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A Series-Connected Inverter Control Technique to connect Renewable Energy Source to Micro grid With Active and Reactive Power Control along with APF Functionality

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Motivation & Project Background

- In the present day PV systems, the solar power is fed to the grid and loads are connected to the grid in the "conventional grid connected system" or to the PV system directly as can be seen in "conventional stand alone system".
- In the grid connected system, power flow can be controlled but, load voltage or the power quality can not be controlled.
- On the other hand in the stand-alone system, there is no connection between the grid and the load directly.
- If the utility-grid is considered in the under-developed countries, there is always a voltage sag as well as some frequency deviation in the utility grid supply.
- Due to heavy use of the electronic load, the mains voltage also becomes rich in voltage harmonics.
- So to overcome all these problems, the inverter compensating voltage should work in such a way that, irrespective of any type of disturbances in the micro-grid voltage (such as sag, swell or harmonic distortions), the load voltage is maintained at its rated voltage level with low THD.

Main Objectives

- **A novel control strategy for a single-phase series connected inverter with the micro-grid to interface AC loads not only to regulate the load voltage under voltage disturbances but also to control the load power drawn from the micro-grid.**
- **To facilitate a specific amount of active power flow (from renewable energy source) to the load irrespective of the micro-grid voltage condition. The rest of the load power is supplied by the micro-grid.**
- **To ensures dynamic stability of the system even if there is a sudden change in the micro-grid frequency.**

