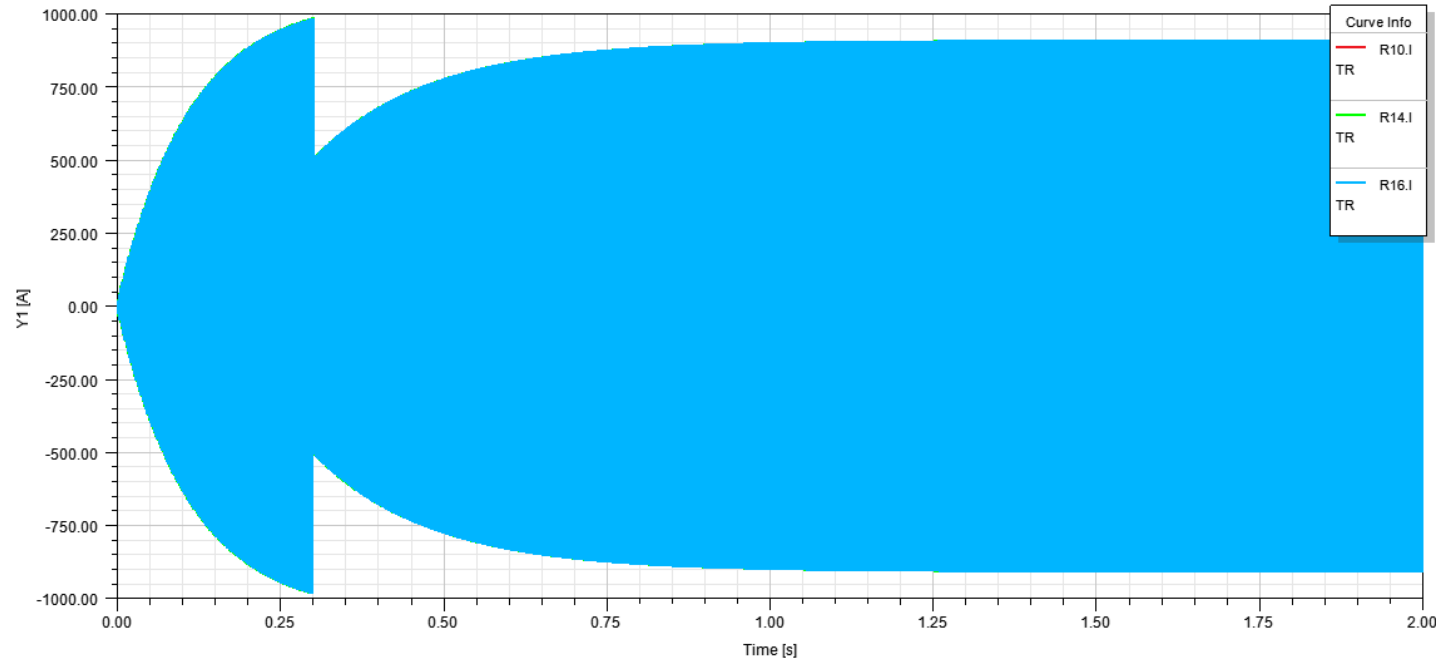


Figure 13 Output current of IDG.

Results

Transformer Rectifier Unit

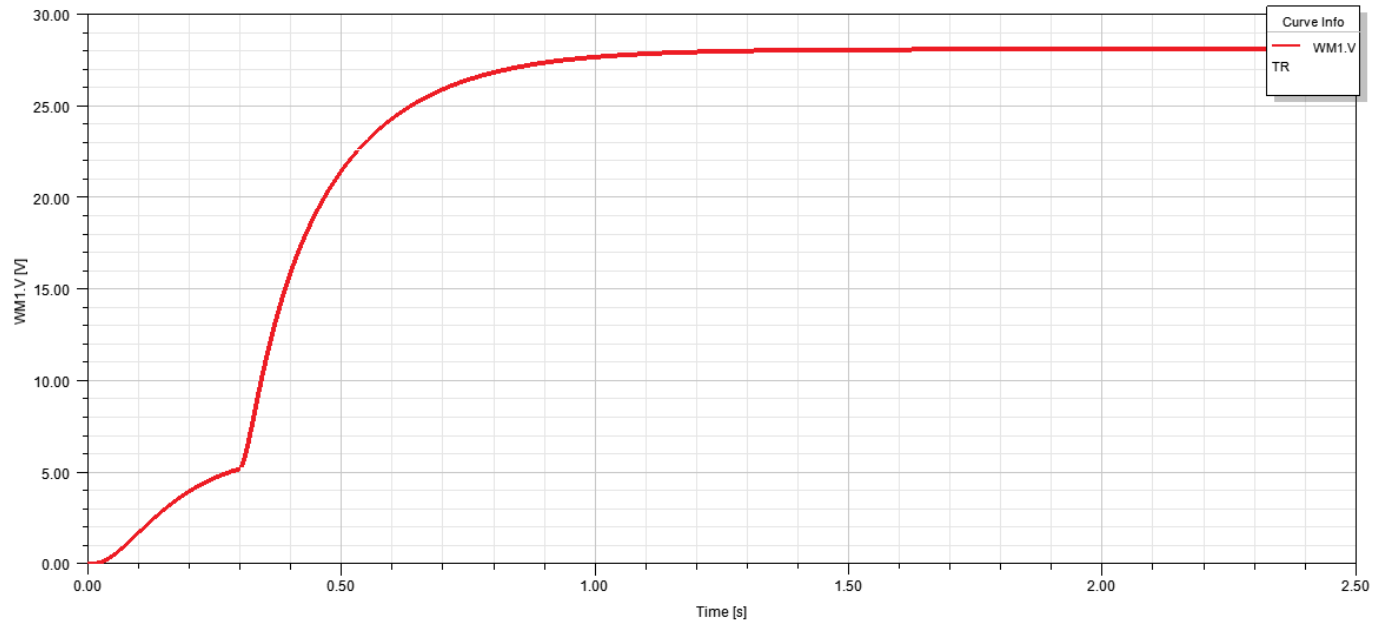


Figure 14 Output voltage of TRU in the left lane.

