Grid Connected Converter

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Di Miao
Kaiqiong Ji

AMPERE
Advanced Motors, Power Electronics, and Renewable Energy Laboratory

NORTHERN ARIZONA UNIVERSITY | College of Engineering, Forestry, and Natural Sciences

Introduction

Client

Dr.Venkata Yaramasu
Assistant Professor at NAU
Director of AMPERE Lab
School of Informatics, Computing, and Cyber
Systems

Mentor

Ashwija Reddy Korenda

Client's Research Focus:

A- Wind Power Systems.

B- Photovoltaic Systems.

C- Motor Drives.

Problem
- There is no laboratory scale prototype converters available in the market that fits all of these applications.
- Needs plug and play converter to fit the three power conversion applications.
- Having such converter will help our client to develop new power converter topologies and test new controlling schemes such as model predictive control.

Goal
- Implement and build a prototype of multilevel converter for high power applications and test it using model predictive control.
- Practical power level is at 5 MW.
- Prototype power level is at 5 kW.

Fahad

Update WBS of Fahad

ID	Activity/Task	Description	Deliverables	Other People
Convertor Designing				
1.0	Designing the NPC convertor	Finding the parameters of the NPC convertor using theoretical equations and according to the specification	Complete design of NPC convertor	Sayaf & Mohammed
Hardware Implementation				
2.1	NPC convertor hardware implementation	Implementing the designed NPC convertor schematic on Hardware using PCB	Designed PCB	Sayaf & Mohammed
2.2	Components Soldering	Soldering all the components on a PCB	Complete NPC convertor	Sayaf & Mohammed
Testing				
3.1	Testing the designed NPC convertor	Check the working of the designed NPC convertor	Testing results	Team
3.2	Testing the NPC convertor with grid load	Check the working of the designed NPC convertor with grid load	Testing results	Team
Documentation				
4.1	Documenting all the results	Storing all the results of the NPC convertor for different load	Document containing all the results	Team
4.2	Writing IEEE paper	Writing the Simulations results and experimental results	IEEE paper	Sayaf
4.3	Revise & edit	Revise and edit the IEEE paper	Results Section	Team

1- Convertor Designing : (DONE) 100%
- Hardware team have finished Designing the NPC converter.
- Checked the working of the designed NPC converter.
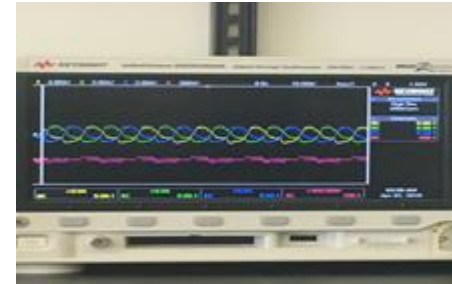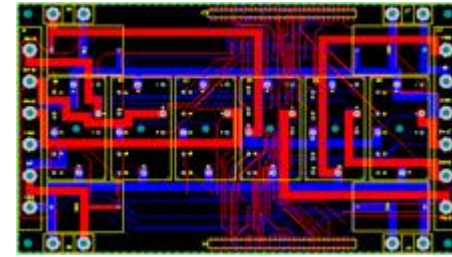
2- Hardware Implementation: (DONE) 100%
- Hardware Team have implemented the NPC convertor schematic on hardware using PCB.

