A Parallel-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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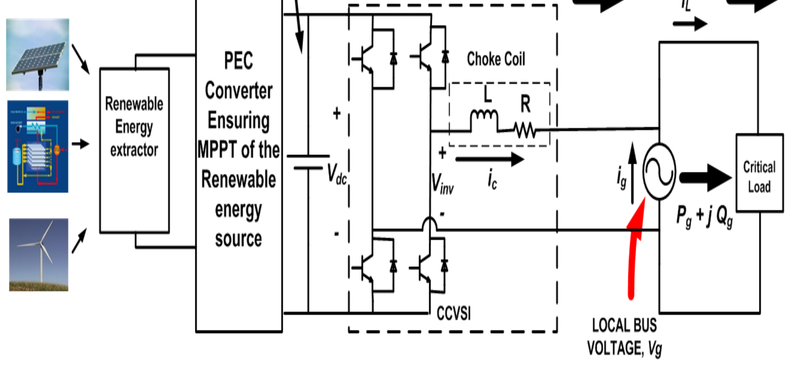
Motivation & Project Background

- Power Electronic Converter (PEC) extracts the maximum power from the renewable energy source and converts it to electrical power at the DC link of the inverter.
- The total load active power is shared between inverter power and grid power based on the user command and the inverter operates in CC-VSI mode.
- The loads normally draw non-sinusoidal periodic current from grid leading to distorted grid current resulting to high Total Harmonic Distortion (THD) of the grid current
- So, in the market some circuits are available which when connected in parallel reduces the THD. These devices are called “Power Factor Correction” circuits.
- On the other hand parallel connected PV inverters are gaining more and more popularity to feed the PV power to grid.

Main Objectives

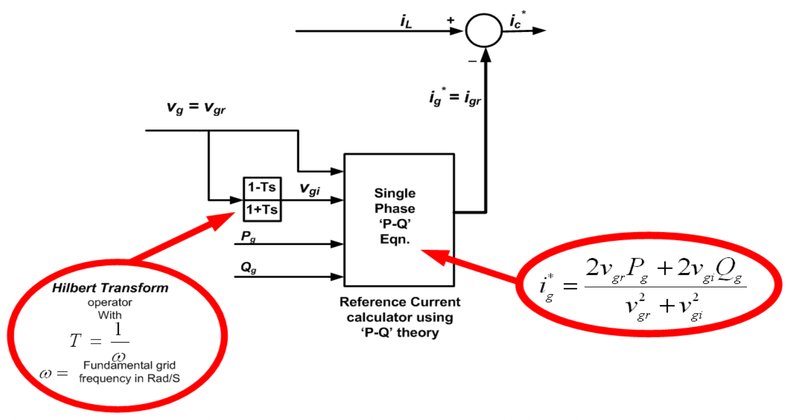
- A novel current control technique to control both active and reactive power flow from a renewable energy source feeding a micro-grid system through a single-phase parallel connected inverter.
- Shaping the grid current in the presence of non-linear load at the PCC . And the inverter current, i_c is controlled in such a way that, active and reactive power drawn from the grid can be controlled.
- The control technique also ensures the grid current, i_g to be pure sinusoidal and in-phase with the grid voltage.

System Description



Schematics of the grid connected PV inverter with MPPT tracking system

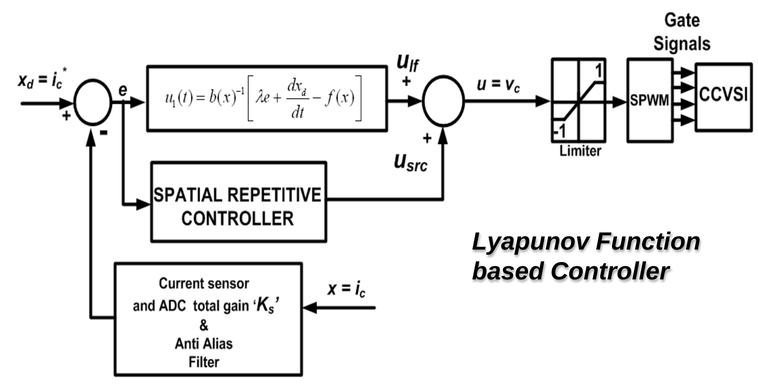
- Non-linear load makes the inverter current reference, i_c^* highly non-sinusoidal and periodic, thus solved by *Lyapunov function* based controller.