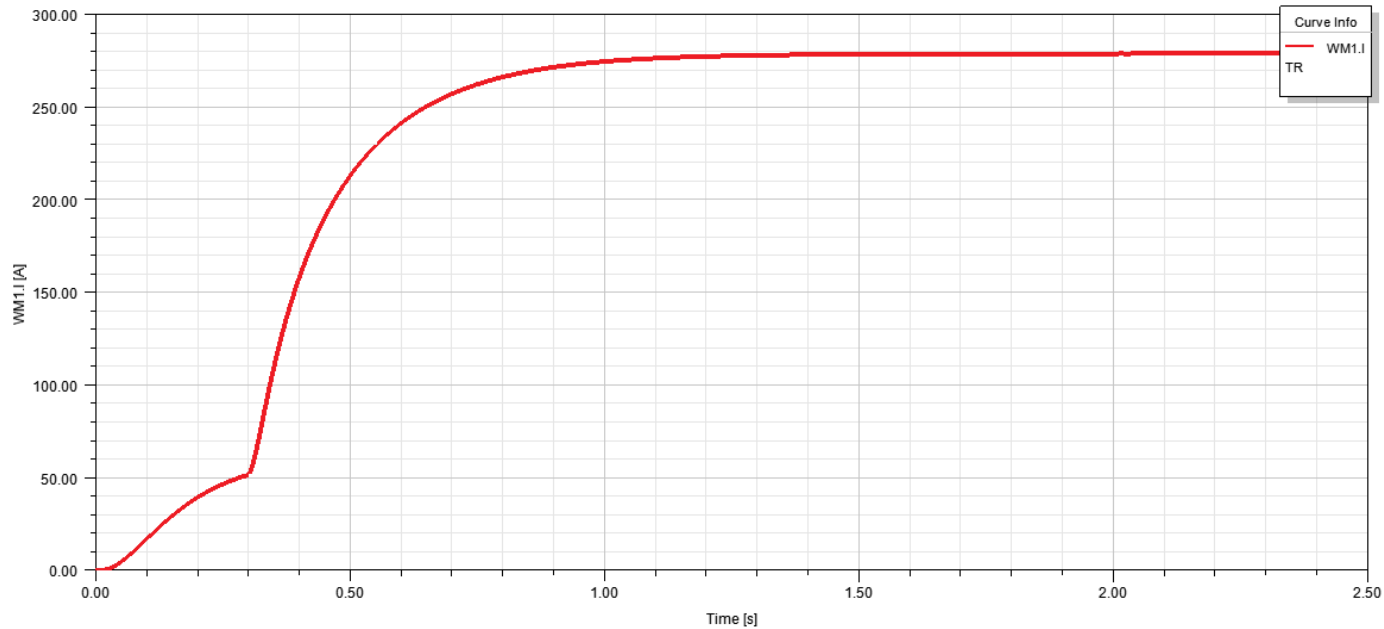


Figure 15 Output current of TRU in the left lane.

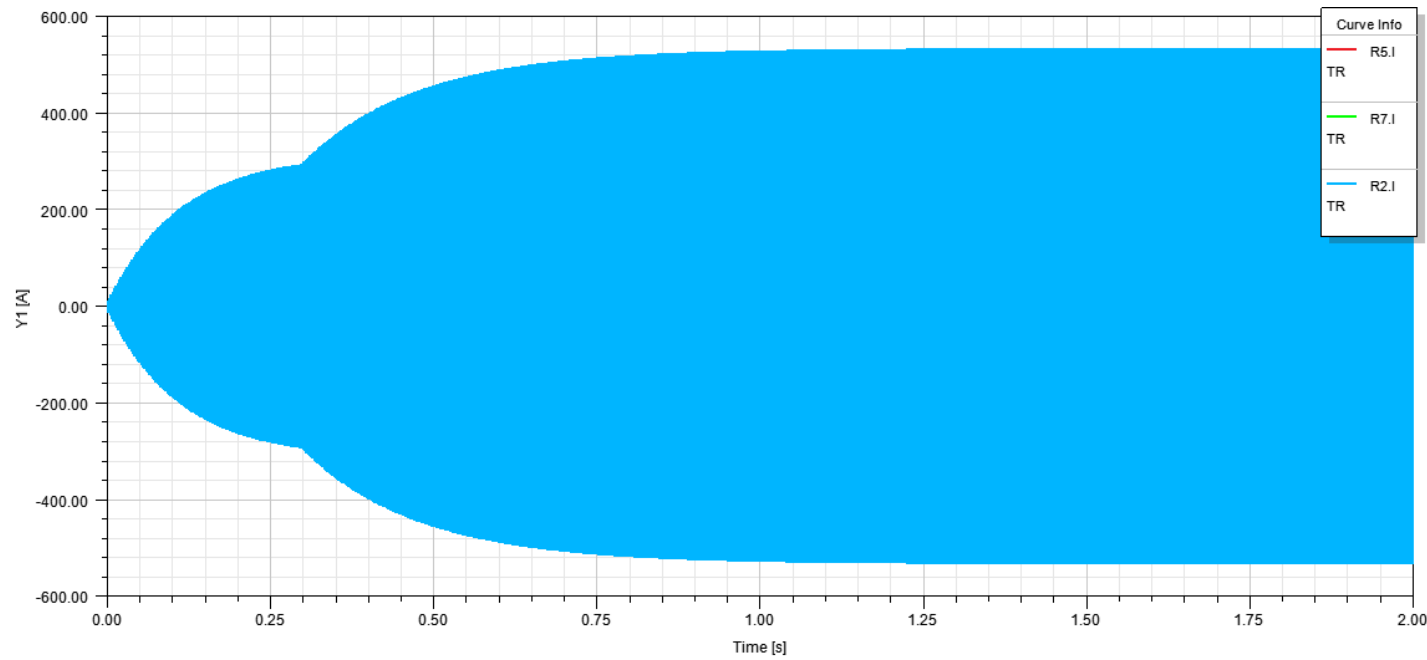


Figure 16 Output current of utility busbar.

