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Enhancing Power Quality of System Grid With Unified Power Quality Conditioner Strategy (UPQC) Method

Mrs. I. Dhana Bharathi, Mrs. M. M. Rajeshwari, Mrs. R. Jayalakshmi,

Assistant Professor, Department of Electrical and Electronics Engineering, Sriram Engineering College,
Tiruvallur, India

Assistant Professor, Department of Electrical and Electronics Engineering, Sriram Engineering College,
Tiruvallur, India

Assistant Professor, Department of Electrical and Electronics Engineering, Sriram Engineering College,
Tiruvallur, India

ABSTRACT: In development of industrial sector, national trade, commercial and also in residential brought the installation of non-linear loads which has been distorting the currents and voltage waves from sinusoidal and there is an integer multiple of fundamental frequency which is called as harmonics. This causes many major problems such as malfunctioning, heat generation and damages of devices in power system and also it reduces the life of the devices and equipment. The smart and economical solution to reduce this problem is implementing passive filter. This project is to design unique effective passive filter using passive components alone and in simple way.

I. INTRODUCTION

The electricity is more important for our day today life. The quality of the power is also having the important role in it. From the recent years the power generating stations and large scale industries showing more attention on power quality. The increased non-linear loads in industries, residential and commercial make the power quality poor. The non-linear loads such as personal computer, variable frequency drives, chargers, television, etc. These electronic loads produce harmonics and heat in the power system. This will damage the sensitive equipment and make malfunction in devices operation and also reduces the life of the device. Harmonics distorting the current and the voltage waveform from sinusoidal. The integer multiple of fundamental frequency is known as harmonic. The order of the harmonics is depends on the number of inter multiple of frequencies.

II. HARMONICS

Harmonics are the integer multiple of fundamental frequency (50Hz) which make the distortion in voltage and current waveform from sinusoidal waveform. The order of harmonics depends on multiple value of fundamental frequency. The 50Hz multiplied by 3,5,7,11... are called as 3rd harmonic, 5th harmonic, 7th harmonic, 11th harmonic and so on. The main reason for occurrence of harmonics in the power and network is usage of non-linear load. The non-linear loads such as personal computer, mobile charger, inverter, television, etc. in commercial loads and variable frequency drives, control system, etc. in industrial loads which are all made up of electronic components like diode, SCR, IGBT, MOSFET, transistors, etc.

The presence of harmonics in a system will create heat at the load side, consume more current and also produce noise in the motor loads. This will damage the sensitive equipment which connected in that system, make malfunctioning, make more stress on insulations and reduces the life of the device.

III. EXISTING SYSTEM

In existing system the filter's cost is very high due to separate capacitor for different order harmonics. At no load condition it may produce over voltage in the power system due to higher capacitor value. For separate filter it need

more space for installation. Both active and passive filters are using in existing system. By the use of active components in the filters will also produces some heat and harmonics.

IV. PROPOSED SYSTEM

The passive filter is used to mitigate the harmonics current in economical way due to low cost. The passive filter will proved the reactive power for compensation of voltage sag. It will improve the power factor of the system and maintain its stability. Reduce the stress produced on the insulation of the transformer. Improving the sinusoidal waveform of voltage from its distortion. Reducing the temperature rise of the equipment and device. Control the over current consumption of load and increases the economical benefit from power supply cost.

BLOCK DIAGRAM



Fig.1 block diagram of power system with passive filter

4.1 Passive filter

Passive filter is the method commonly used for filtering the harmonics from early years. This passive filter is made up of inductor, capacitor and resistor. The passive filter is designed in tuned or broad band. The passive filter is the best method for filtering harmonics in high voltage system. The passive filter connected in parallel to the network which is called as shunt passive filter. The inductor connected in series to the network which create high impedance path to the harmonic current, it is called as band stop filter and the inductor connected in parallel which create low impedance path to harmonic current, it is called as band pass filter.

4.2 Filter Designed

Passive filters: They usually designed by inductors, resistors and capacitors which are tuned at a characteristic resonance frequency.

The function of passive filters is to absorb the load harmonic currents, preventing them from circulating through the electrical system.

Reactor: The series reactor makes high impedance path to the high frequency current (harmonic current) and the parallel reactor makes low impedance path to the harmonic current.

So it will block the harmonic currents of 7th, 11th order under load side reactor and block the 3th order under source side reactor and 5th order harmonic current flow to the LC connected parallel. Inductors usually vary about -3% to 7%.

Capacitor: It will charge and discharge the reactive power at the condition of voltage swell and sag. The power factor is also improved here. Some of the harmonic currents are dissipated as heat and grounded. Capacitors usually vary about 0% to 10%.

