Grid Connected Converter

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Outlines:

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- Introduction.
- Client’s Problem Definition.
- Client needs and constraints.
- Possible solutions.
- Recommended solution.
- Project parts.
- Conclusion.

Client

Dr.Venkata Yaramasu

Assistant Professor at NAU

About:

Renewable energy, high power converters, and model predictive control.

Education:

PhD, Electrical Engineering, Ryerson University, Toronto, Canada

ME, Electrical Engineering, S.G.S. Institute of Technology and Science, India

B.Tech, Electrical and Electronics Engineering, Jawaharlal Nehru Technological University, India

Introduction

- Our Project is to implement and build a power conversion system.
- Power conversion systems consists of two main parts:

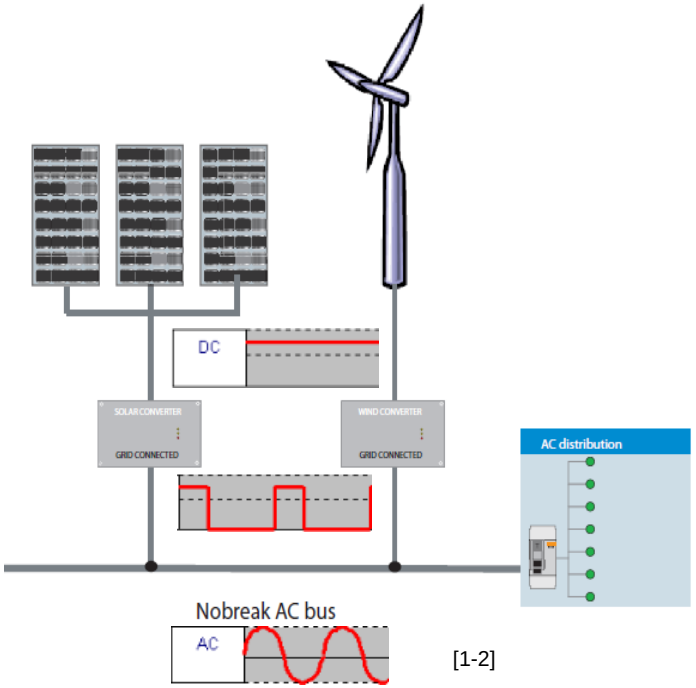
  A- converter.

  B- controlling unit.

- A grid connected converter is used in various power conversion applications. Renewable energy such as wind turbines and photovoltaic.

A-What is a Grid Connected Converter?

- Connected to the utility grid and to the power supply.
- The direct current (DC) generated from the power supply goes to the converter.
- The converter take the DC input and convert it to an AC.
- Output of converter is AC which matches the current flowing in the utility grid.



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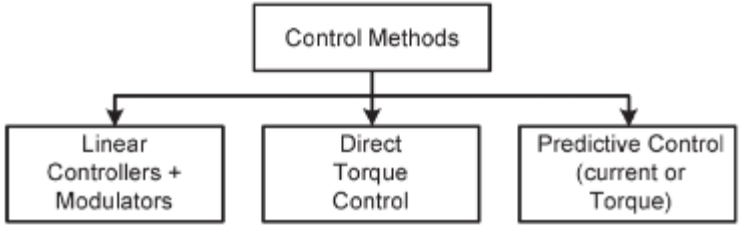
B- What is a controlling unit?

- Control Unit : a control unit is the brain of the converter.
- Regulate the current output so it matches the reference current (utility grid current).
- Some controlled variables:
- Phase angle.
- Voltage frequency.
- Simply, the controlling unit’s function is to make sure that the output voltage of the converter matches with the voltage flowing in the utility grid.



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Client's Problem Definition

- Our client Dr.Yaramasu research focuses on renewable energy resources.
- He is focusing on three renewable energy applications which are :

  A- wind turbines.

  B- photovoltaic.

  C- Motor Drives.

- Our client needs a power conversion system to convert the Direct Current (DC) generated from these applications to Alternating Current (AC).

Client Needs and Constraints

- Multilevel converters using model predictive control for efficient high power conversion.
- Design a complete multilevel converter for high power applications, simulate the system and implement it on hardware.
- The constraints is to improve efficiency, reliability, cost, size, power density and simplicity of multilevel converters.
- Dr. Yaramasu emphasized on keeping the design simple and use surface mounted electrical components.

