Industry Day Theme # {CE}

Implementation of PV fed Grid-Connected NPC Converter with Neutral Point Voltage Balancing Capability

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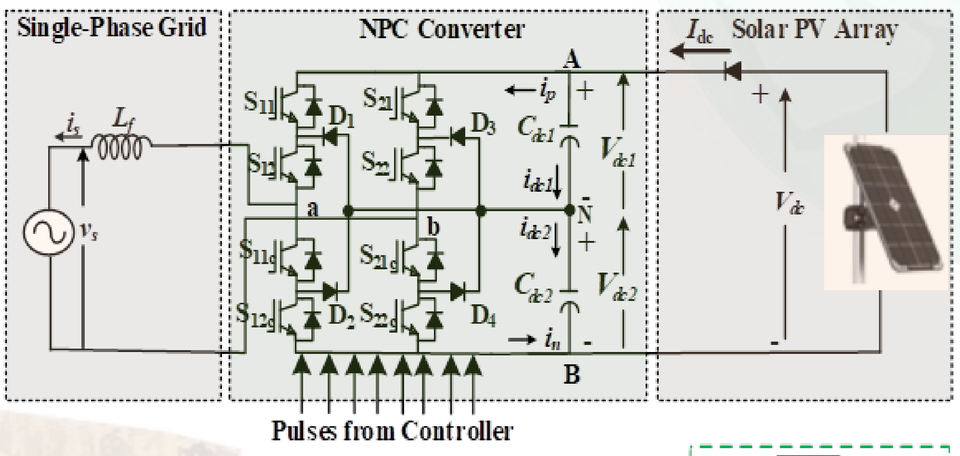
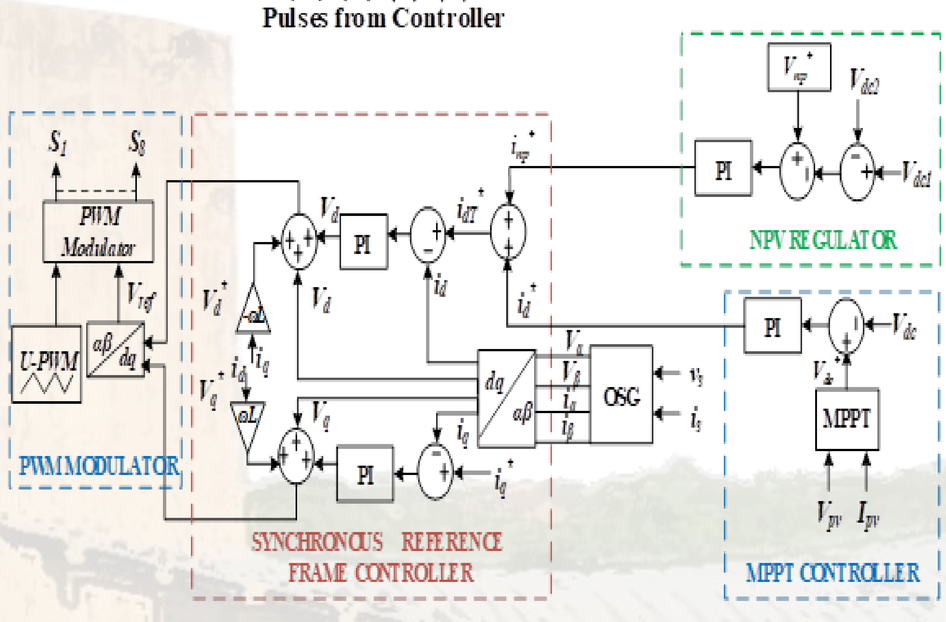
Abstract

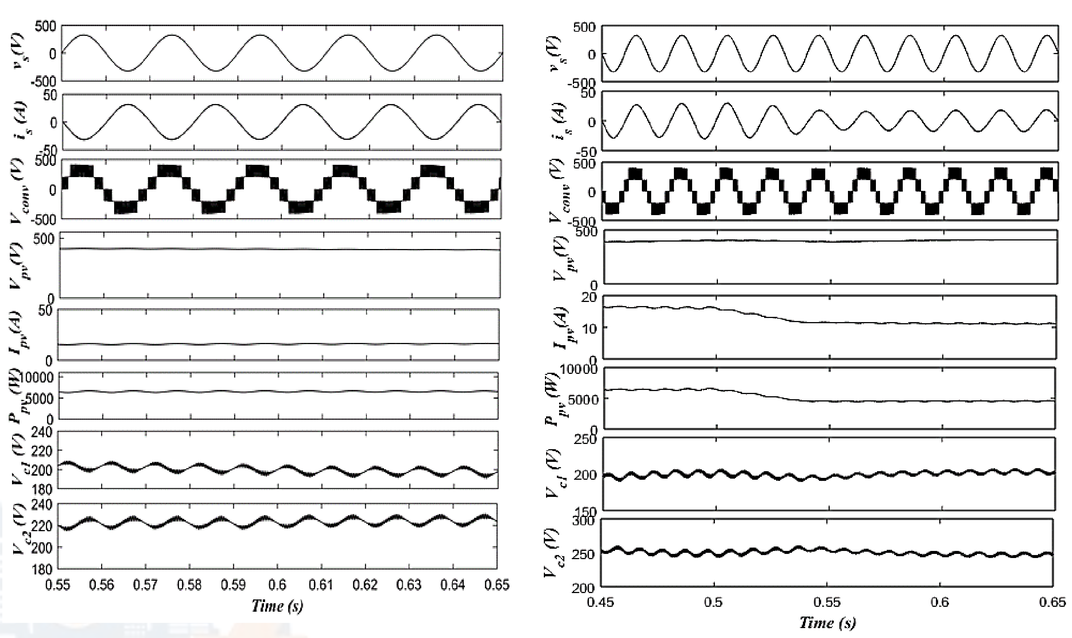
The work presents a single-phase neutral point clamped (NPC) multilevel converter configuration for grid-connected photovoltaic (PV) applications. A single-stage control strategy is developed to control power flow from DC power source to AC grid at unity power factor. The direct and quadrature component based controllers provide independent control over active and reactive powers injection. A proportional integral (PI) controller based neutral point voltage (NPV) balance regulator is added in the proposed controller for NPC, which ensures equal charging and discharging of DC-link capacitors. Moreover, pulse width modulation technique with unipolar pattern is applied at lower switching frequency to adhere with minimum switching losses and power quality standards. The system performance in terms of parameters such as NPV balancing, converter voltage harmonics, current harmonics, and unity power factor operation is analyzed at constant as well as variable irradiances.

