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Active power filters for harmonics reduction in power system

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Abstract
Harmonics lead to premature ageing of the electrical Installation. Excessive amount of harmonics must eliminate for economic reasons. The utility company impose penalties on users due to this fact. Harmonic pollution may disturb equipment in other plants. Assessment of emission limits for disturbing loads in MV and HV power systems.
Our project is based on the design of Active Power filter along with the use of some passive elements to eliminate the harmonics in the power system. Our proposed scheme has been designed in MATLAB/SIMULINK environment showing various performance measures.

Keywords: Harmonics, Active Filtes, Passive Filters, Matlab/Simulink.

1. Introduction

As always, the main objective of the power system would be generation of electrical energy to the end user. Also, associated with power system generation is the term power quality. So much emphasis has been given to power quality that it is considered as a separate area of power engineering. There are many reasons for the importance given to the power quality. One of the main reason is, the consumers are well informed about the power quality issues like interruptions, sagging and switching transients. Also, many power systems are internally connected into a network. Due to this integration if a failure exists in any one of the internal network it would result into unfavorable consequences to the whole power system. In addition to all this, with the microprocessor based controls, protective devices become more sensitive towards power quality variation than were the past generation protective devices.
Following are some of the disturbances which are common in affecting the power system.

1.) Transients
2.) Sagging
3.) Variations in voltage
4.) Harmonics

Harmonics are one of the major concerns in a power system. Harmonics cause distortion in current and voltage waveforms resulting into deterioration of the power system. The first step for harmonic analysis is the harmonics from non-linear loads. The results of such analysis are complex. Over many years, much importance is given to the methods of analysis and control of harmonics. Harmonics present in power system also has non-integer multiples of the fundamental frequency and have a periodic waveform.

2. Proposed Method

One of the way out to resolve the issue of harmonics would be using filters in the power system. Installing a filter for nonlinear loads connected in power system would help in reducing the harmonic effect. The filters are widely used for reduction of harmonics. With the increase of nonlinear loads in the power system, more and more filters are required.

2.1 Roles of Filters in Power System

There are two types of filters

- The Passive Filters
- The Active Filters

Capacitors are frequently used in the Active and Passive filters for harmonics reduction.
The Passive filters are used in order to protect the power system by restricting the harmonic current to enter the power system by providing a low impedance path. Passive filters consist of resistors, inductors and capacitors.
The Active filters are mostly used in distribution networks for sagging in voltage, flickering, where there are harmonics in current and voltages, etc. Using the filter would result into a better quality of power.
There is also a third type of filter which is used i.e. The Hybrid Filter. Hybrid filters are composed of the passive and active filters both.

2.2 Approach for Solving Harmonics Problem

Active filters are a perfect alternative to the passive filters. The active filters are used in a condition where the harmonic orders change in terms of magnitudes and the phase angles. In such conditions it is feasible to use the active elements instead of passive ones in order to provide dynamic compensation.
Advantages of Active Filter over Passive Filter:

- One of the main advantage of using an active filter over the passive filter is that it can be used to reduce the effects of harmonics of more than one order.
- Active filters are also useful in flickering problems that are caused in the power system.

Figure 1 and 2 shows single phase active filters in shunt and series configuration respectively.