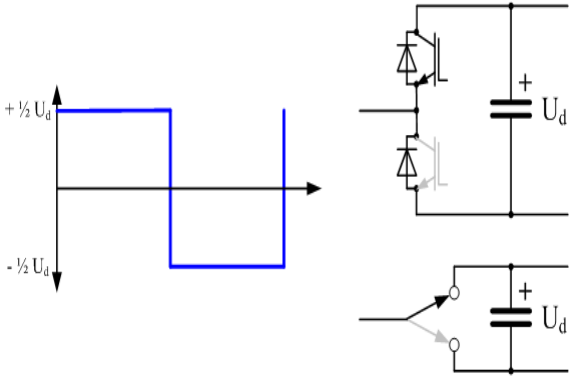
Possible solutions

- Two-level converter
- Three-level converter
- NPC converter
- Cascaded h-bridge converter
- Flying capacitor converter
- Modular multilevel converter (MMC)

Two-level converter vs Three-level converter

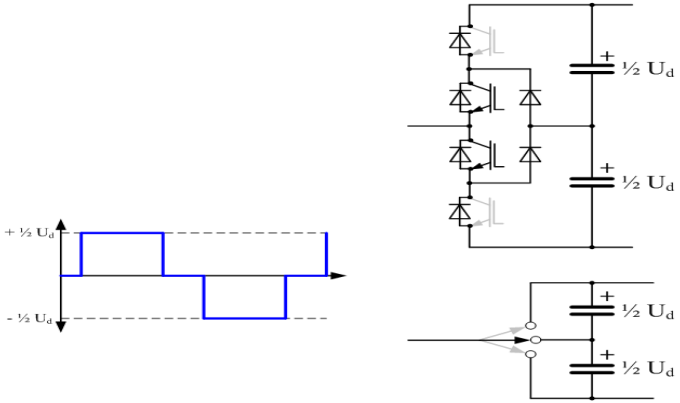
Two-level converter:

- Output voltage has two values.
- Simpler Design and less Components.
- Cost $661.86



Three-level converter:

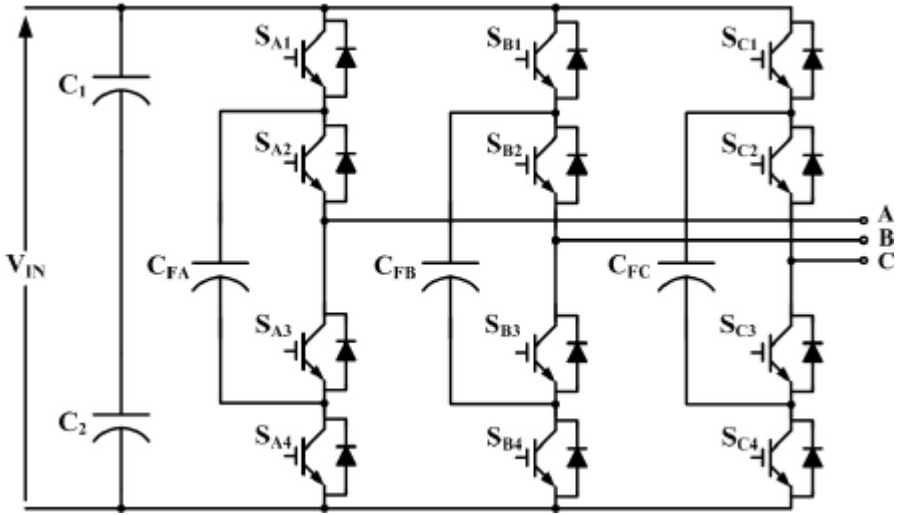
- Smoother output voltage and has three values.
- Complex design and more components.
- Cost $905.4



Flying capacitor converter

About:

The main concept of this inverter is to use capacitors. The capacitors transfer the limited amount of voltage to electrical devices. the switching redundancy within phase to balance the flying capacitors.