System Description

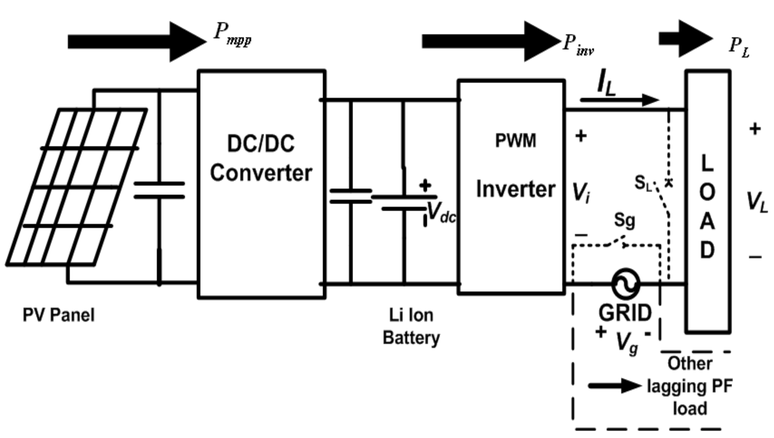


Fig 1. Schematics of the PV inverter with MPPT tracking system

Control Methodologies

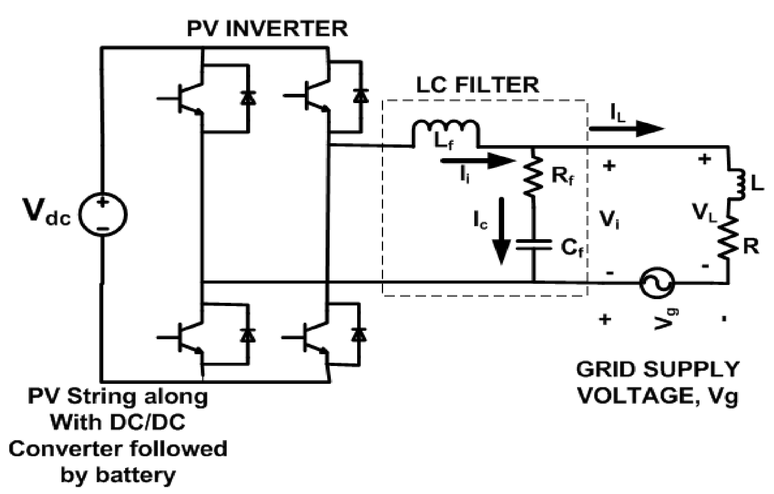


Fig 2. Detailed schematics of the invented inverter

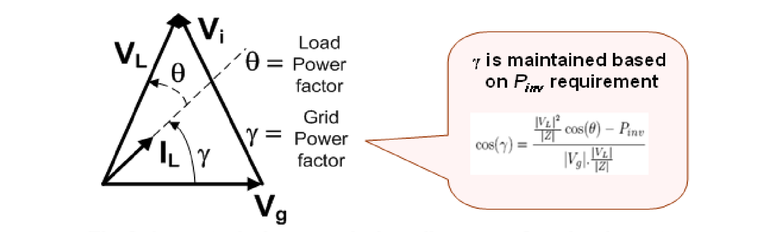
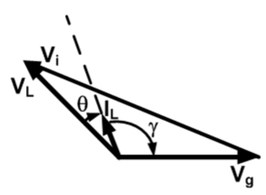
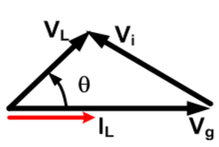


Fig 3. Invented phasor relation diagram of series inverter



Invented phasor relation diagram of series inverter when PV power is fed back to grid



Invented phasor relation diagram of series inverter in rectifier mode charging battery from grid power

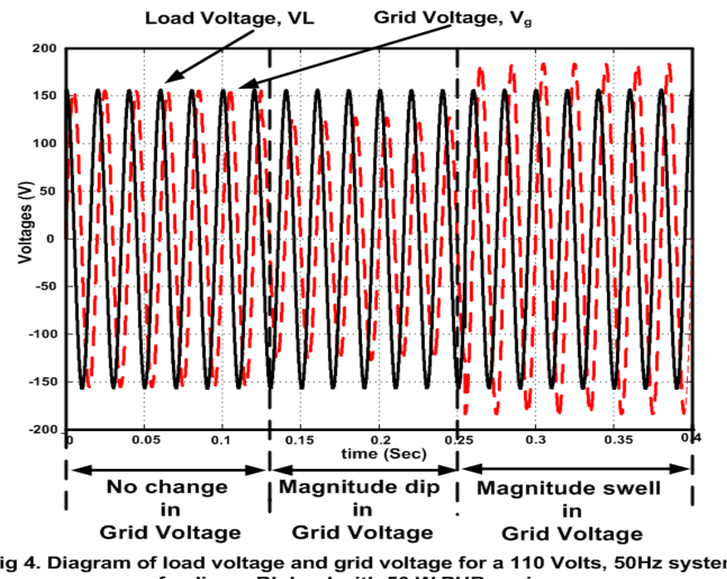


Fig 4. Diagram of load voltage and grid voltage for a 110 Volts, 50Hz system feeding a RL load with 50 W PUB savings

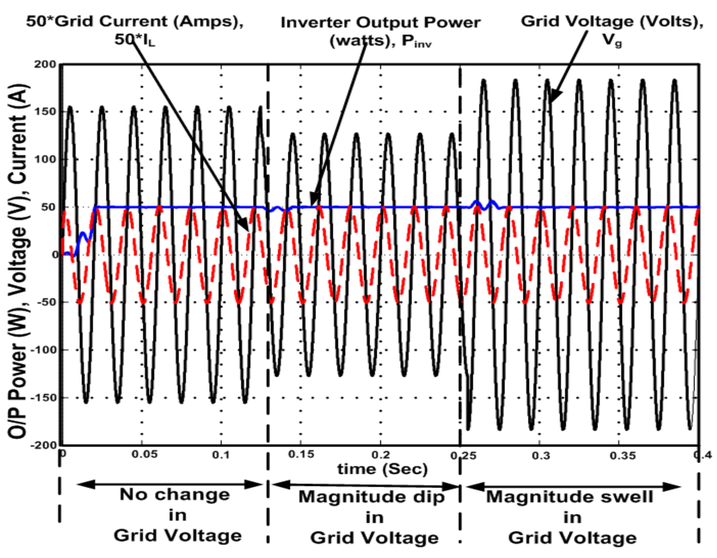


Fig 5. Diagram of grid current, inverter power and grid voltage for a 110 Volts, 50Hz system feeding a RL load with 50 W PUB savings