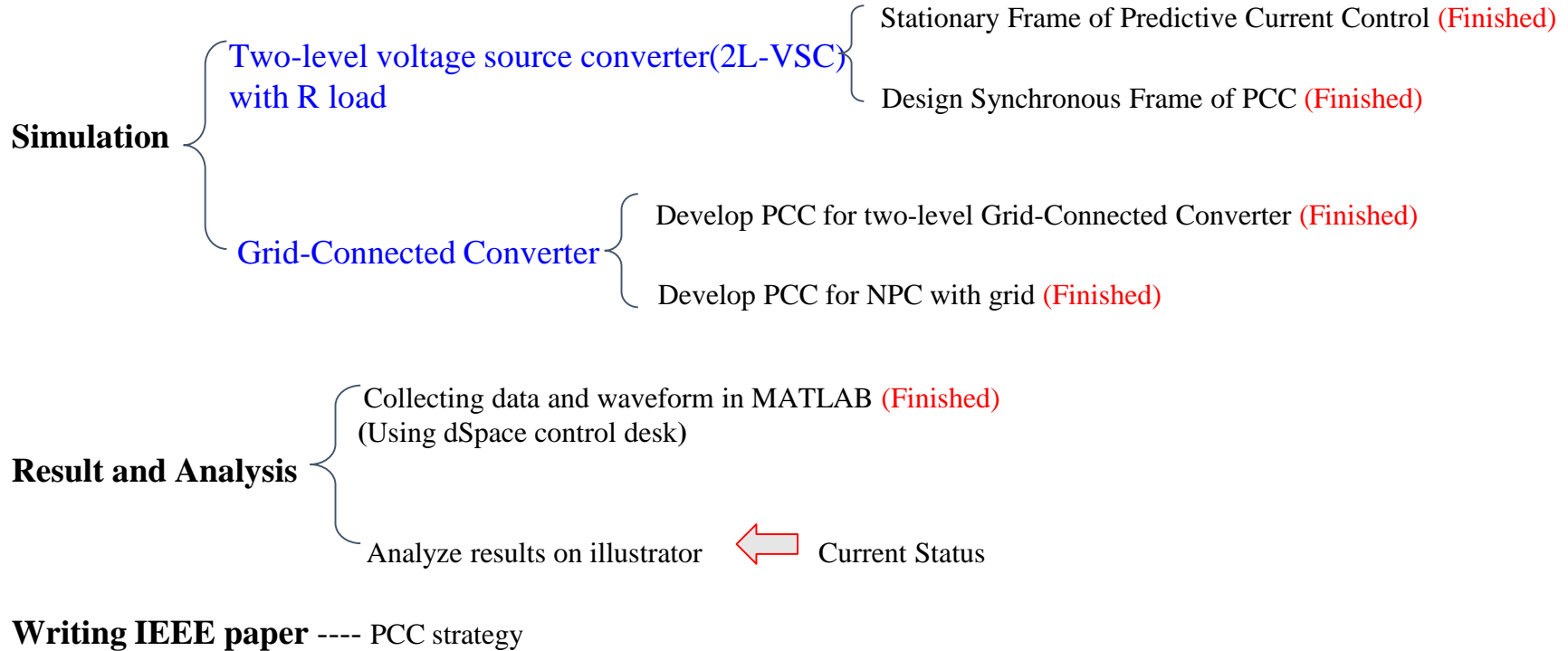**3- Testing: (DONE) 60%** ⟵ **Current Status**
- Team Tested the designed NPC converter, But we faced problems in the converter.
- One of the gate drivers did not working.
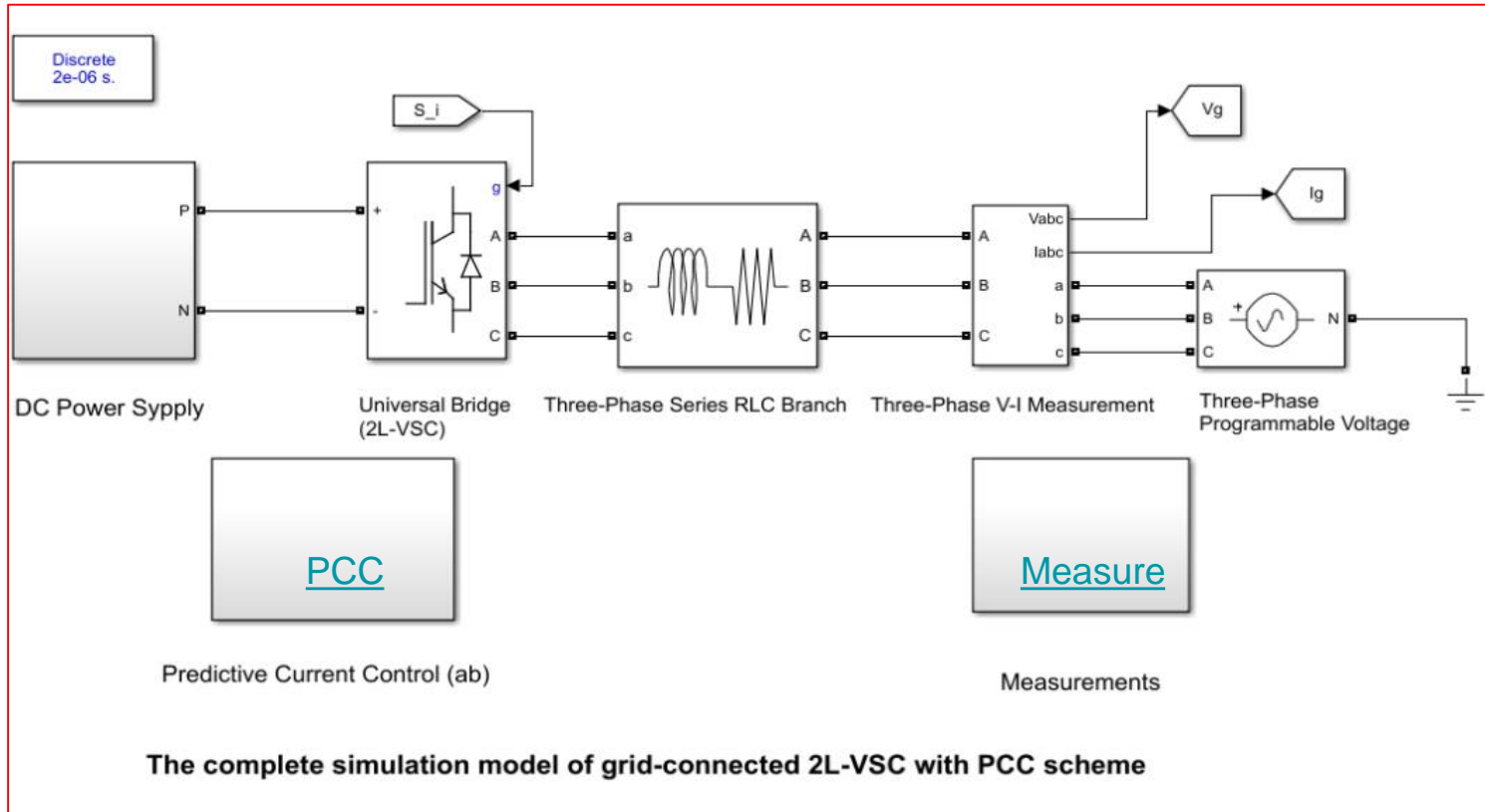- Replaced the gate driver with a new one.