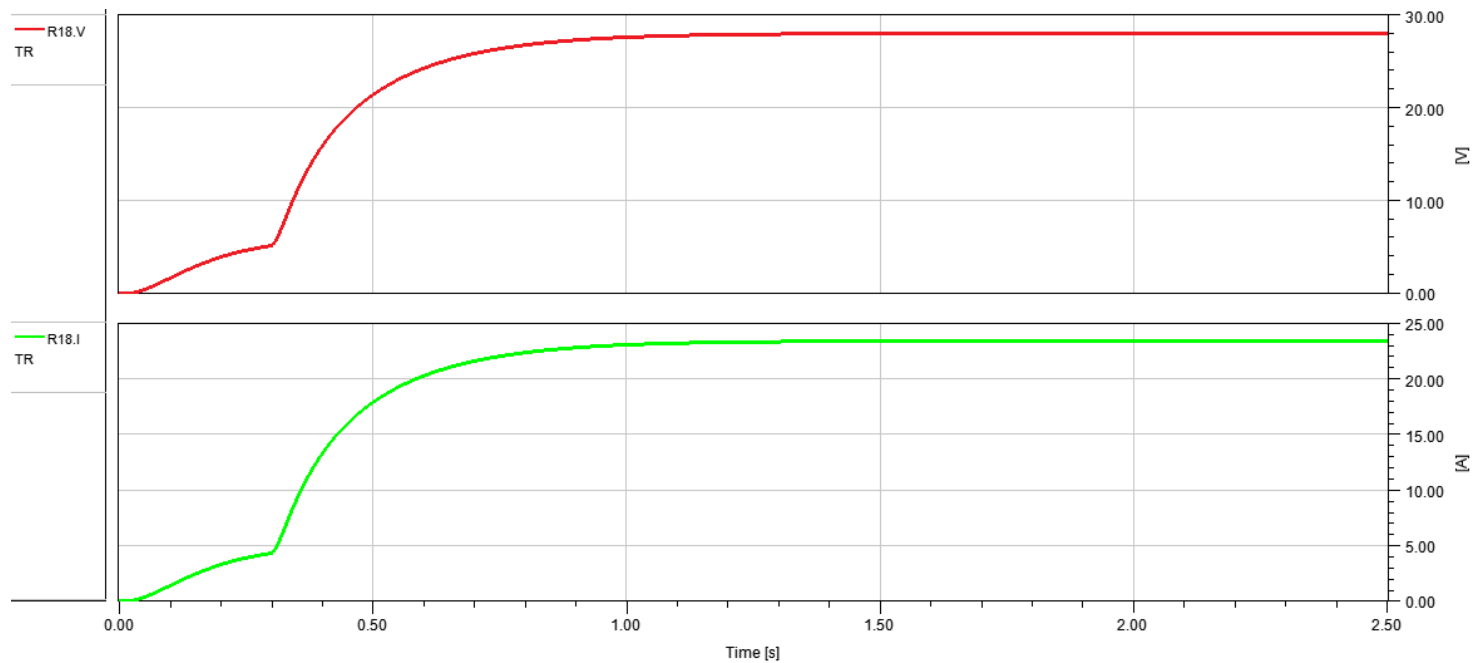


Figure 17 Output voltage and current of DC left busbar.

Results

Busbars

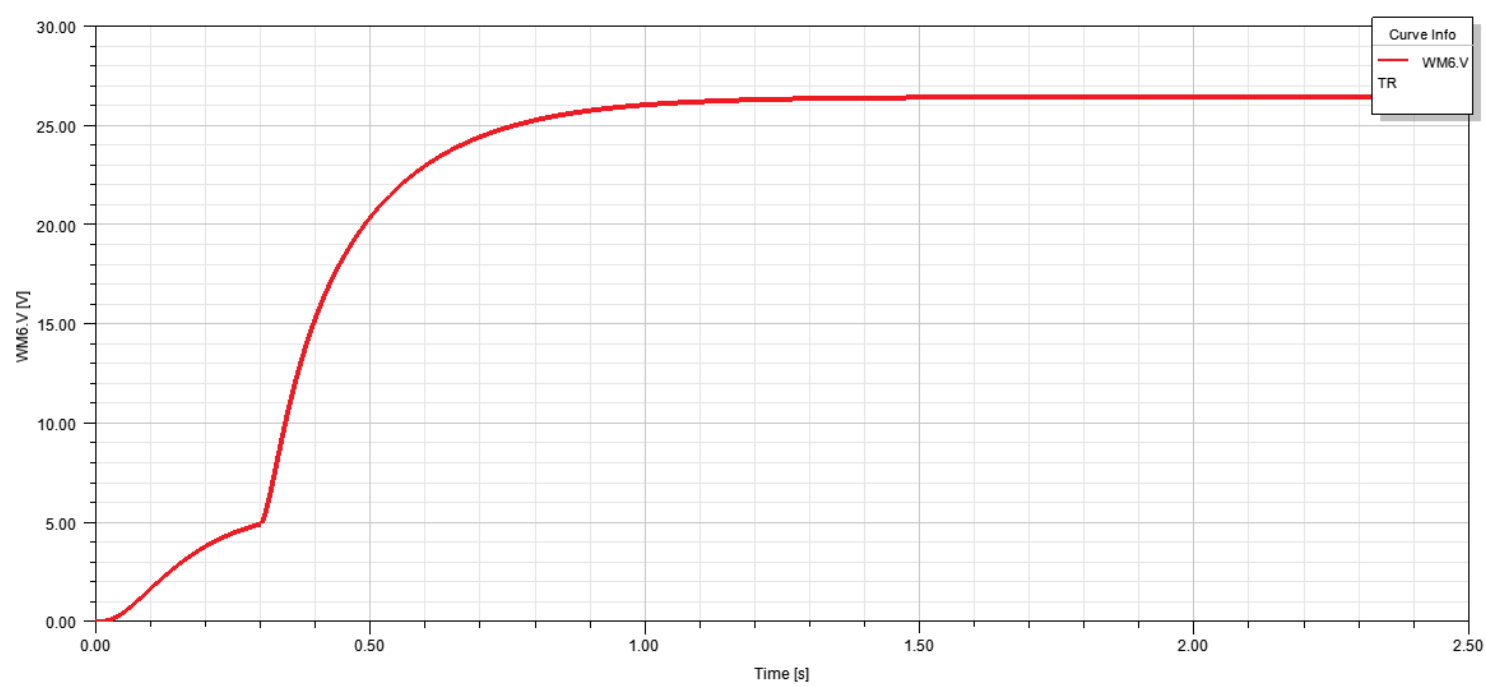


Figure 18 Output voltage when is supplied by DC busbar.

