ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

Multilevel Inverter Based Active Power Filter for Reactive Power Compensation and Harmonic Reduction in Distribution System

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ABSTRACT: This paper proposes a universal active filter with multilevel inverter for harmonics and reactive power compensation for single-phase systems applications. Sensitive loads are greatly affected by power-quality (PQ) disturbances in the system. The Increased NON-Linear loads todays life increase the distortion which causes Voltage Swell and sag. The increased reactive power, harmonics and unbalance cause an increase in line losses, instability and voltage distortion. The proposed system is based on the active filter connected series to the multilevel inverter without transformer. The possibility of harmonics and voltage swell is demonstrated by connecting the non-linear load from single-phase supply. It reduces the lower order harmonics and thus effectively reduces total harmonic distortion. Comparison between the closed loop and open loop are shown theoretically and the%THD, Reactive power are founded to be improved.

KEYWORDS: Non-Linear loads · Voltage swell · Total harmonic distortion · Universal active powers filter (UAPF)

I.INTRODUCTION

Sensitive loads are greatly affected by power-quality (PQ) disturbances in the system. The Increased NON-Linear loads todays life increase the distortion which causes Voltage Swell and sag. The strict requirement of power quality [1] at input ac mains and the output load in the area of power line conditioning is very important in power electronics. Different kind of topologies is used to improve the power quality. Thus, the problem grows rapidly for Single-Phase power (3-Phase) systems. The electric-grids at present using different Active and Passive filters in the series and parallel combinations. This paper proposes a [2] universal active power filter topology. It is a combination of rectifier and inverter. The rectifier connected as series and the inverter connected in parallel to the single-phase grid. The topology is without the Transformer. It is a two-levelpower conversion stage from AC-DC from rectifier and then DC-AC by inverter. The series active power filter (SAPF) provides load voltage control eliminating voltage disturbances, such as unbalance, sags, notches, flickers and voltage harmonics, so that a regulated fundamental load voltage with constant magnitude is provided to the load. The purpose of a [3-5] parallel active power filter (PAPF) is to absorb harmonic currents, compensate for reactive power and regulate the dc-bus voltage between both active filters. The universal active power filter (UAPF)which is a combination of both, is a versatile device that operates as series and [6] parallel active power filter. It can simultaneously fulfill different objectives like maintaining a sinusoidal voltage (harmonic free) at the load, source current harmonics elimination, load balance and power factor correction. For standardConfiguration, the series converter utilizes a transformer for isolation. The cost and size associated with the transformer makes undesirable such a solution, mainly for office and home environments. The improvement in the power electronic switches has the technical progress by enhanced numerical methods and more efficient control algorithms. The system considered here is a [7]-[9] UPFC model in Practical.

This paper proposes a 2-Level rectifier with a combination of 7-level inverter and without a transformer. Multilevel inverters are used for high-voltage applications. Their contribution is more superior to 2-level inverter due to reduction in harmonic distortion [10]-[11]. Seven level reduced switches topologyhas been