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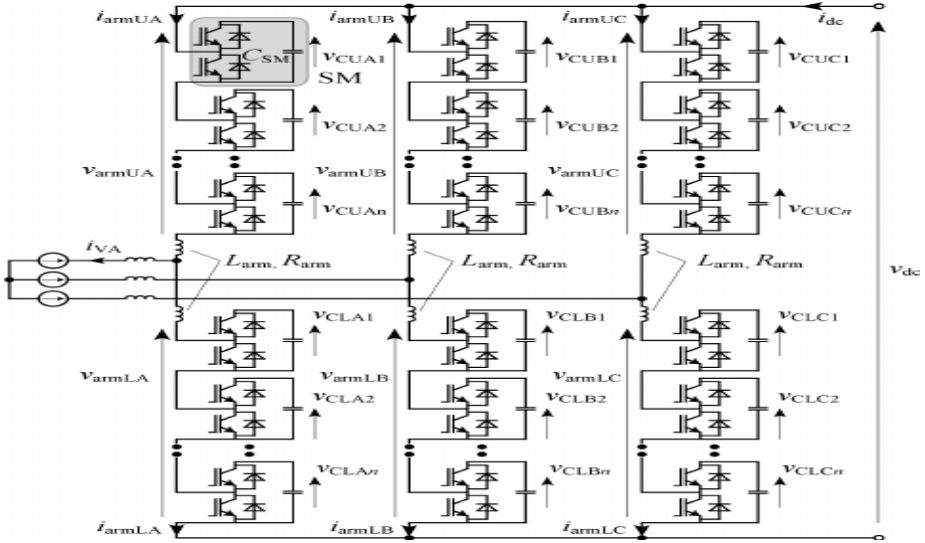
Modular multilevel converter

- Modular structure
- easy scalability in terms of voltage and current
- low expense for redundancy and fault tolerant operation
- high availability
- utilization of standard components and excellent quality of the output waveforms.



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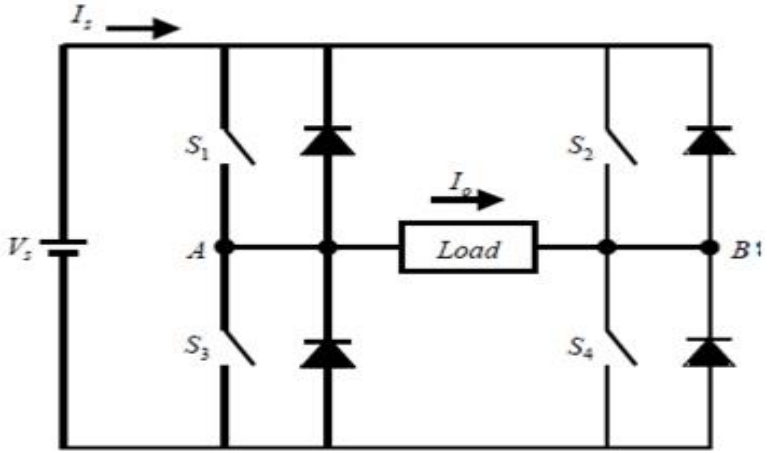
Cascaded H-bridge converter



- Used for both single and three phase conversion.
- It uses H-Bridge including switches and diodes.
- It does not need any capacitors or diodes for clamping.
- The wave is quite sinusoidal in nature even if you don’t filter it.

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NPC converter

The neutral point clamped (NPC) converter is the most widely used in all types of industrial applications, in the range of 2.3 to 4.16 kV.