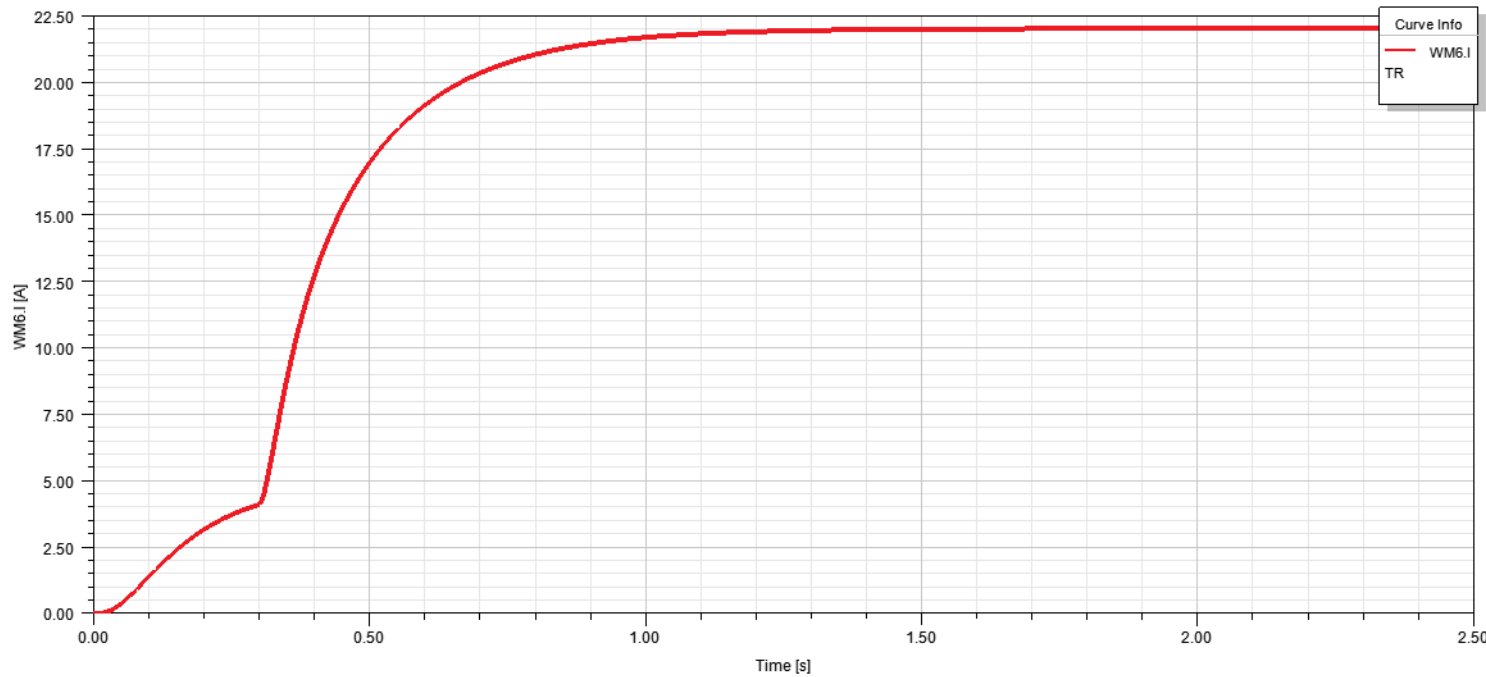


Figure 19 Output current when is supplied by DC busbar.

Results

*Flight Control Direct Current
with DC busbar*

Results

*Flight Control Direct Current
with battery*

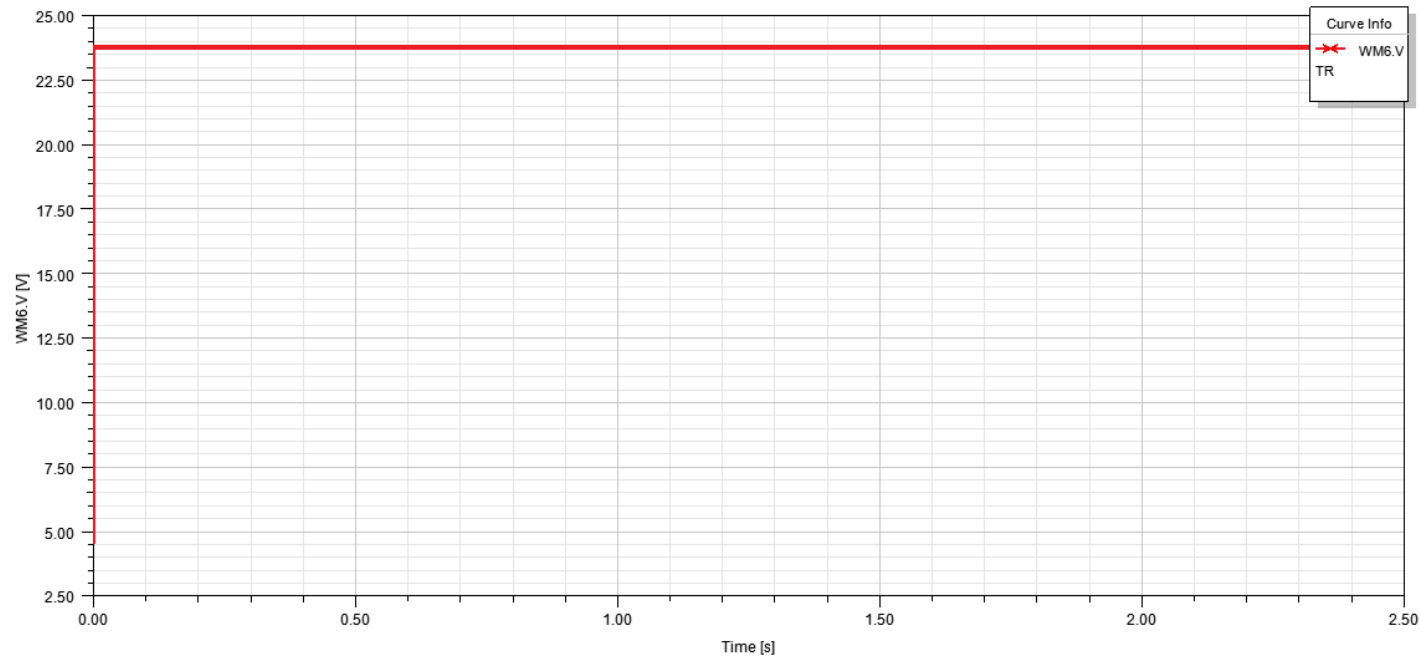


Figure 20 Output voltage when is supplied by the battery.

