Grid Connected Converter

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Abstract

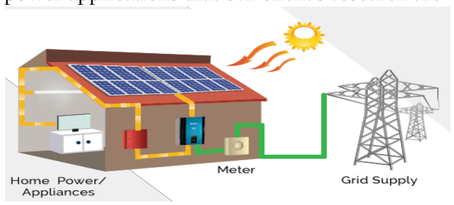
Purpose:

- Implement and build a laboratory scale prototype of multilevel converter for high power applications and test it using a digital controlling unit (PCC).
- The converter should fit three power applications that our client's research are focusing on which are :

A- Wind Power Systems.

B- Photovoltaic Systems.

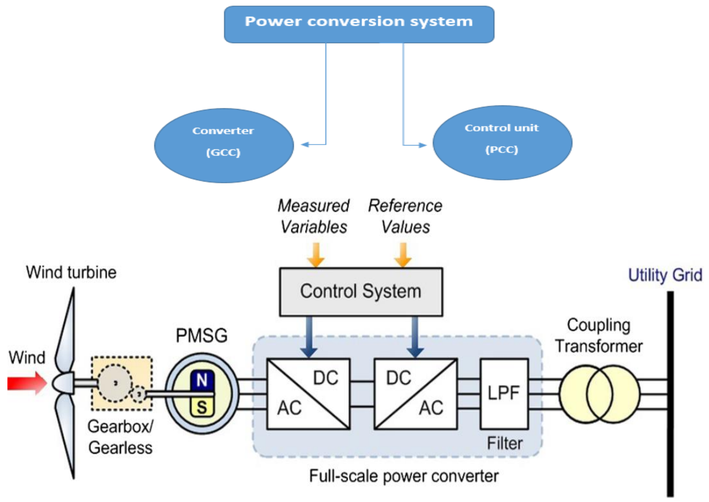
C- Motor Drives.



[1] Grid Connected Converter

- Improve overall performance of the converter through improved simulation models using the model predictive control topology.

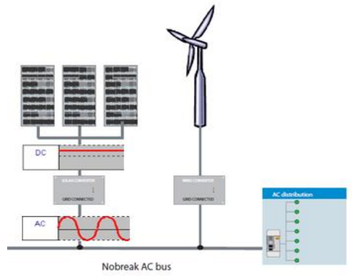
Power Conversion System



[2] Power Conversion System

Grid Connected Converter (GCC)

- Connected to the utility grid and to the power supply.
- Converts the input (AC/DC) to AC with specific frequency and voltage phase that matches the current flowing in the utility grid.



[3-4]

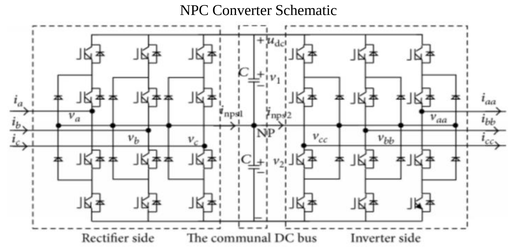
Solution: Back-to-Back NPC Converter

A-Wind Power Systems.
AC (variable v,f) => DC => AC (fixed v,f)

B- Motor Drives.
AC (fixed v,f) => DC => AC (variable v,f)

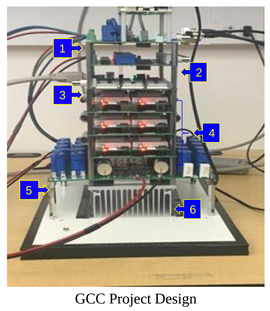
C- Photovoltaic Systems.
DC => AC (fixed v,f)

NPC Converter Schematic

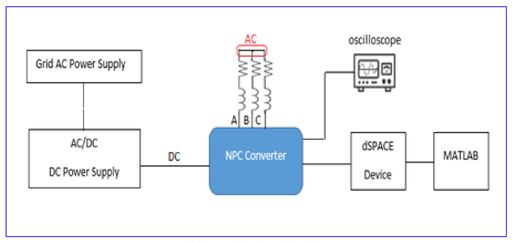


Design Overview & Subsystems

1. **Current sensors:** send current measurements to the control unit.
2. **Voltage sensors:** send voltage measurements to the control unit.
3. **dSPACE Interface Board:** Convert TTL logic signals from the dSPACE DS1103 to CMOS logic.
4. **Gate Drivers:** Provides electrical isolation , turn on/off switching devices.
5. **NPC Power Board:** contains IGBT converting to AC.
6. **Heatsink:** cool down power board.



GCC Project Design

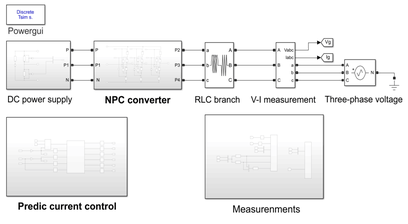


R-Load Testing Set Up

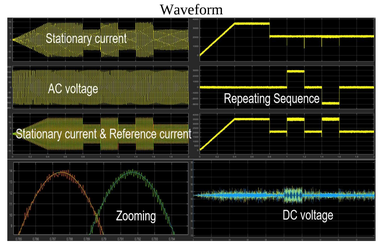
Predictive Current Control (PCC)

The algorithm is based on a model of the system. From that model, the behavior of the system is predicted for each possible switching state of the inverter.

Simulation model in MATLAB

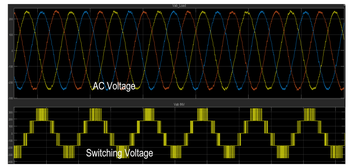


Waveform



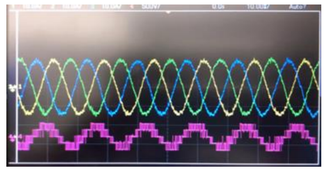
Result & Analysis

Simulation



- The converter was supplied with 350 V and 10 Amp DC power.
- Three phase AC waveforms.
- 5 level line to line AC waveform.

Actual results

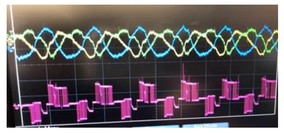


- Successful conversion of a 3500 Watt to AC that can be fed to the utility grid.

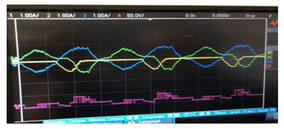
Issues & Solutions

Issues:

1- Noise Problem.



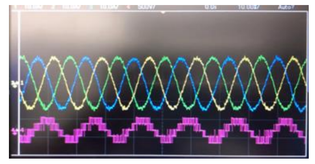
2- Phase dysfunctionality



Solutions:

A- Shield wires connection.

B- Replacing IGPT's.



Conclusion

- Implementing a prototype converter for high power applications helps our client Dr.Yaramasu to contribute in the research field.
- Improved PCC simulation models are used to improve the overall performance of the converter.
- Efficiency of converter is improved 1-2% through reducing harmonic distortion based on model predictive control topologies.
- Future work includes publishing an IEEE paper, and doing more tests.

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References

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[2] Molina, M. and Alvarez, J. (2011). Technical and Regulatory Exigencies for Grid Connection of Wind Generation. Universidad Nacional de San Juan Argentina, p.15.
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