4- Documentation:
- Storing all the results of the NPC converter.
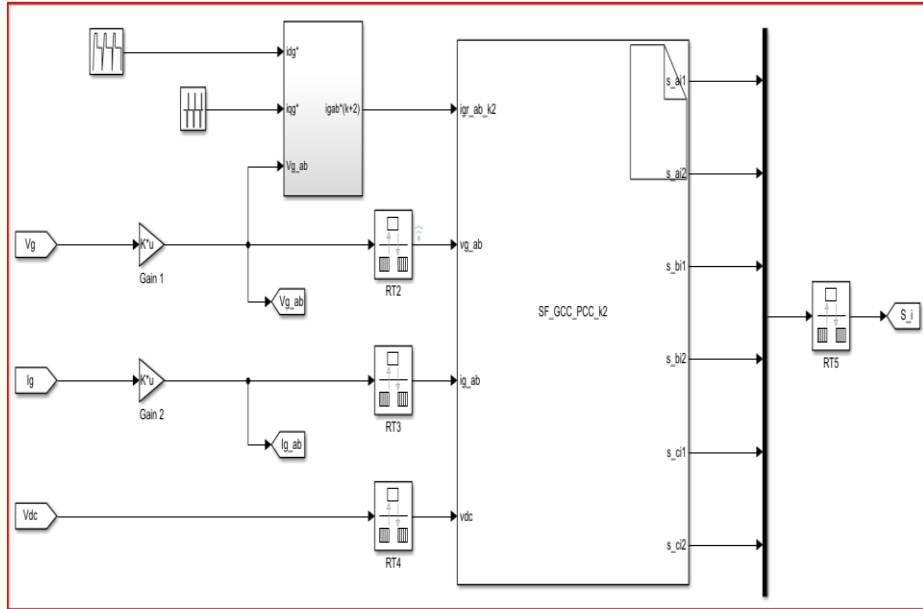
- Writing IEEE paper
- Revise and edit the IEEE paper

Fahad

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WBS of Kaiqiong Ji

Simulation

Two-level voltage source converter(2L-VSC) with R load
- Stationary Frame of Predictive Current Control (Finished)
- Design Synchronous Frame of PCC (Finished)

Grid-Connected Converter
- Develop PCC for two-level Grid-Connected Converter (Finished)
- Develop PCC for NPC with grid (Finished)

Result and Analysis
- Collecting data and waveform in MATLAB (Finished) (Using dSpace control desk)
- Analyze results on illustrator ⇐ Current Status

Writing IEEE paper ---- PCC strategy

PCC for Two-level Grid-Connected Converter

The complete simulation model of grid-connected 2L-VSC with PCC scheme

Kaiqiong Ji

Subsystems of simulation

Predictive current control(αβ frame)