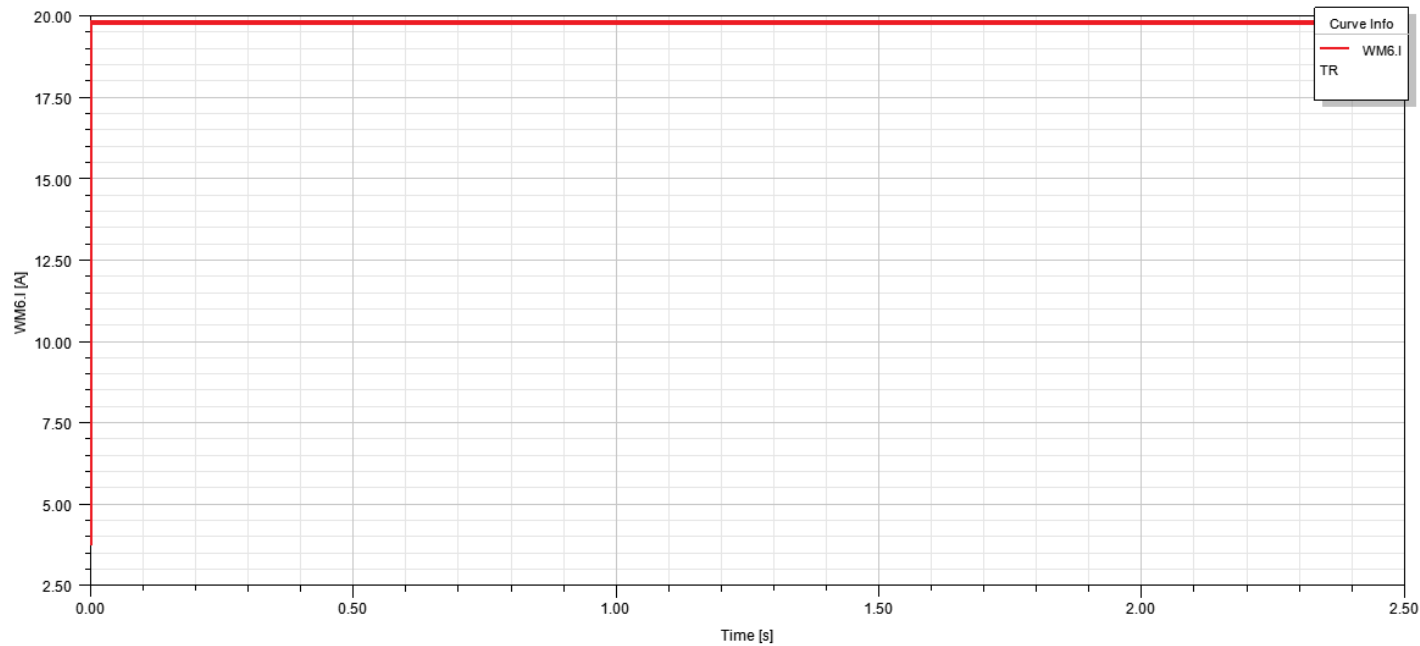


Figure 21 Output current when is supplied by the battery.

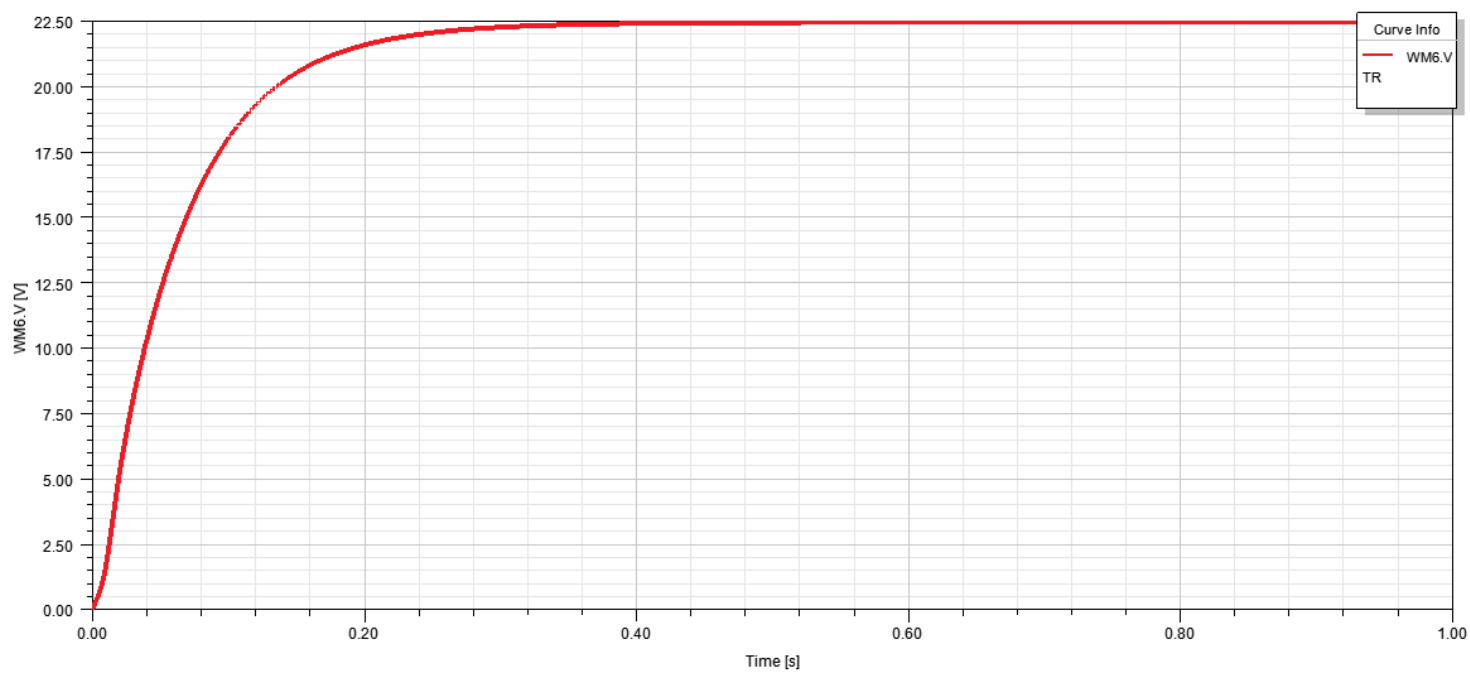


Figure 22 Output voltage when is supplied by PMG.