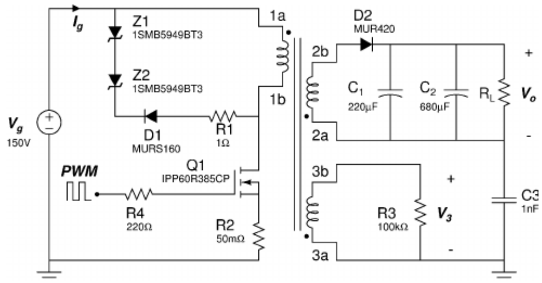

Fig. 1: Line model with Transformer and Converter Circuit

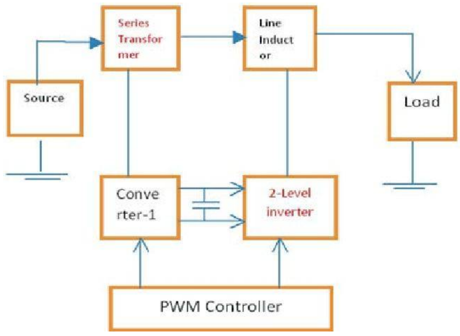

Fig. 2: Block Diagram of Existing Model

Implemented with only six switches. Fundamental Switching scheme and Selective Harmonics Elimination was implemented to reduce the Total Harmonics Distortion (THD) value. Selective Harmonics Elimination Stepped Waveform (SHESW) method is implemented to eliminate the lower order harmonics [12]. Fundamental switching scheme is used to control the power electronics switches in the inverter. The harmonic reduction is achieved by selecting appropriate switching angles. It Shows hope to reduce initial cost and complexity hence it is apt for industrial applications. The steady-state analysis is also presented in order to demonstrate the possibility to obtain an optimum voltage angle reducing the current amplitude of both series and parallel converters and, consequently, the total losses of the system. The operation principle, control strategy, steady-state analysis, simulated and experimental results are presented to validate the theoretical considerations[13].

II. METHODOLOGY

Existing System Module: The existing block diagram consisting of Transformer, Rectifier, Inverter. Transformer is placed in series in the single phase grid. Primary is connected to the grid, secondary is connected to the filter and filter is connected to rectifier and inverter combination. A capacitor is placed between the rectifier and inverter. Rectifier is connected in series to line and the inverter is connected parallel to line.

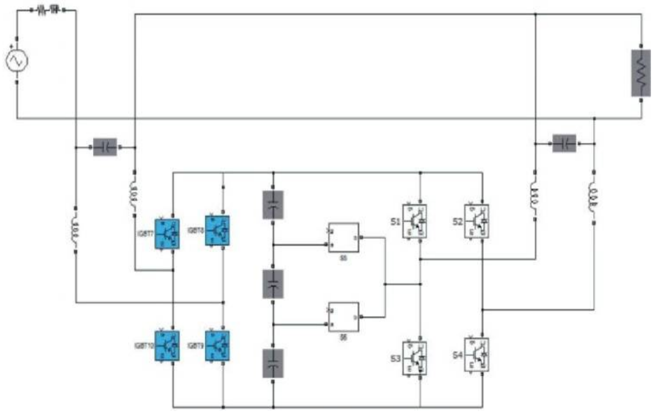

Fig. 3: Line Model with Multi-Level inverter

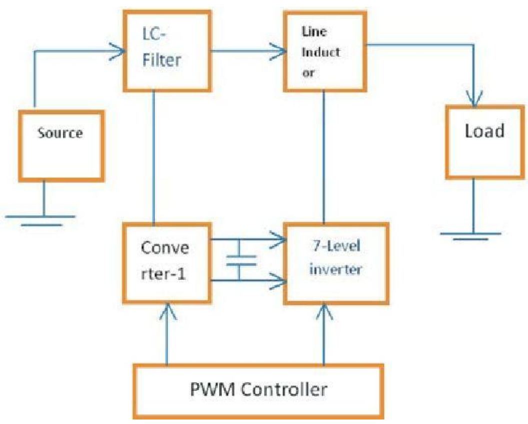

Fig. 4: Block Diagram of Proposed Model

Proposed System Module: The proposed system module consists of LC- filter, Rectifier, 7-level inverter.7 -level inverter consists of 6-switches which are formed by using new reduced multilevel inverter topology, the reduction in the number of power electronic components. This new topology will improve the efficiency of the inverter which improvises the reduction of Harmonics as the level of inverter increases, the output waveform will be near to the sinusoidal.The modification is the LC-filter is replacing the series transformer and the 7-level inverter replacing the 2-level inverter. Those changes are highlighted in the block diagram. The series rectifier is fed with the AC voltage from the Single-Phase Grid, the inverter is connecting parallel to the grid.

III.RESULTS AND DISCUSSIONS

Existing System Model: Existing system model is a Line model with Transformer and Converter Circuit Model

The source voltage of the system is 230v AC and is Step downed by using a transformer from the single-phase grid. The waveform is assumed to be pure sinusoidal.
The real and reactive power are get distorted at 0.4sec.at that time we are introducing non-linear load which cause disturbance in system. The values of real and reactive power are 133.2w,20.96var respectively

THD is a harmonic measurement of the signal. The fundamental frequency to the magnitude of the order frequencies.

