Reduction of Harmonic Distortions Using Feedback Control Strategy in Grid Connected DG Units

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ABSTRACT

The power quality in the distribution system is first and foremost task which needs to be maintained for the efficient and reliable functioning of various devices and equipments in Power System. To work out on this, a feedback mechanism to control and mitigate the harmonics present in the currents, has been used. The proposed system utilizes current controlled method in this work, which significantly reduces the harmonics present in the different currents like DG current, grid current and fundamental currents. Here the implementation of Distributed Generation (DG) unit in closed loop having grid and the load has been done.

Introduction

The installation of non-linear loads have a negative impact on main bus power quality and entire power system. This harmful effect is due to the fact that these loads do not draw purely sinusoidal current. Some examples of nonlinear loads are laser printers, uninterruptible power supply, drives with altering speeds, loads with diode capacitor power supplies etc. Due to the reactive current and harmonic current electromagnetic interference with nearby equipment and heating of transformers occurs.

Mohammad Irshad shaik et al. [2]: In this paper the author explains "Active power filter continues to draw considerable attention because of sensitivity of consumers on power quality and advancement in power electronics. Active power filter technology is the most efficient way to compensate reactive power and cancel out low order harmonics generated by non-linear loads. An active power filter is a device that is connected in parallel and cancels the harmonic currents from the group of nonlinear loads so that the resulting total current drawn from the ac main is sinusoidal. The shunt active power filter was considered to be the most basic configuration for the APF. The proposed NPC based APF is tested its performance under balanced non-linear load, unbalanced non-linear load and variable non-linear load with the source current harmonic analysis APF is tested its performance under balanced non-linear load, unbalanced non-linear load and variable non-linear load with the source current harmonic analysis."

INTERHARMONICS:

Voltages or currents having frequency elements that are not integer multiples of the frequency at that the supply system is intended to work (e.g., 50 or 60 Hz) are referred to as interharmonics. They will seem as distinct frequencies or as a wideband spectrum. Interharmonics are often found in networks of all voltage categories. The most sources of interharmonic wave shape distortion are static frequency converters, cycloconverters, induction furnaces, and arcing devices.

SUBHARMONICS:

Sub harmonics have frequencies below the basic frequency and are rare in power systems. Once subharmonics are present, the underlying cause is resonance between the harmonic currents or voltages with the power system capacitance and inductance. Subharmonics could generated once a system is extremely inductive (such as an arc chamber throughout start-up) or if the power system also contains massive capacitance banks for power factor correction or filtering. Such conditions turn out slow oscillations that are comparatively undamped, leading to voltage sags and light flicker.

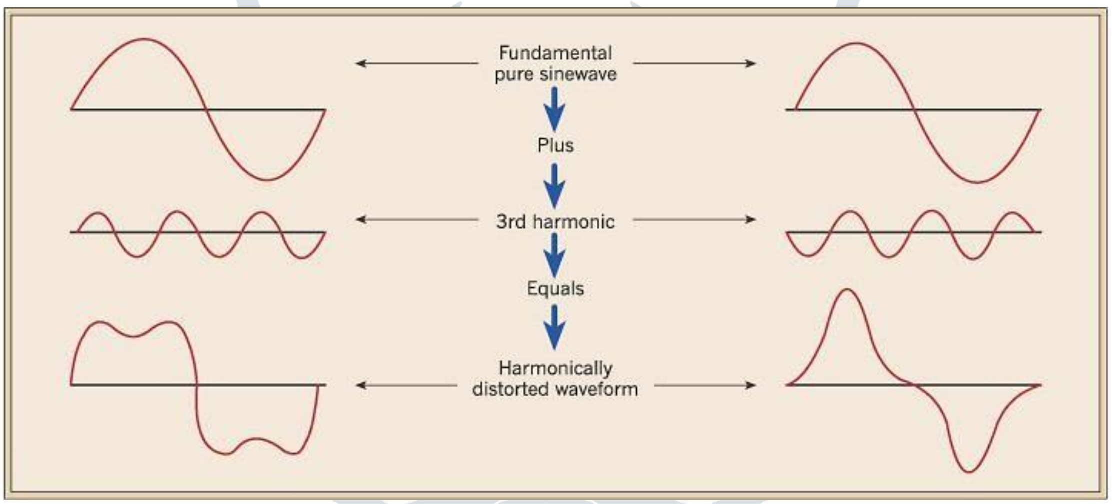


FIGURE 1 Periodically distorted waveforms

Total Harmonic Distortions (THD)

The THD is a measure of the effective value of the harmonic components of a distorted waveform. Total harmonic distortion is the ratio between the RMS value of the harmonics and the RMS value of the fundamental.

$$THD = \frac{\sqrt{\sum_{h>1}^{h_{max}} M_h^2}}{M_1}$$

Shunt Active Power Filter

The shunt-connected active power filter, with a self-controlled dc bus, contains a topology similar to that of a static compensator (STATCOM) used for reactive power compensation in power transmission systems. Shunt active power filters compensate load current harmonics by injecting equal-but opposite harmonic compensating current. in this case the shunt active power filter operates as a current source injecting the harmonic components generated by the load however phase-shifted by 180°.