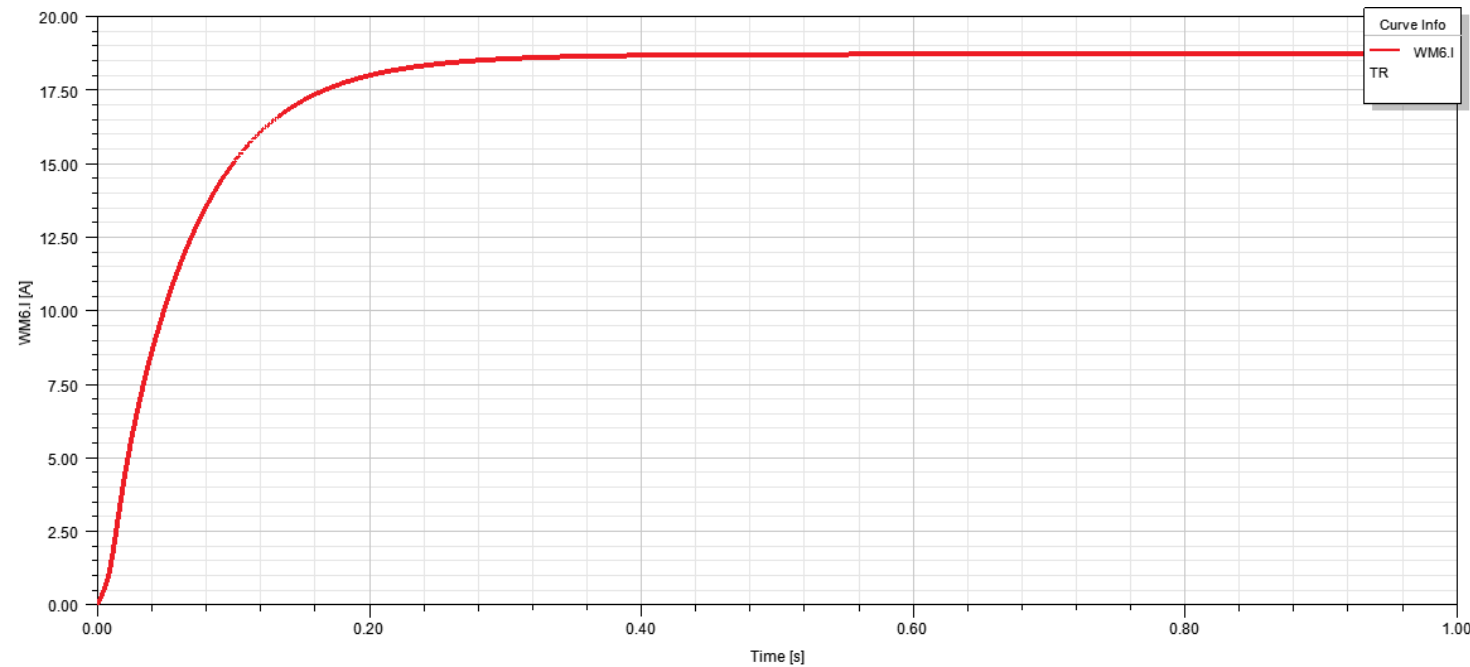


Figure 23 Output current when is supplied by PMG.

Results

*Flight Control Direct Current
with PMG*

Results

Right lane

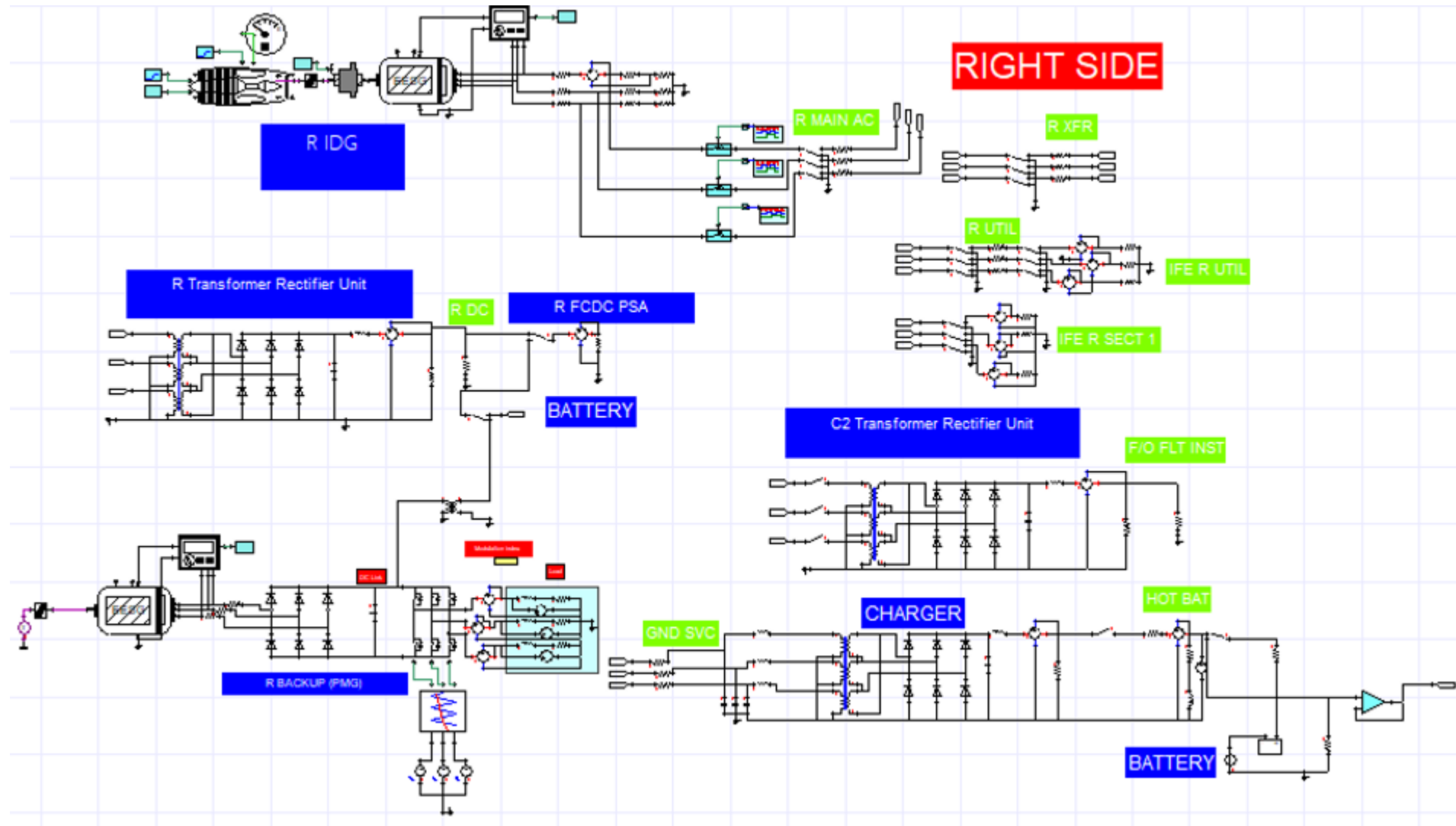


Figure 24 Simulation corresponding to the right side of the electric system.