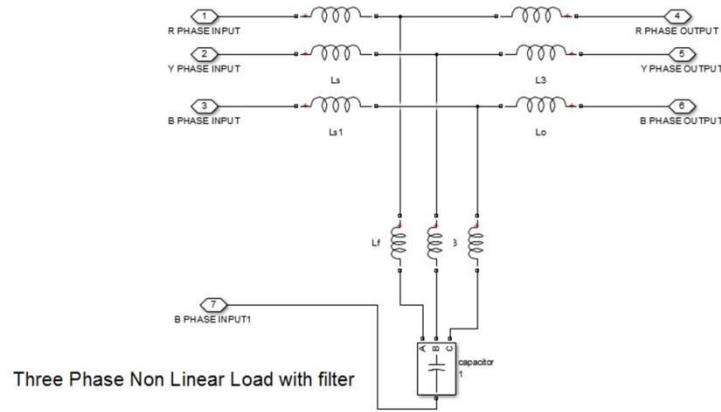


Fig. 2 circuit diagram of passive filter

4.3 Harmonics Calculation

For total harmonic distortion,

$$THD\% = \frac{\sqrt{\text{sum of square of amplitude of all harmonics}}}{\sqrt{\text{square of amplitude of fundamental}}} * 100$$

For current THD-I,

$$THD\% = \frac{\sqrt{I_2^2 + I_3^2 + \dots + I_N^2}}{I_1} * 100$$

For voltage THD-V

$$THD\% = \frac{\sqrt{V_2^2 + V_3^2 + \dots + V_N^2}}{V_1} * 100$$

4.4 Filter calculation

Impedance of inductor:

$$Z = 2\pi fL \quad \Omega$$

Impedance of capacitor:

$$Z = 1/2\pi fC \quad \Omega$$

Resonant frequency:

$$f_0 = 1/2\pi\sqrt{LC} \quad (\text{HZ})$$

$$L_f = 1/\omega^2 C_f \quad (\text{H})$$

Line inductor formula:

For 3 phase,

$$X = [2\pi fL I_{ac} / V_{ac} / \sqrt{3}] * 100 \quad (\%)$$

For 1 phase,

$$X = [2\pi fL I_{ac} / V_{ac}] * 100 \quad (\%)$$

Reactive power:

$$Q = CV^2 2\pi f \quad (\text{KVAR})$$

$$Q = \sqrt{3} V I \sin\theta \quad (\text{KVAR})$$

Real power:

$$P = VI \cos\theta$$

4.5 Hardware block diagram

HARDWARE BLOCK DIAGRAM

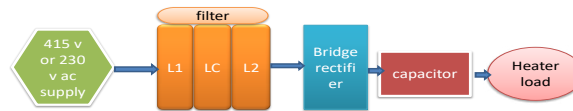


Fig.3 hardware block diagram

V. SIMULATION DESIGN

The MATLAB simulation is used to implement our new ideas without any investments of hardware. From the library of MATLAB simulation we can select the required component for our projection. In the Simulink we can join all the blocks with connecting lines and finally we can compile and run our block diagram.

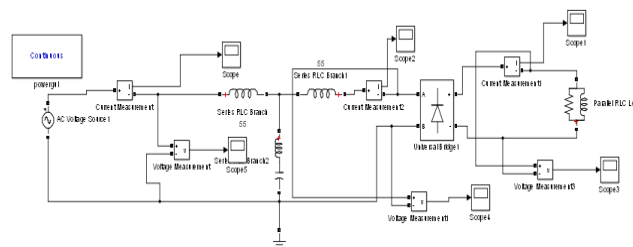


Fig 4.Simulation design

From the block ac voltage source the supply is passed to the non linear load through shunt passive filter. The shunt passive filter is the combination of inductor and capacitor. The block universal bridge is connected at the load side to convert ac to dc supply. In this universal bridge block there is a snubber capacitor which is used to filter the repulsion in the supply. The inductive load is used under the dc supply which acts as non linear load. This will generate the harmonics in the network which will distort the waveform of voltage and current from its perfect sinusoidal. To analyse the voltage and current waveform we included the blocks of voltage measurement and current measurement. To display the waveform graphically we included the scope block.

VI. SIMULATION RESULT

The simulation result is shown in waveform of voltage and current variation. The voltage waveform before filter is distorted from its perfect sinusoidal waveform. The voltage waveform after filter is in the perfect sinusoidal waveform. It shows that reduction in harmonics current by the use of shunt passive filter.

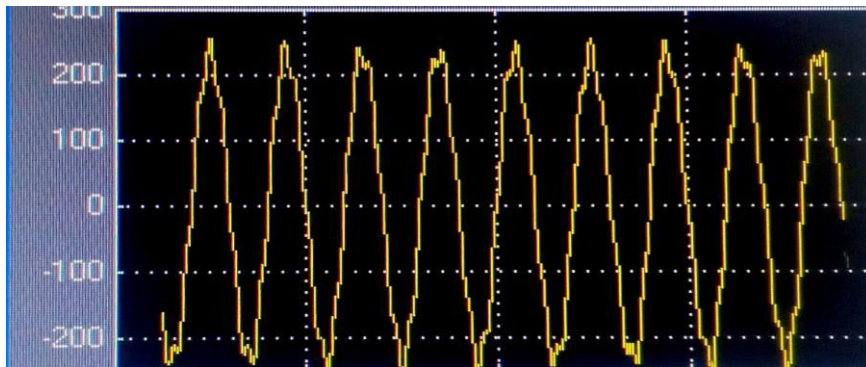


Fig 5. Distorted waveform of voltage before filtering

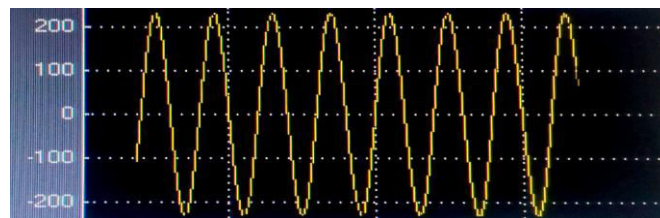


Fig 6. Perfect sinusoidal waveform of voltage after filtering

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