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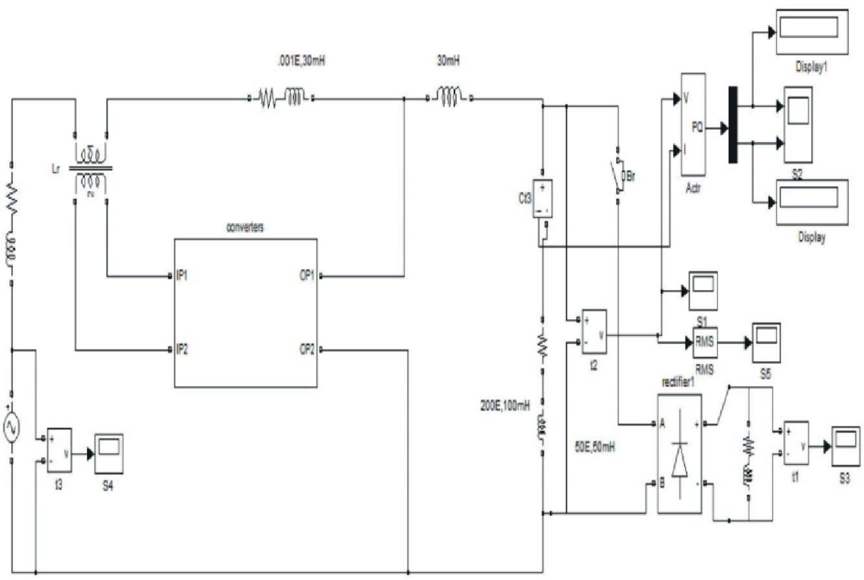

Fig. 5: Simulink Model of Existing System

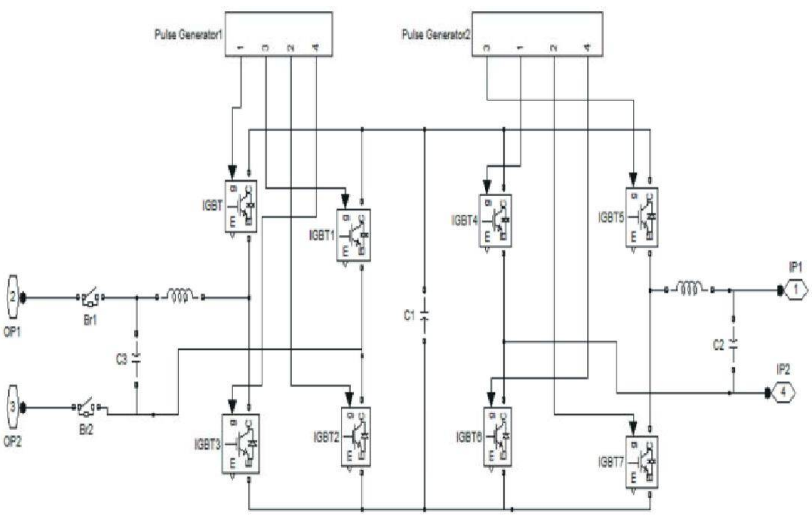

Fig. 6: Converter Model of Existing System

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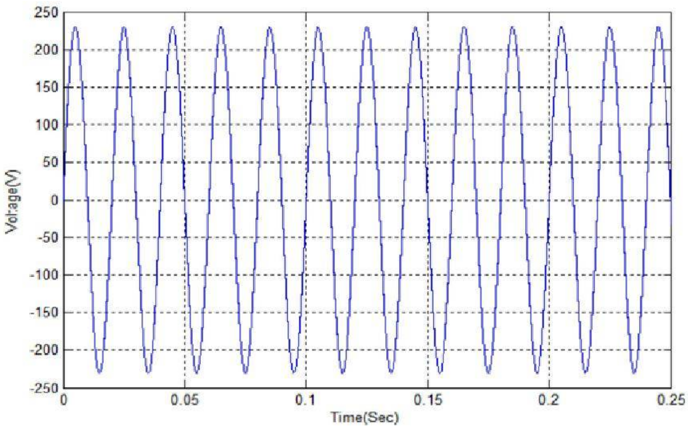