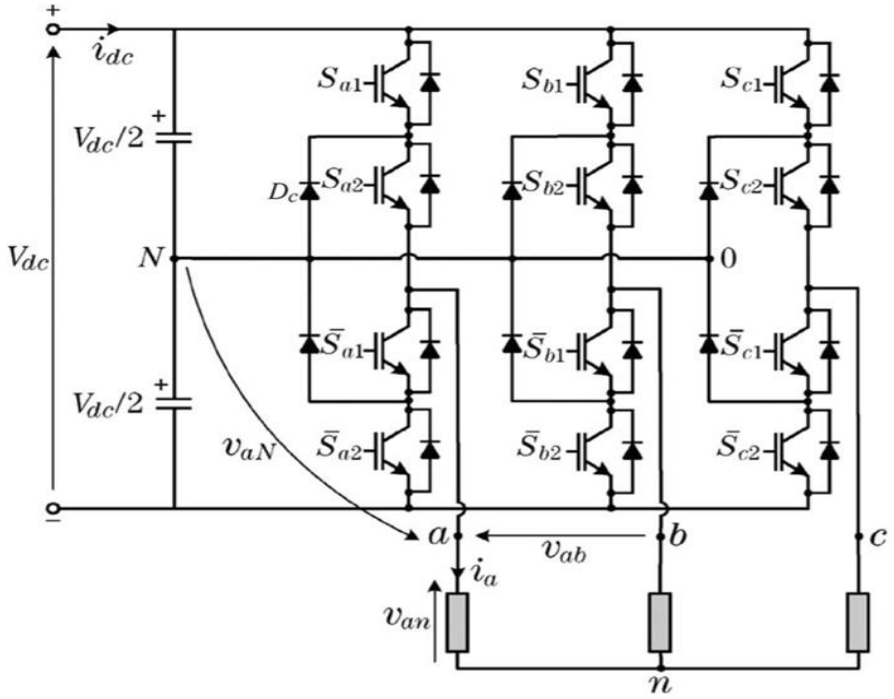


Fig. 2. Power circuit of the three-level diode-clamped inverter.

Recommended Solution

- A three level converter using neutral point clamped topology with model predictive control.

- model predictive control, system non-linearity can be handled easily and predictive control algorithm will provide better switching as compare to other technique.

- We will be using microprocessor to control the high frequency switching which will improve the cost, gives better performance and will be more flexible as compare to previous approaches.

Main Parts of Project

- The project is divided into three parts

Hardware :

-Designing electrical circuits.

- Building PCB’s.

-Wiring electrical components.

Simulation:

-Creating different scenarios.

-simulate results on MATLAB/Simulink.

Documentation:

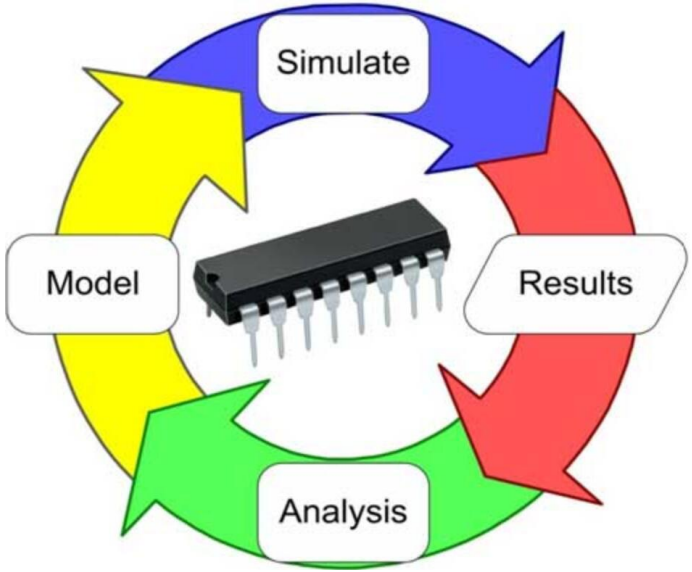
-Writing a user manual.

-Writing a conference paper.

Criteria	Software
Printed Circuit Board Design	Altium Designer
Simulation	MATLAB/Simulink
Documentation	Latex/WinEdt

Simulation

- Test the experimental results
- Analyze the performance of the digital control schemes