Results

*Main Battery – Main Battery
Charger*

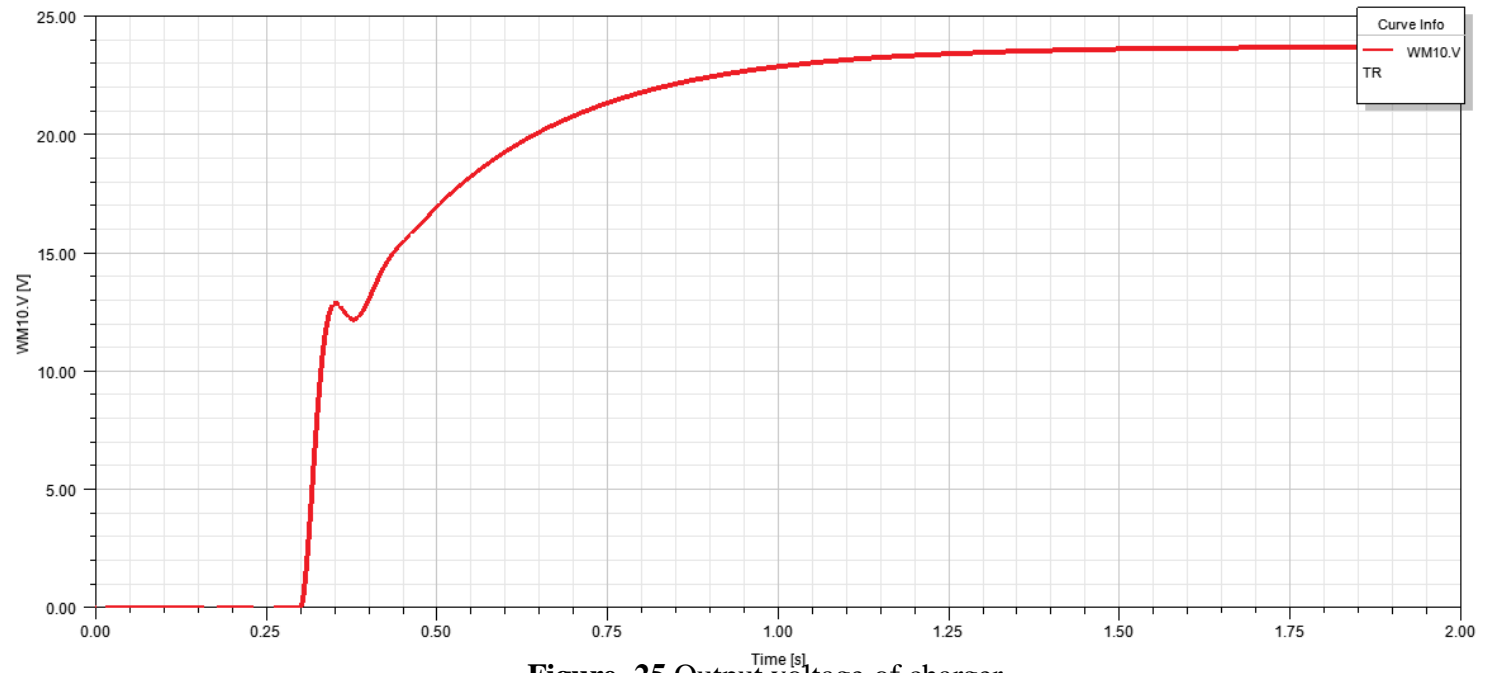


Figure 25 Output voltage of charger.

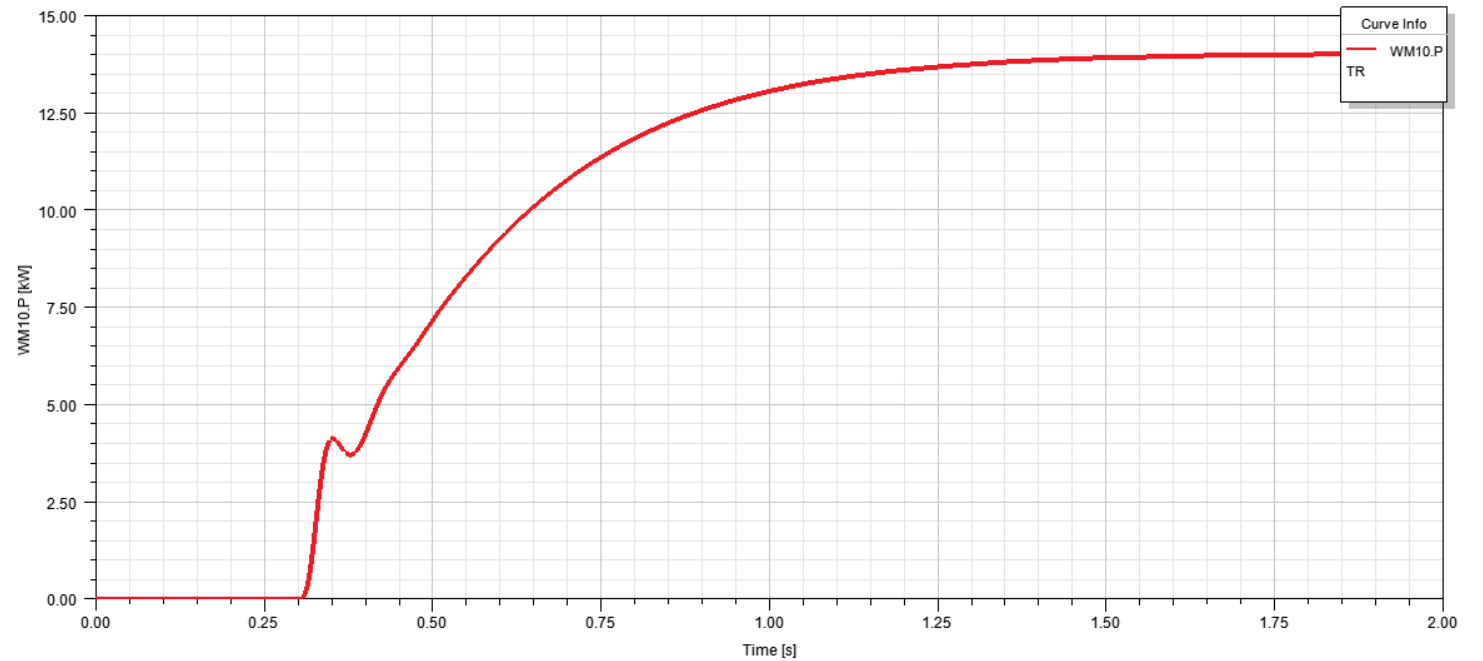


Figure 26 Output power of charger.