Measurements

Stationary current

Stationary current &
Reference current

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Waveform Analysis

Ig_ab

Repeating sequence

Vg

Ig_ab & Ig_ab(reference)

After amplification

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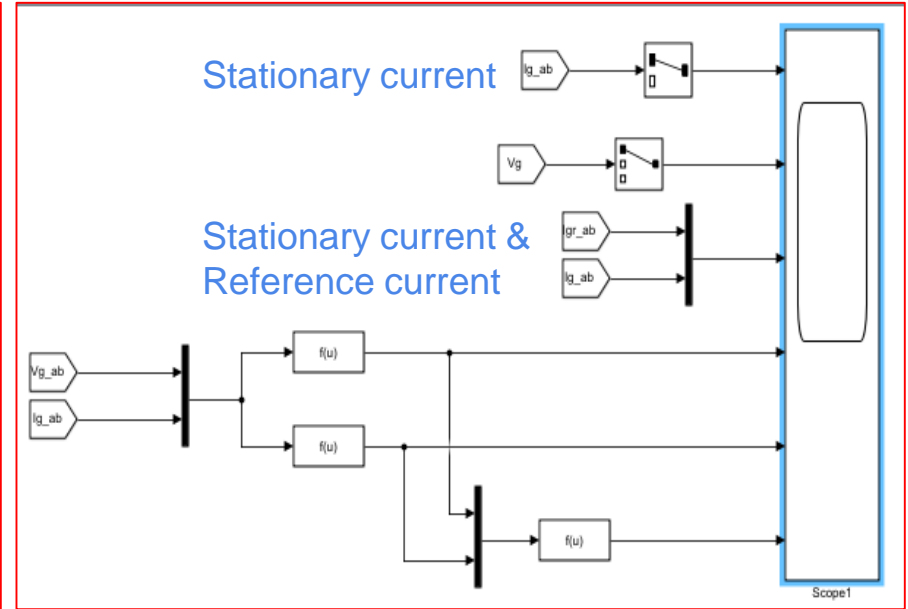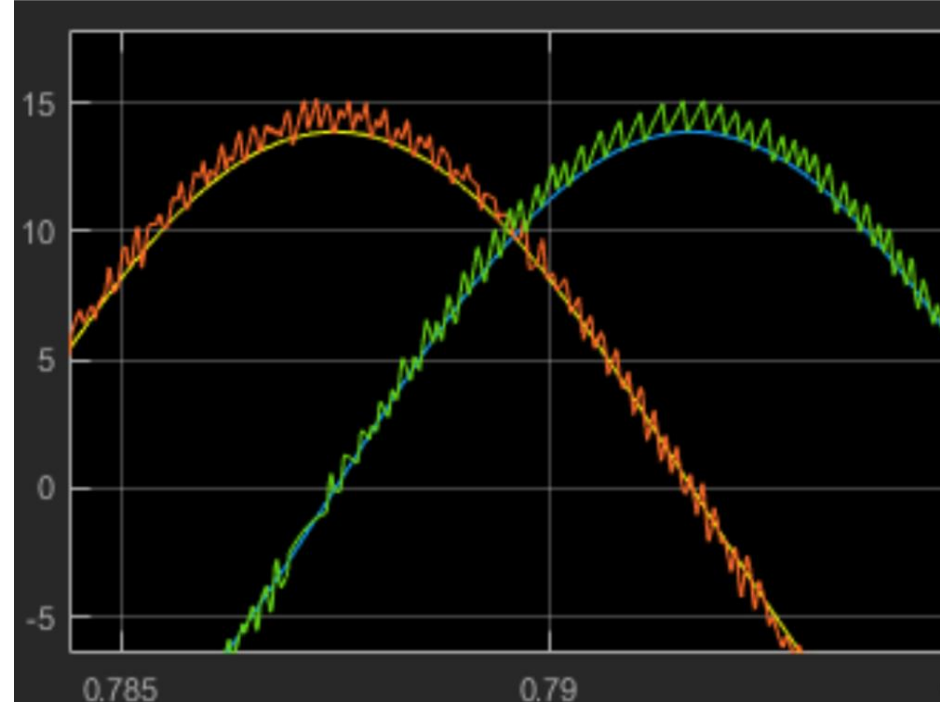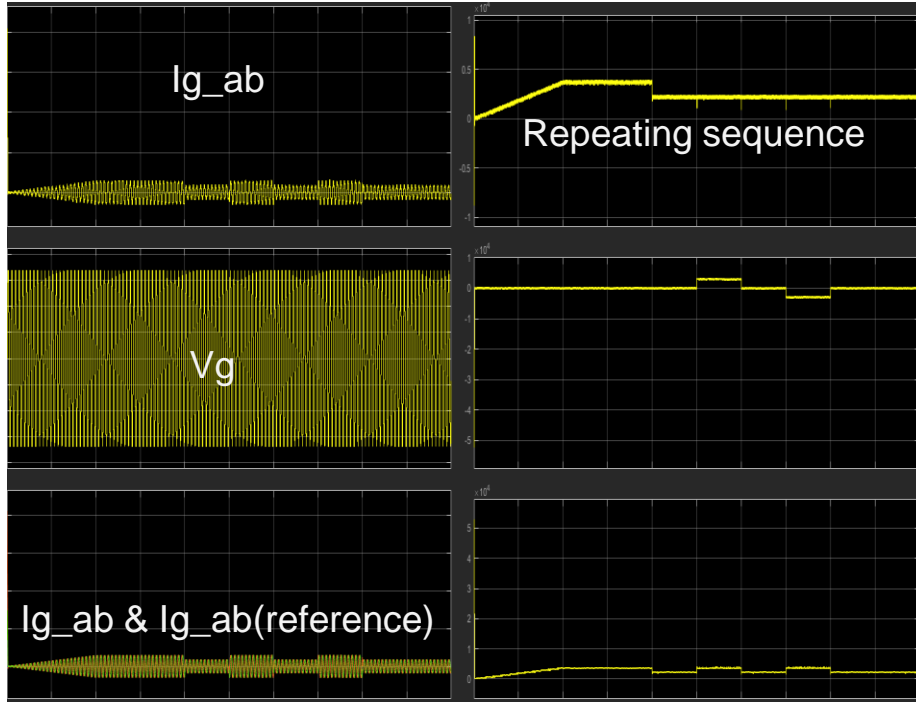
WBS of Di Miao