Inverter current reference calculation block utilizing single phase p-q theory

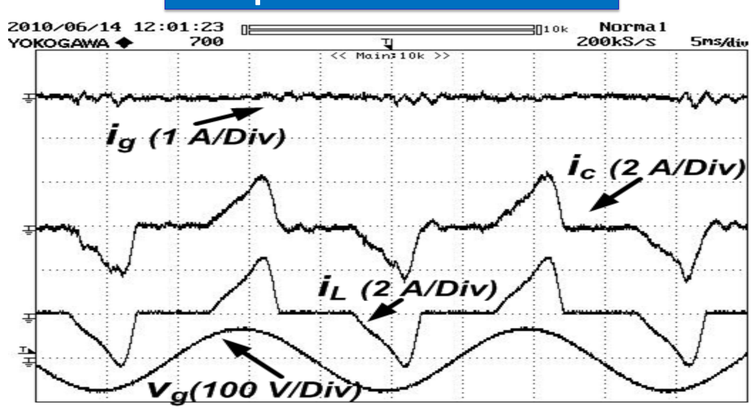
Control Methodologies

- *Spatial Repetitive Controller* (SRC) is connected in parallel to take care of grid voltage and other periodic disturbances such as blanking time of the inverter etc.



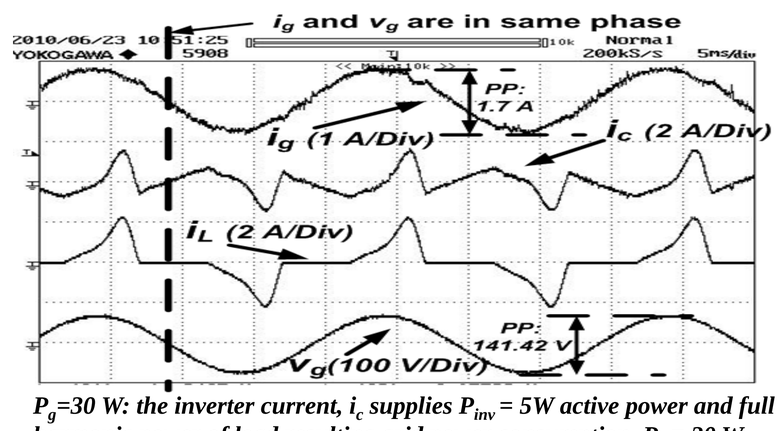
Lyapunov Function based Controller

Experimental Results



P_g=0 W: the inverter current, i_c supplies P_{inv}= 35W active power and full harmonic power of load resulting in grid power consumption, P_g= 0 W with i_g = 0 A.

A typical rectifier load is connected with P_L = 35W at V_g = 50 V(rms).



P_g=30 W: the inverter current, i_c supplies P_{inv} = 5W active power and full harmonic power of load resulting grid power consumption, P_g = 30 W with pure sinusoid i_g and DPF = 1.

Discussion

Possible Specific Industrial Applications :

- The proposed inverter technology is very suitable for residential application of PV energy.
- The inverter is used for not only for controlling power flow control form the renewable energy source to the grid but also does the power factor correction job as an extra benefit of the proposed system.

Impact

- This effectively reduces the investment cost of the residential installation.
- Besides this the inverter can be used to interface the micro-grid with any other type of renewable energy sources.
- The inverter along with the proposed control strategy can be used to facilitate bidirectional power flow control from and to the micro-grid.
- **In the proposed technique a single inverter is not only feeding active power to grid (how much power needs to be stored in battery and how much power will be fedback to grid can be decided by the user) but the same circuit provides low THD in grid current assurance also at the same time.**
- **So a single power electronic converter can do both the works reducing the cost of the total electrical appliances for single phase residential application.**
- **The control method of the inverter will ensure specific amount of power flow to the grid under different voltage distorted conditions of the grid.**