Fig. 7: Source Voltage vs Time of the existing system

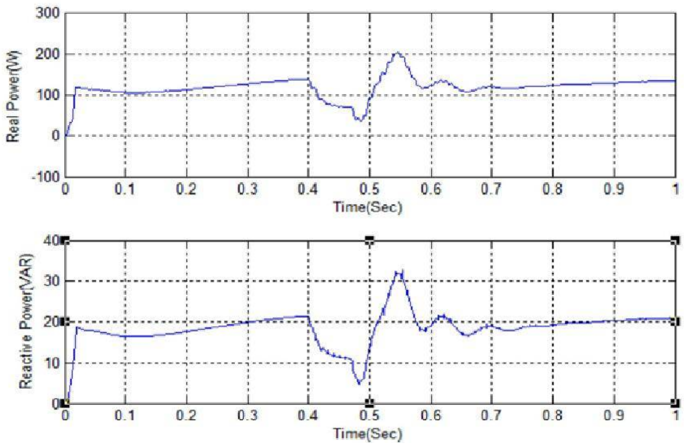

Fig. 8: Real and Reactive Power vs Time in Existing Model

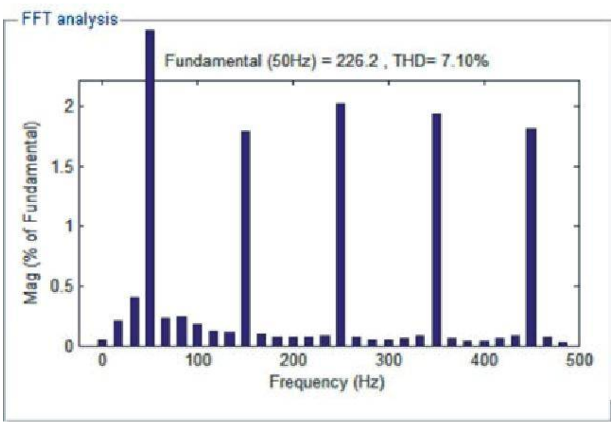

Fig. 9: THD content of Existing System

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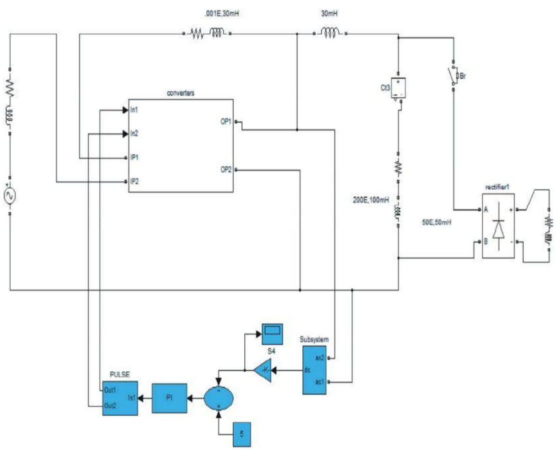

Fig. 10: Simulink Model of Proposed System Model

Proposed System Model: Proposed system model is a transformer less multilevel inverter based active power filter. The system consists PI controller closed loop to regulate the voltage the converter circuit is connected to closed loop for voltage regulation.

The source voltage of the system is 230v AC and is Step downed by using a transformer from the single-phase grid. The waveform is assumed to be pure sinusoidal The real and reactive power are get distorted at 0.4sec.at that time we are introducing non- linear load which cause disturbance in system. The values of real and reactive power are 142.2w,22.34var respectively THD is optimized, that we can notice from above analysis compared with the existing system.THD content reduction is achieved by using controller circuit, which maintains the voltage constant by comparing with reference value 5.