Person Primarily Responsible: Di Miao			
ID	Activity/Task	Description	Deliverable(s)
1.0	simulation		
1.1.1	*Design Stationary (αβ)* Frame PCC of 2L-VSC	Initialize parameter in Matlab and connect circuit in simulink function	1. Circuit schematic 2. Simulink model 3. waveform
1.1.2	Design Predictive Current Control for Grid-Connected Converter	The PCC scheme for two-level GCC and calculate of reference grid currents	1. Simulink model 2. waveform 3. Feedback signals
2.1	Analyze waveform and results		1. Feedback signals 2. Correct data

← **Completed** (row 1.1.1)

← **Completed** (row 1.1.2)

← **Current Status** (row 2.1)

Di Miao

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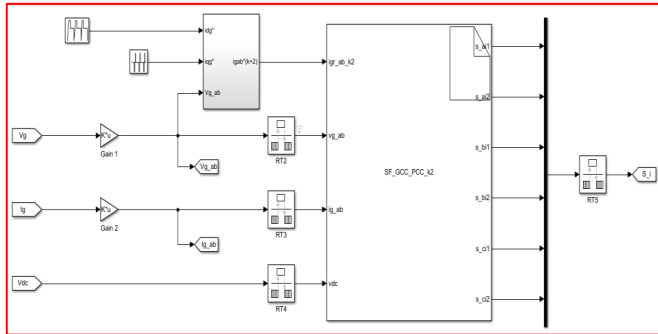NORTHERN ARIZONA UNIVERSITY | College of Engineering, Forestry, and Natural Sciences