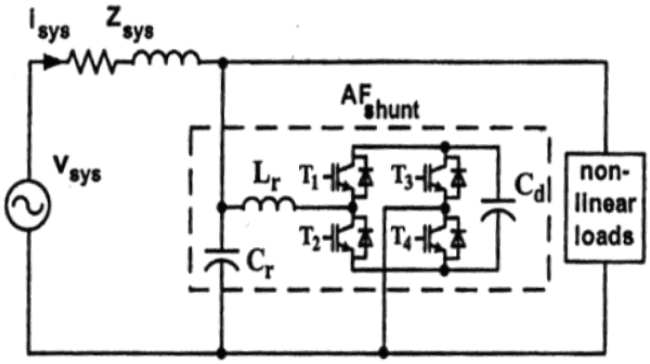

Fig 1: Single Phase Active Filter, Shunt Configuration

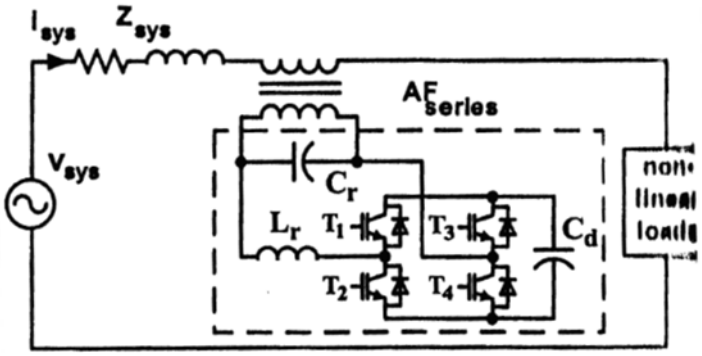

Fig 2: Single Phase Active Filter, Series Configuration.