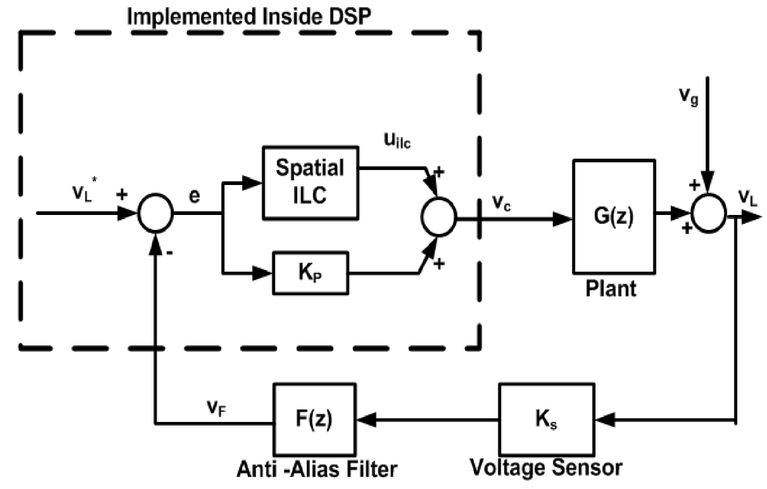


Fig 8. Schematics of the implementation of the Spatial ILC controller for the series converter application

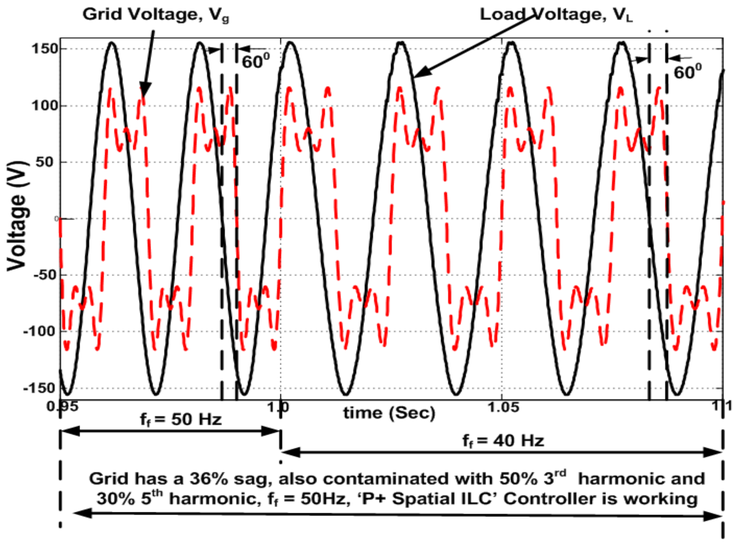


Fig 9. Diagram of load voltage and grid voltage for a 110 Volts, 50Hz system when grid has sag, harmonic contamination and frequency change

Discussion & Impact

- In the invented topology, not only load voltage is maintained at rated undistorted sinusoid but also, appropriate grid power control can be carried out.
- If the micro-grid scenario is considered, the grid is very weak and each residential load needs to be interfaced with micro-grid with an inverter
- As micro grid is a weak grid, it may contain large voltage harmonics, sag, swell type of disturbances with adequate fluctuation in the grid frequency.
- It can be seen that the invented inverter control can take care of all these issues. Micro-grid interconnection also requires bidirectional power flow through the grid.
- And also the proposed series connected inverter system can take care of this bidirectional power flow criterion also.