PCC for NPC with grid
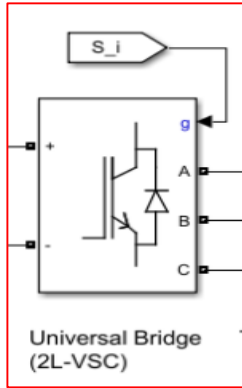
2L-VSC

NPC converter
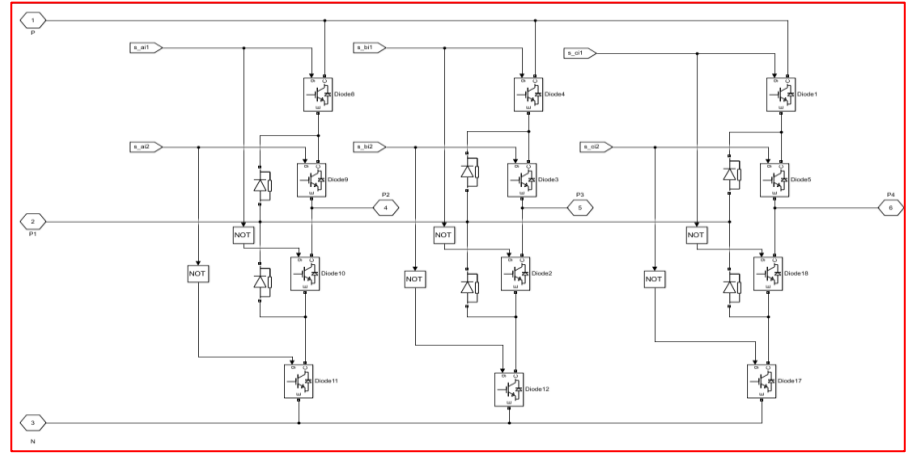
8 Switching states

27 Switching states

Di Miao

Waveform Analysis

Di Miao
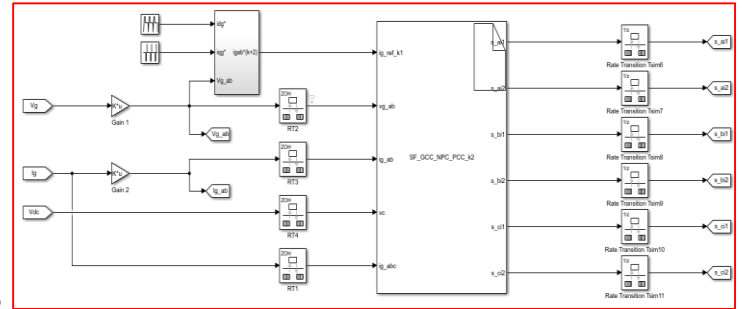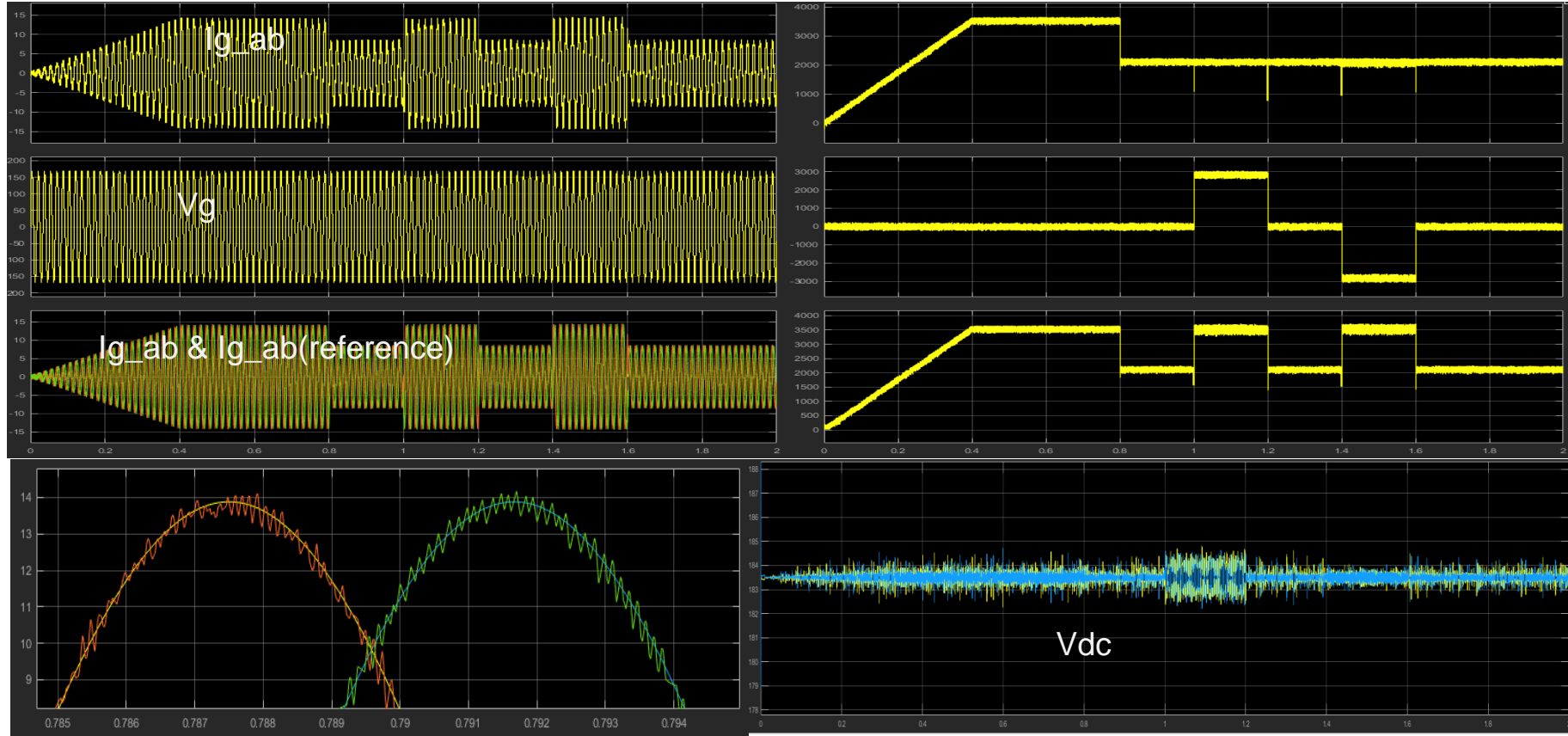
WBS of Sayaf