Results

Busbars

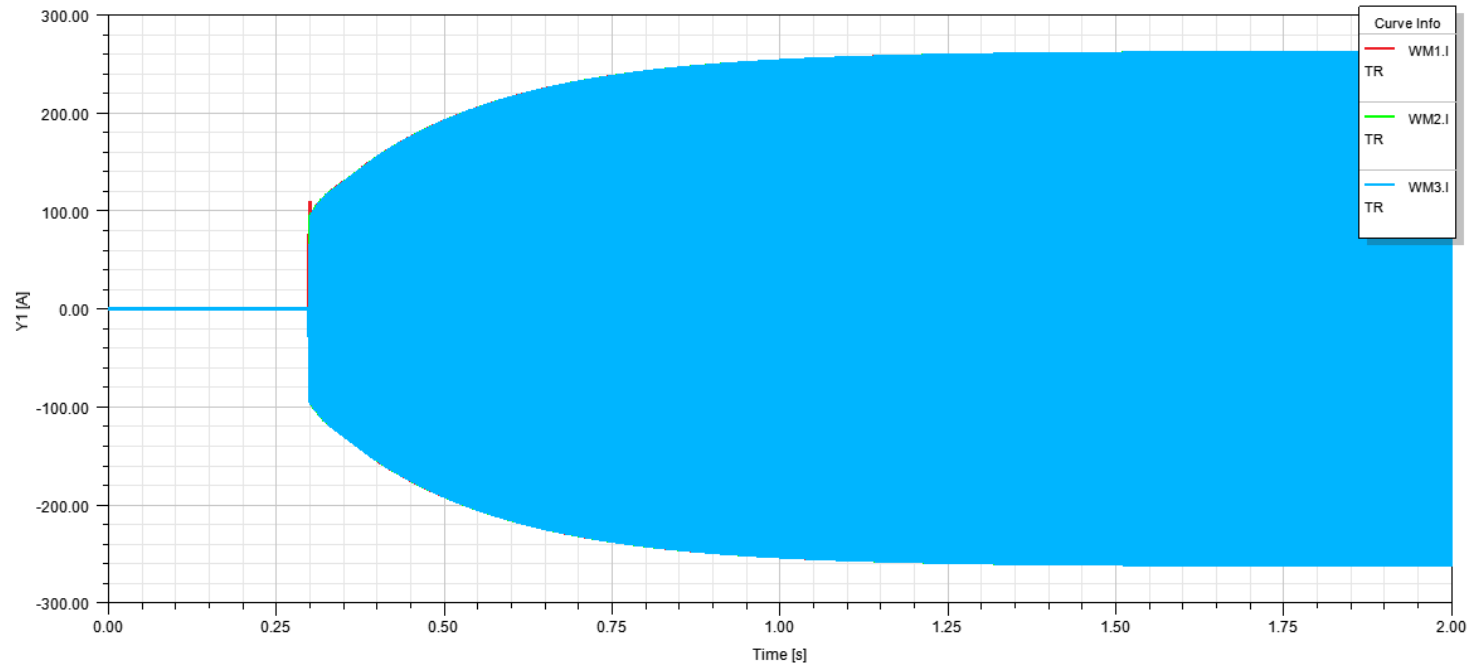


Figure 27 Output current of utility IFE busbar.

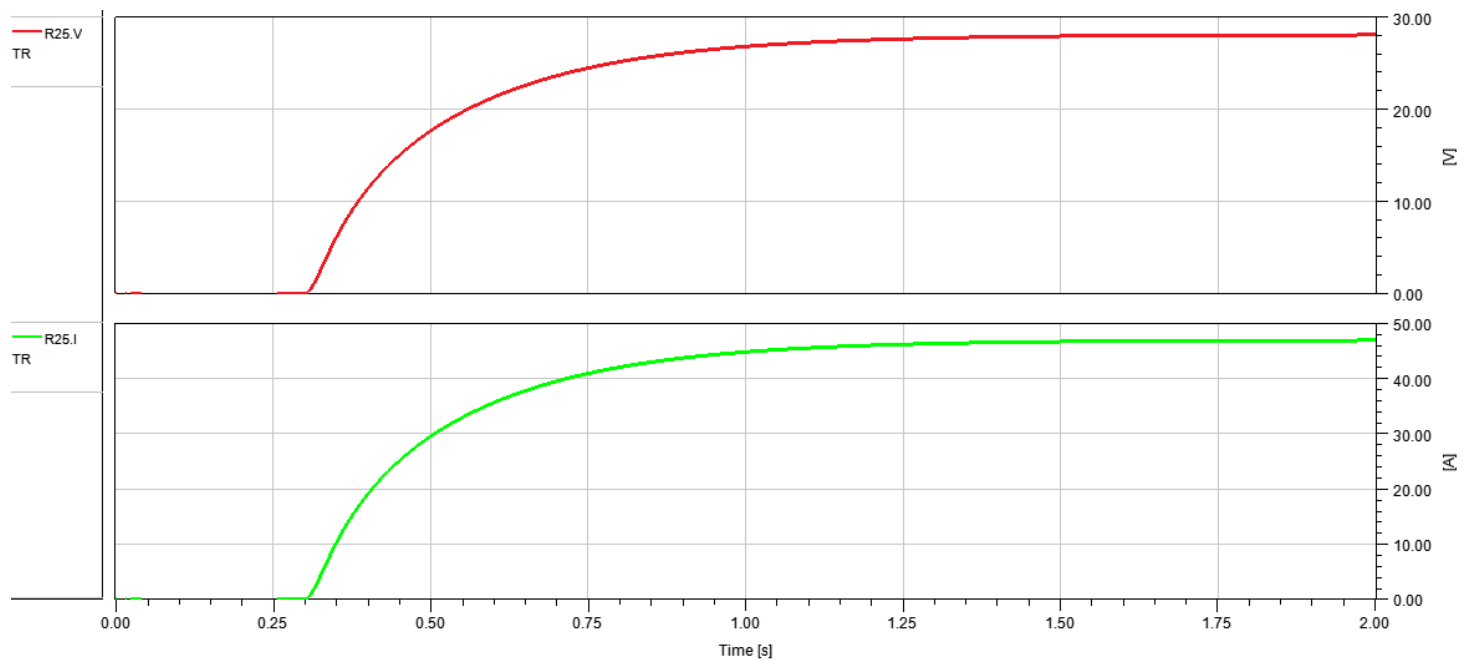


Figure 28 Output voltage and current of DC right busbar.

Conclusion

- Analysis of voltage and current
- Analysis in normal conditions
- The differences between right and left side
- Switches to control which subsystem will work in this condition

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