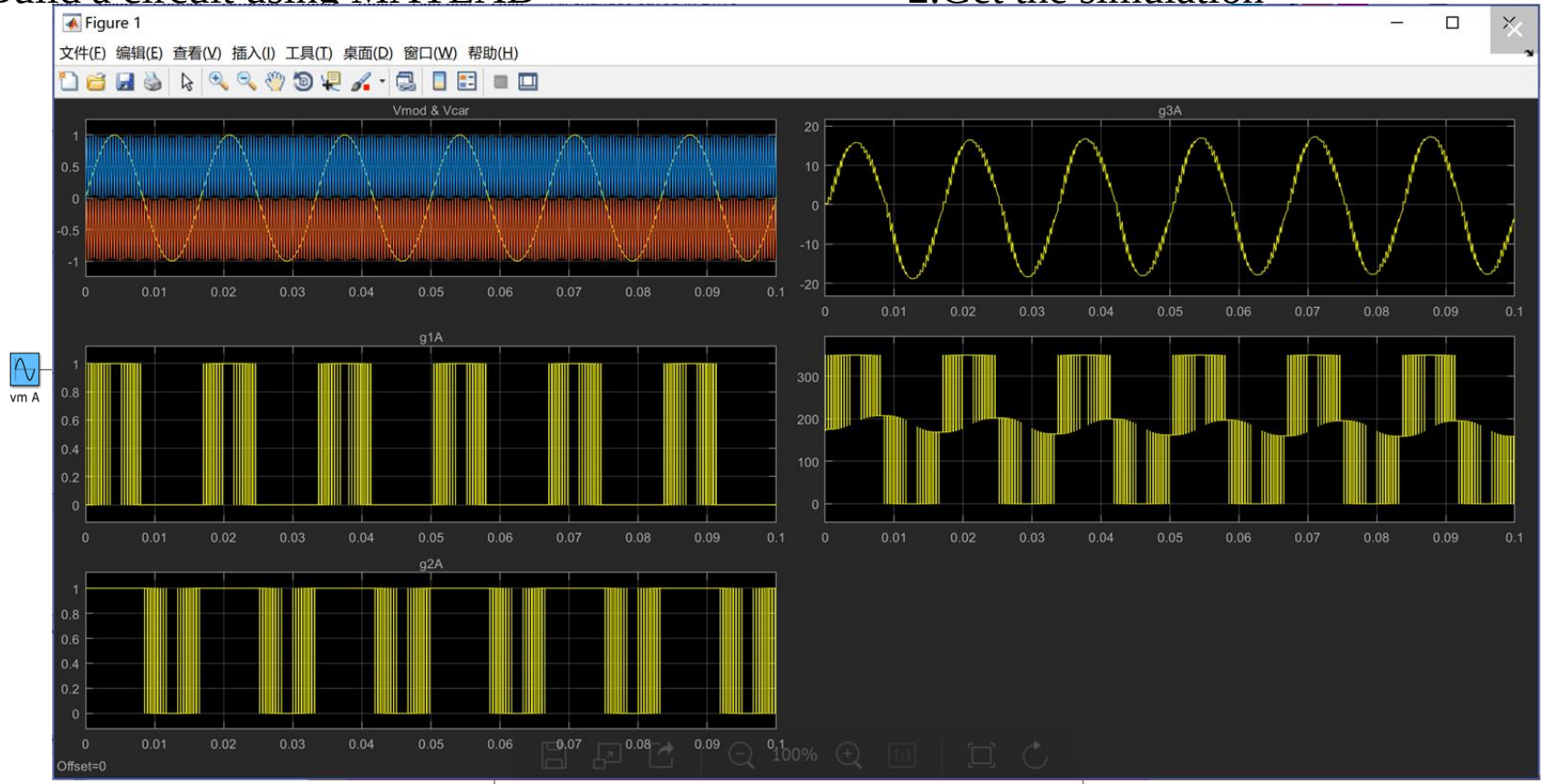


How to achieve it

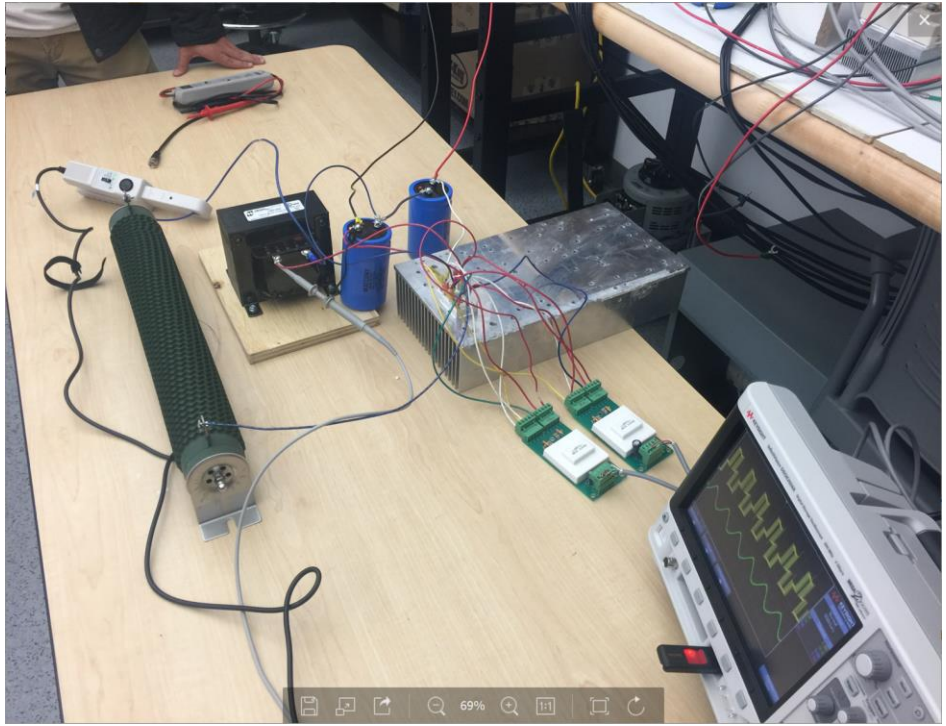
MATLAB/Simulink software with SimPowerSystems Toolbox for simulation

1.Build a circuit using MATLAB

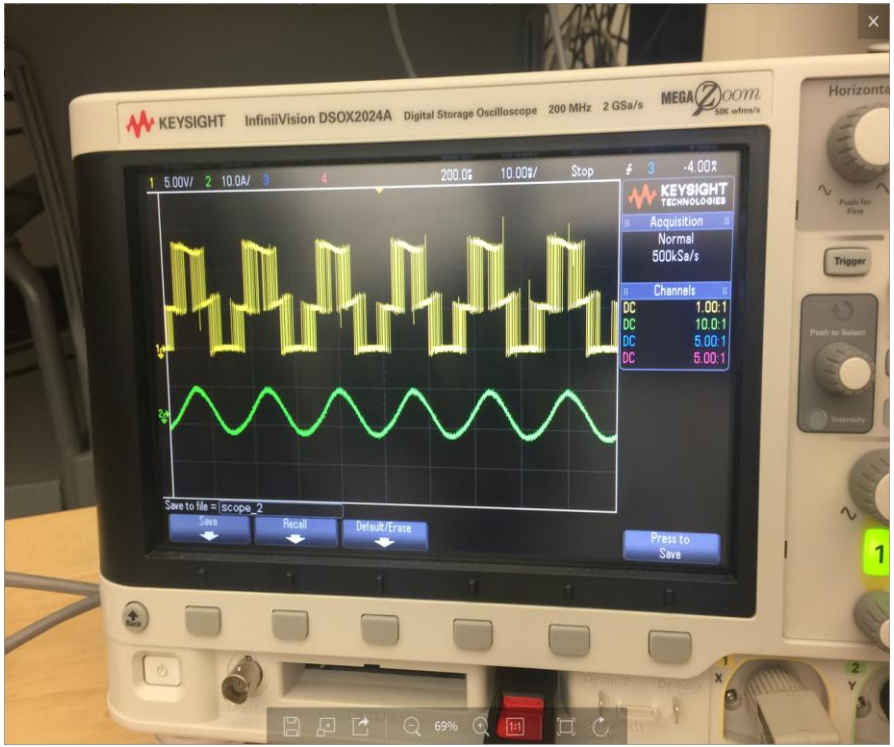
2.Get the simulation



3.Connect the components



4.Waveform in oscilloscope



Conclusion

- We will be designing a multilevel converter using predictive control which provides better efficiency for high power applications, reduce the cost of a system significantly and make the system flexible.

- We will design our system as per the requirement of our client and make it as simple as possible meeting all the constraints of our client.

- We will simulate our designed system and implement it on hardware as well and form a complete prototype for our client meeting all the desired requirements.

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