ID	Activity/Task	Description	Deliverables	Other people
1	Hardware			
1.1	Reconnection	Disordered the pins that connect the GD to interface GD boards then connect GD directly to NPC bower board with a wires	Reach 3500w with no shortcut and less noise	Mohammed
1.2	Soldering	Soldering wires instead of 60 bin connectors	Waveform with less noise	Mohammed & Fahad
1.3	Checking before testing	Checking all connections by multimeter to making sure that all connection are right	The NPC converter is working well	Mohammed & Fahad
2	Testing			
2.1	Subsystem testing and set up	Test each PCB's individually to make sure every signals are working then connect all the PCB's together	Build NPC converter	Mohammed & Fahad
2.2	NPC converter testing	Test NPC converter with 350V and 10A	Reach 3500w	Mohammed
3	Writing IEEE Paper			
3.1	Simulation results	Include simulations results from oscilloscopes and explain it	IEEE Paper	Fahad
3.2	Experimental results	Include experimental results and explain it	IEEE Paper	Fahad
3.3	Revise & edit	Revise and edit before submitting the IEEE paper	Revise & edit the IEEE paper	Whole team

Complete

Hardware: **100%**

- Reconnection
- Soldering
- Checking before testing

Testing: **60%**
- Subsystem testing and set up
- NPC converter testing

Writing IEEE Paper: **0%**
- Simulation results
- Experimental results
- Revise & edit

Current status: testing the NPC converter

Sayaf

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WBS for Mohammed

Person Primarily Responsible: Mohammed Abu Radhi.				
ID	Activity/Task	Description	Deliverables	Other people
1	Hardware			
1.0	Redesign PCB Boards	Redesign circuits and modify design mistakes.	Verified PCB design.	Sayaf
1.1	Purchase components	Placing order for modified PCB versions, and buying any missing components.	1- Complete list of missing parts. 2- Placing Order for PCB's and other components. 3- Receiving parts.	-
1.2	Soldering	Soldering PCB's, replacing boards' components.	Soldered PCB's.	Hardware Team
1.2.1	Soldering 60 Pin Connectors	Desoldering the old 60 Pin connectors, and replacing them with the new isolated connectors to solve the noise issue.	Proper connection between boards with less noise.	-
2	Testing			
2.0	Subsystems Testing.	Testing each subsystem individually.	Verifying subsystems functionality.	-
2.1	Testing set up	Connecting all PCB's together, and making sure the converter is ready for simulation testing.	NPC converter, and complete testing set up.	Sayaf, and Fahad
2.2	Testing	Doing experiments, and testing the converter.	Converter working properly	Whole Team
3	Writing IEEE Paper			
3.0	Writing the introduction and the conclusion	Each team member is assigned one section to write. My task is to write my assigned section.	Complete Written Sections.	-
3.1	Revise & Edit	Revise and edit the IEEE paper.	Revised IEEE Paper	Whole Team
3.2	Paper Submission	Submitting the IEEE Paper to Dr.Yaramasu.	Submitted paper	-
4	Experimental set up			
4.0	Dismantling testing set up.	Undo hardware testing set up ,and clean lab	Organized lab.	Hardware Team

Activities & Tasks:

1- Hardware (100%) :
- Client required less wiring
- Tried another solutions.
- Noise problem due to small spacing.
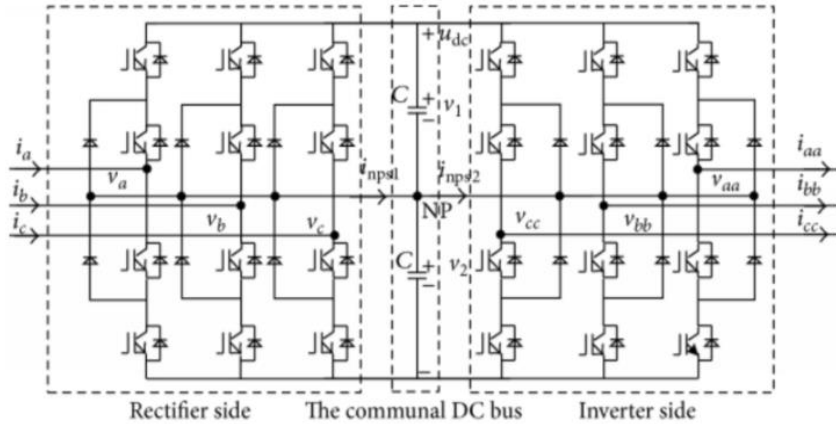- Had to wire them directly.
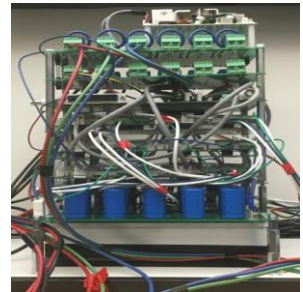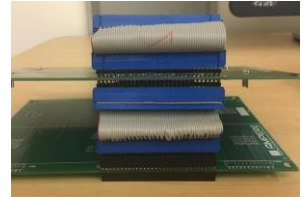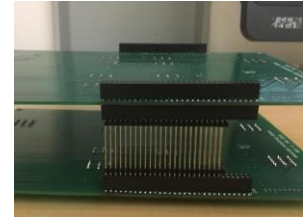
2- Testing (60%):
- Successful test for the rectifier side.
- Need to test inverter side.
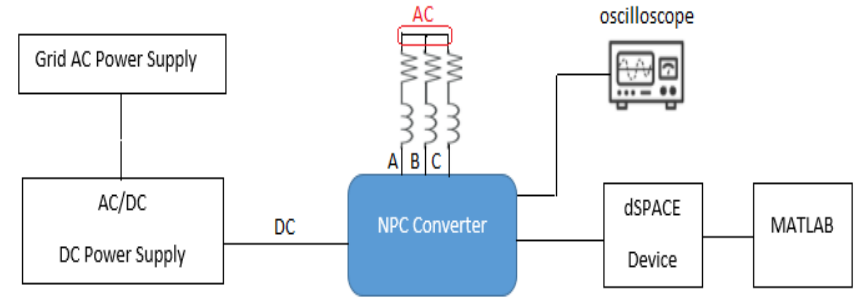- Grid connection testing.

3- Writing IEEE Paper :
- Writing assigned sections.
- Revision.
- submission.

Mohammed

R Load Test

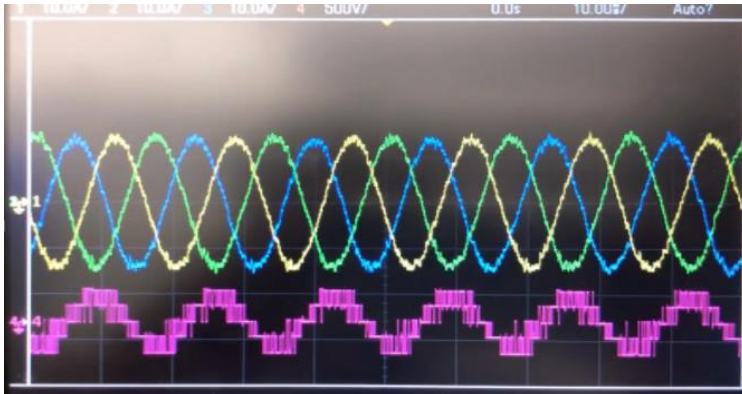### NPC Converter Schematic

R Load Testing Set Up

Mohammed

Demonstration

Results

- Three phase AC waveforms.
- 5 level line to line AC waveform.

Demo Video

Mohammed

Conclusion

- The team is lagging behind due to the noise problem.

- The hardware section is finally done.

- The team is currently doing experiments and collecting results.

- We will start writing the paper this week.

- Converter met client's requirements and specifications as much as possible.

Sayaf

Thank You

Questions?