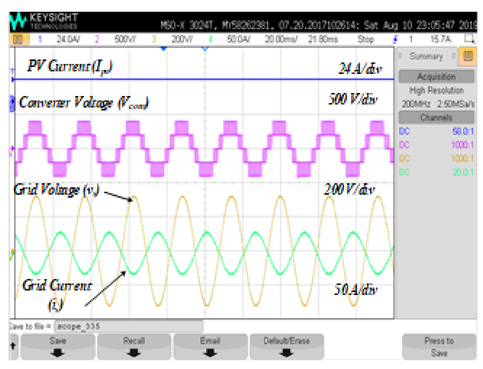
Circuit Configuration and Control Strategy

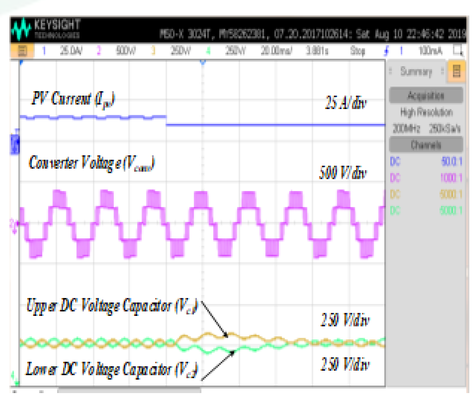


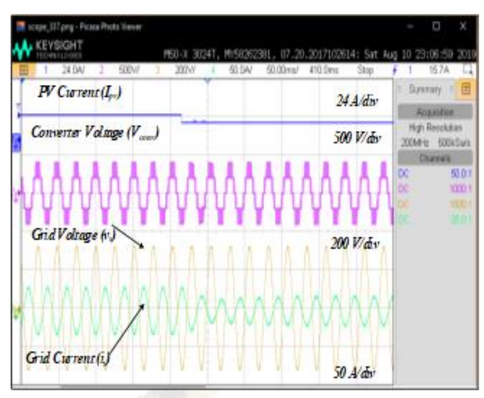


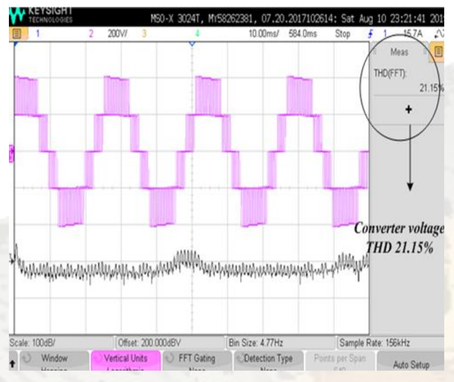
Results

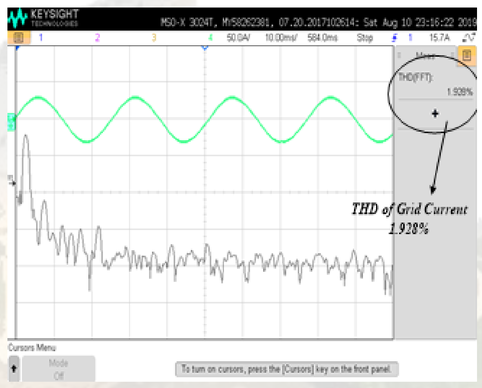








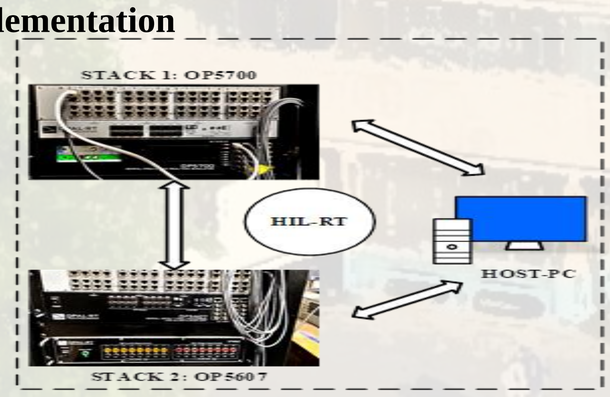




Conclusions

A hardware in loop real time test-bench is implemented for testing the proposed PV fed grid-connected MLI system, which makes it viable for practical applications. Mathematical modeling of NPC converter along with solar PV one-diode model is discussed. Furthermore, PI-based SRF control with pulse-width modulation and simple control methodology has been used for neutral point voltage balancing. Moreover, proposed control reduces computational burden and enhances speed of real-time execution. The power quality according to the IEEE harmonic standards is maintained for grid current. The converter voltage THD is also found under acceptable limits and has improved performance as compared to five-level step voltage harmonics.

OPAL-RT Implementation



Industrial Significance

- Viable from power quality point of view and cost effective.
- Among several topologies, cascaded H bridge (CHB) and neutral point clamped (NPC) converters are widely used in industrial applications from DC to AC power conversion.

Acknowledgement

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