2.3 Block Diagram for Proposed Scheme

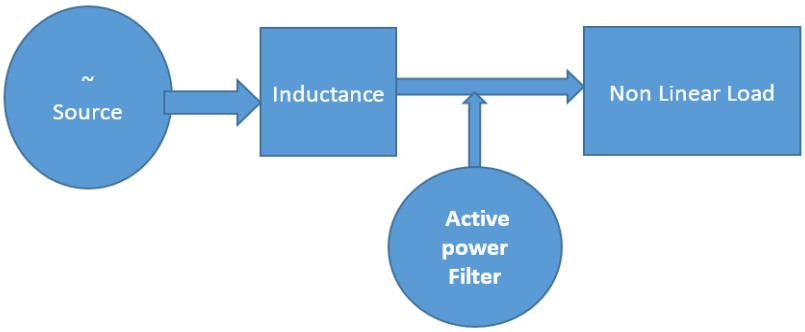

Fig 3: Block Diagram

2.4 Flow Chart for the Scheme

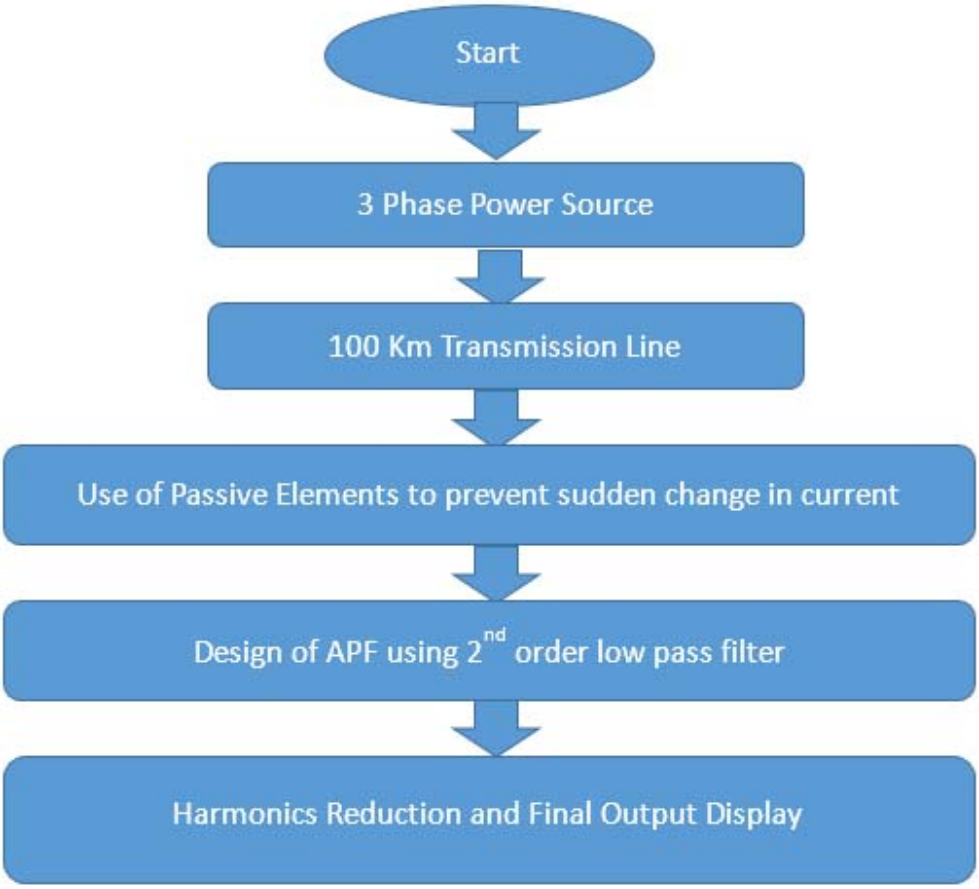

Fig 4: Flow Chart

3. Simulation result

3.1 MATLAB/SIMULINK Based Implementation for the Proposed Scheme

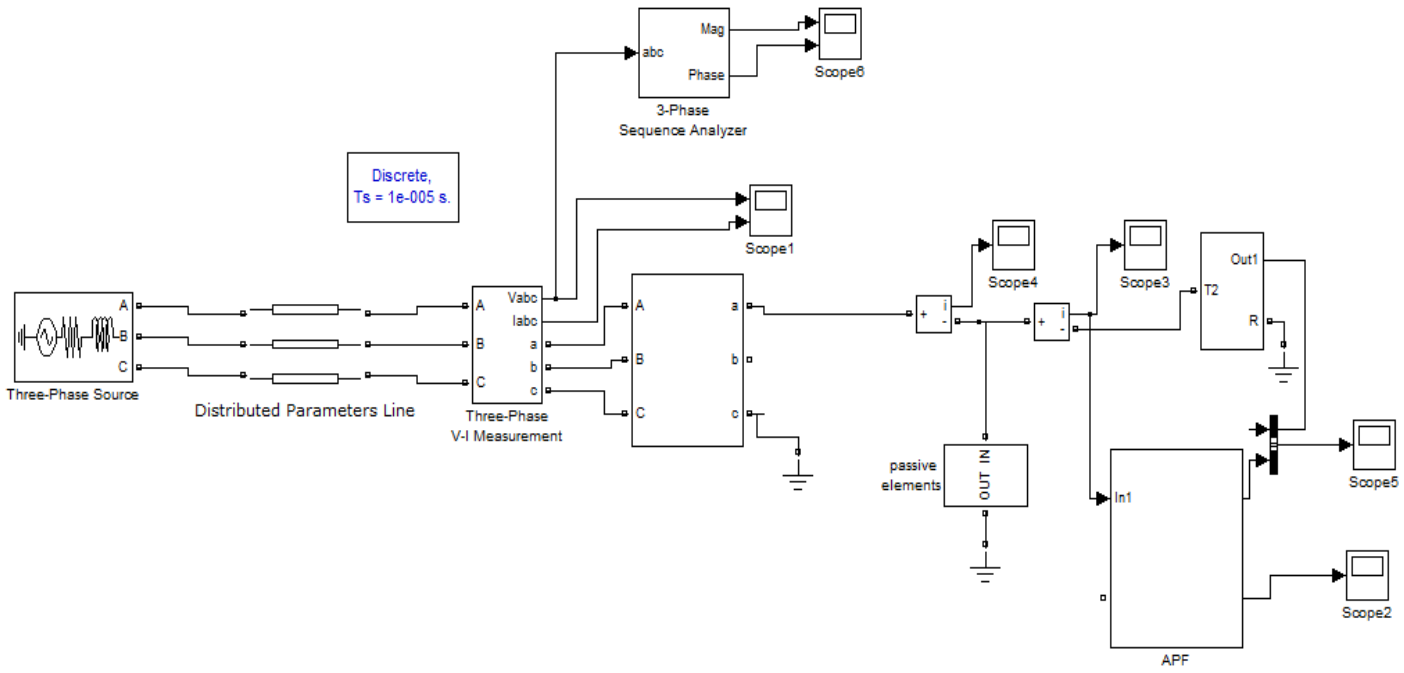

Fig 5: Simulink based design

3.2 Model Description

- In the above shown model a 3 Phase source has been taken which is fed through a distributed parameter element (transmission line of 100 Kms.)
- Then the input signals has been plotted using the Scope Signal
- Out of the 3 Phase, a single phase has been taken for the Active Power filter operations.
- Finally we are evaluating the performance by removing noise.

3.3 Design Steps

- Step1:Open Simulink library, move for the sim-power system
- Step2: choose source and select 3 phase voltage source and measure phase and magnitude through 3 phase sequence signal
- Step3: Look for the distributed parameter for transmission line implementation and choose 100 km distance
- Step4:choose 3 phase VI measurement curve from sim-power system
- Step5:select a single phase for passing the signal through Power Filters
- Step6: Design Active power filters with considering various parameters like 2nd order LPF and cut off frequency etc.
- Step7:Alalyze the results by using Scope