Figure 2 shows the connection of a shunt active power filter and Figure 4.2 shows how the active filter works to compensate the load harmonic currents.

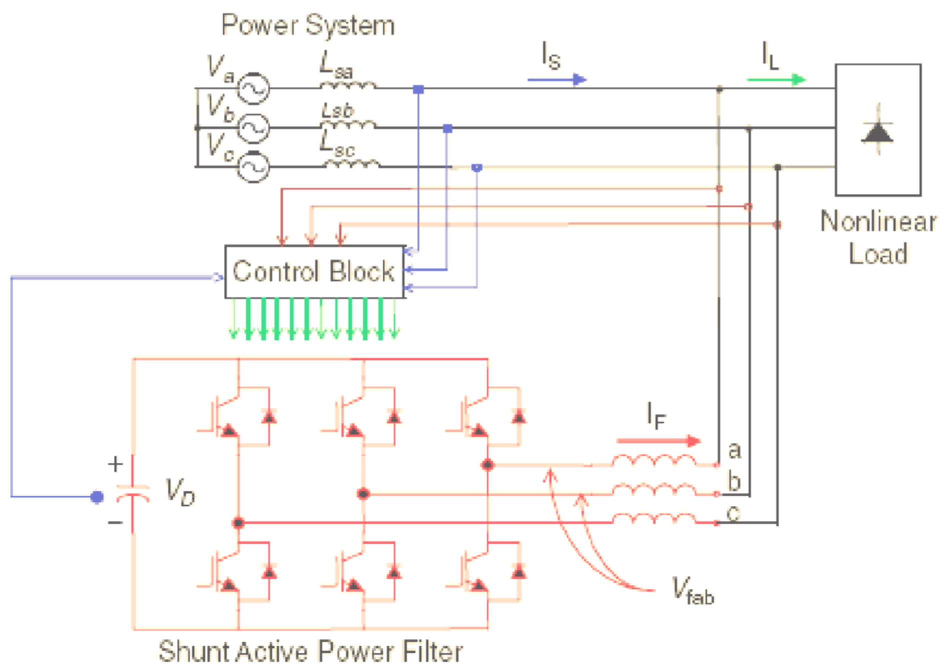


Figure.2.Shunt active power filter topology.

Current Mode Control (CMC)

Current mode control system has two control feedback loops: internal feedback loop called current loop and external feedback loop that senses and regulates the output voltage which is called voltage loop.

The reason that this method is called current mode control is that it controls the inductor current directly via internal control loop, while the output voltage is regulated indirectly by the internal current loop.

Distributed generation technologies

- Fuel cells
- Hybrid power systems (solar hybrid and wind hybrid systems)
- Micro combined heat and power (MicroCHP)
- Micro-turbines
- Photovoltaic systems (typically rooftop solar PV)

Simulation model

With the help of MATLAB and its Simulink feature, the power system model along with its state feedback control is developed and simulated.

The simulation model is as follows:

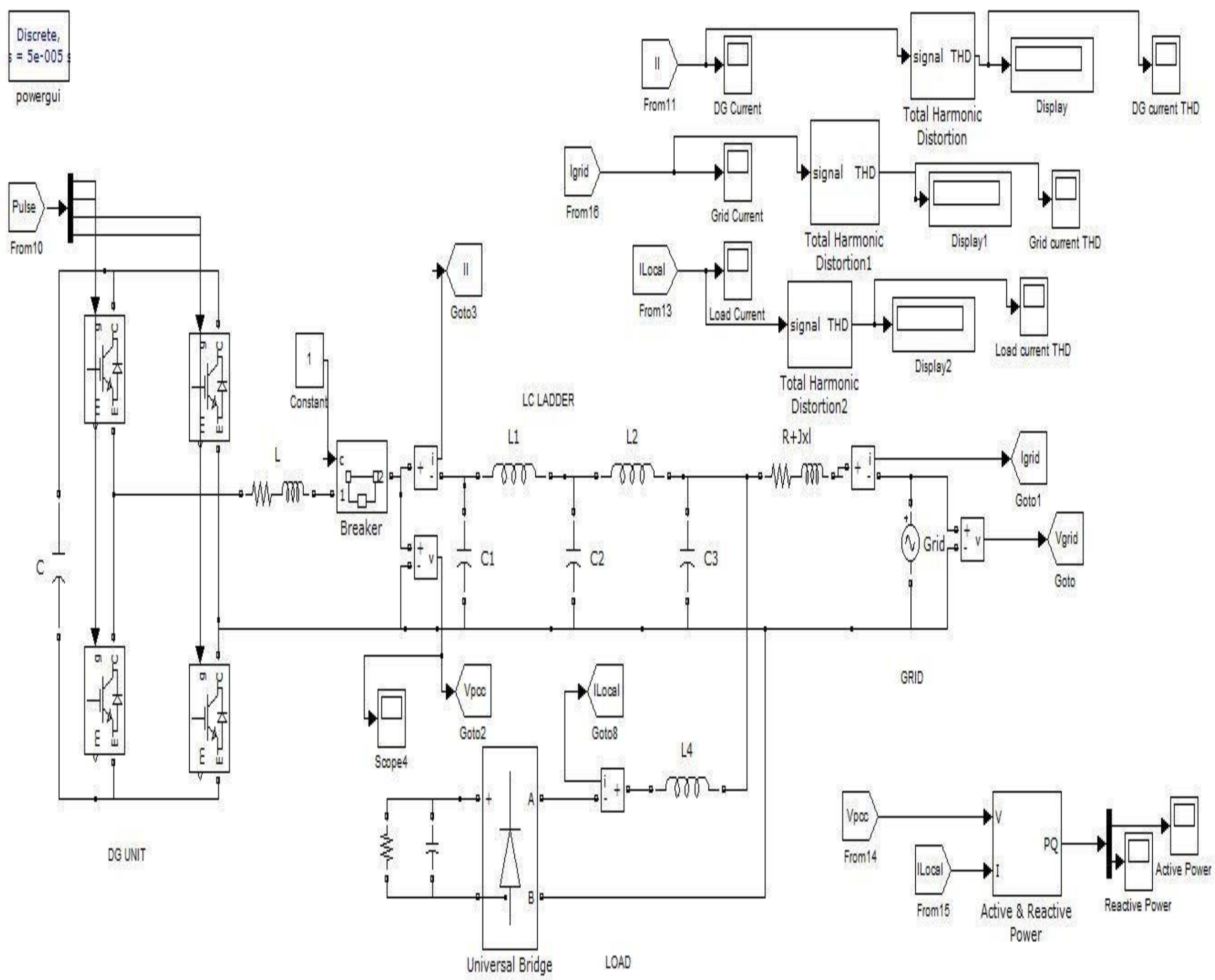
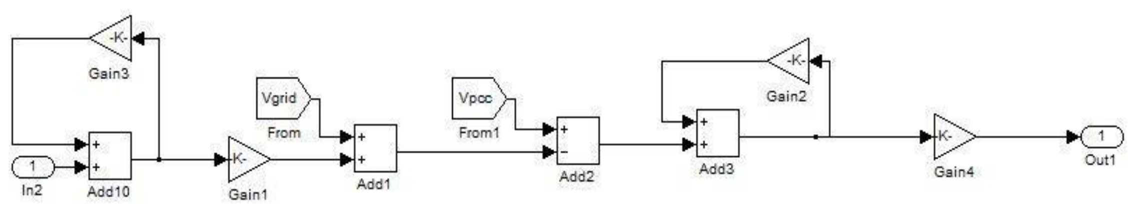


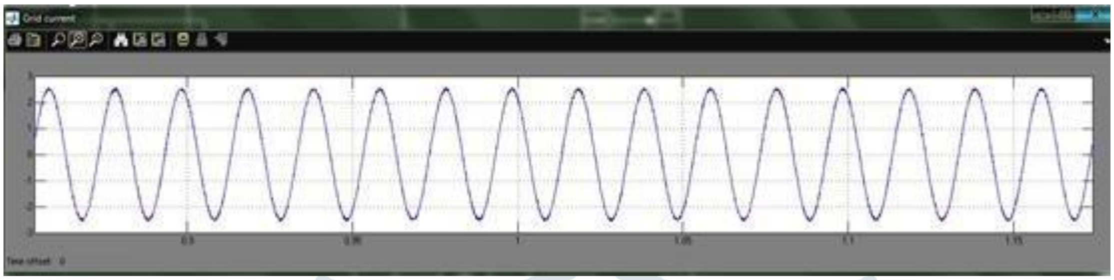
Fig 3 Simulation model of grid connected DG unit



During DG harmonic rejection:

Using feedback control, improved waveform of currents are obtained which is very near to purely sinusoidal shape.

(a)



(b)

(c)

Fig.4 During DG harmonic rejection: (a) grid current I_2; (b) DG current I_1 ; (c) local load current I_{Local}

The Grid current is found to be 2.5 Ampere

DG current is 5 Ampere

Load current is 27 Ampere.

Conclusion

Non-linear loads, such as diode rectifiers and switch power supply in transmission and power systems, are increasing fast in recent years as a result of the development of power electronic technology. While they bring in high efficiency and high performance, they may also cause some problems in power systems, for example, harmonic current and voltage resulting from the nonlinear load become more and more serious in power systems. Power distortions occurs due to the nonlinear load which draws non-sinusoidal currents from the system.

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