3.4 Active Power Filter using SIMULINK

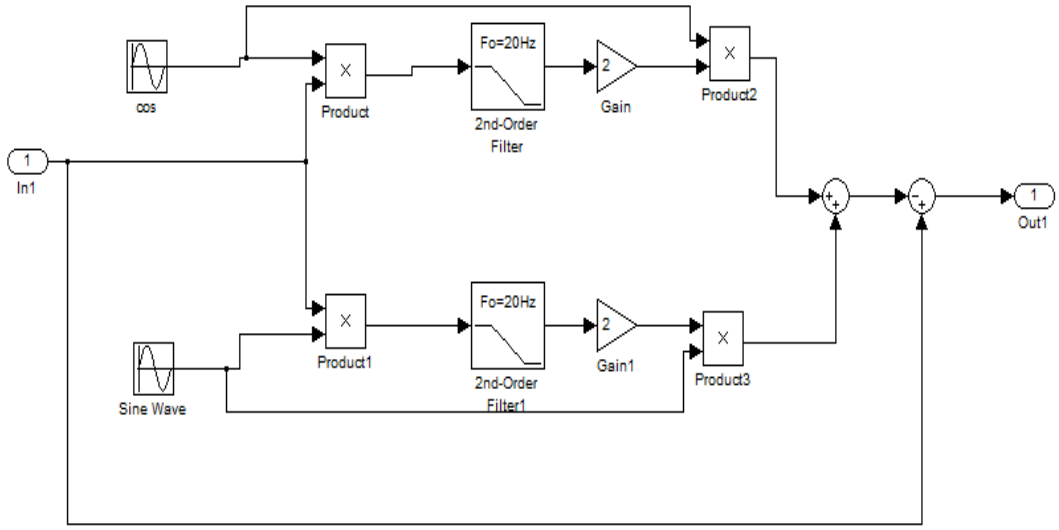

Fig 6: Simulink Design for APF

4. Results

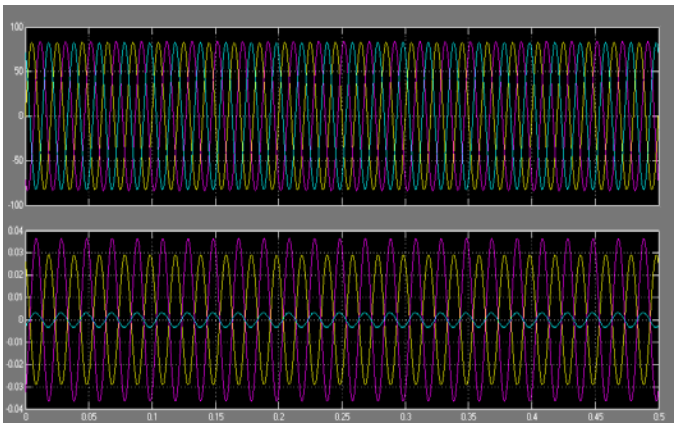

Fig 7: 3 phase voltage and current output

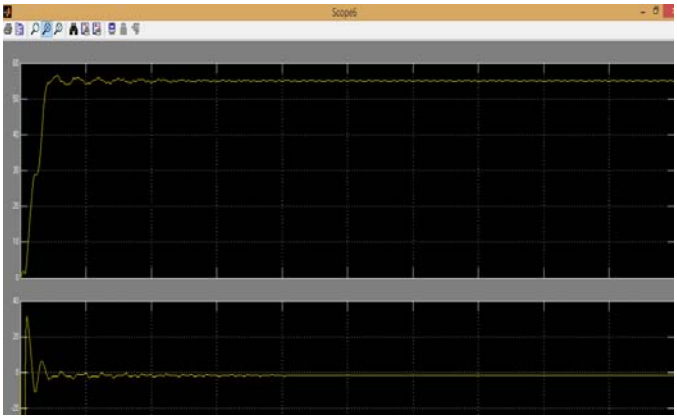

Fig 8: 3 phase sequence analysis

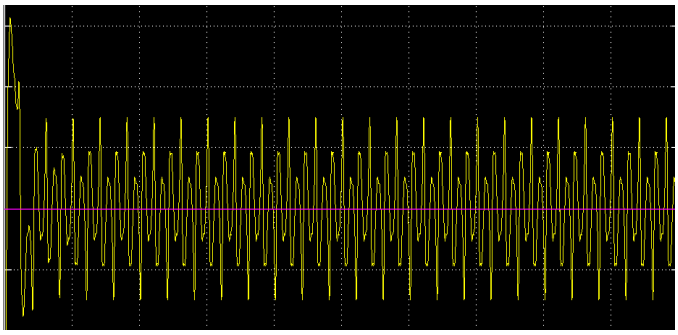

Fig 9: Output signal

Description: Above fig shows the output response for the Input signal after Active power filtering

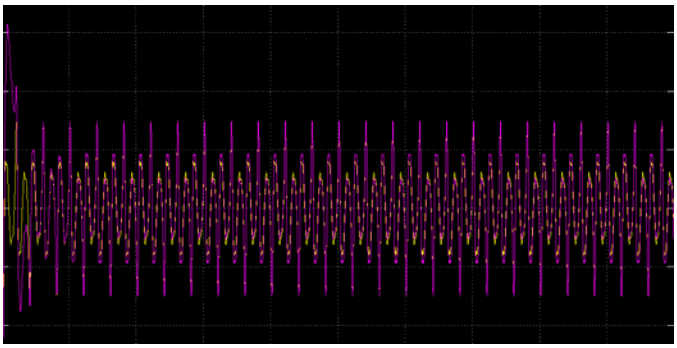

Fig 10: Merged input & Output signal

Description: Above figure shows the harmonics eliminated signal which is merged with original signal to show the difference.

5. Conclusion

In recent years there has been considerable concern over power quality, at both distribution and consumer levels, and the need to control reactive power and voltage stability at transmission levels.

Active filtering of electric power has now become a mature technology for harmonic and reactive power compensation in two-wire (single phase), three-wire (three phase without neutral), and four-wire (three phase with neutral) ac power networks with nonlinear loads.

The study reveals a simulation based architecture using MATLAB/SIMULINK for the APF with various performance evaluations.

In the future works a more advanced technique using Hybrid Active Power Filter (HAPF) may be proposed to reduce the harmonics combining the concepts of PF and APF.

6. References

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