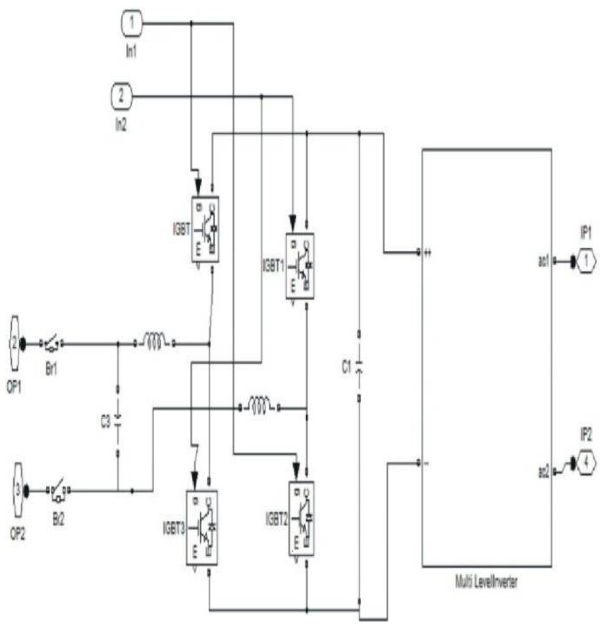

Fig. 11: Converter Model of Proposed System

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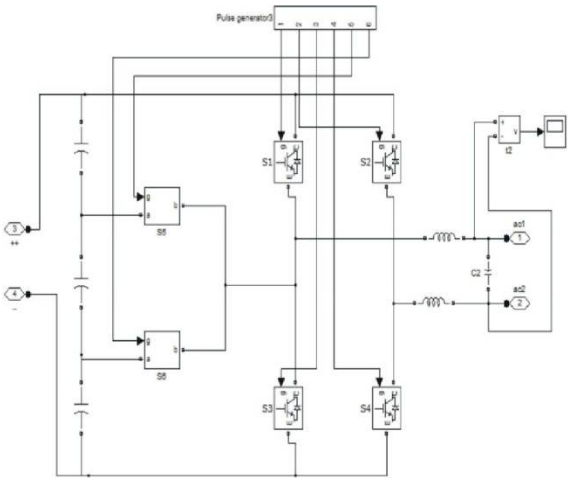

Fig. 12: Multi-Level inverter model of Proposed System

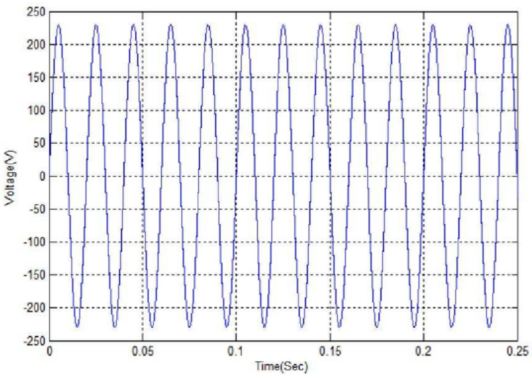

Fig. 13: Source Voltage vs Time of Proposed System

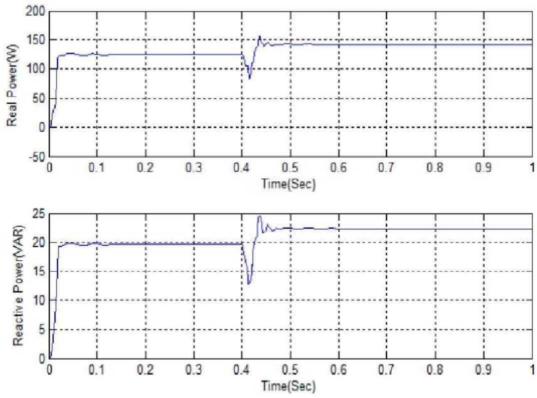

Fig. 14: Real and Reactive power vs Time of Proposed System

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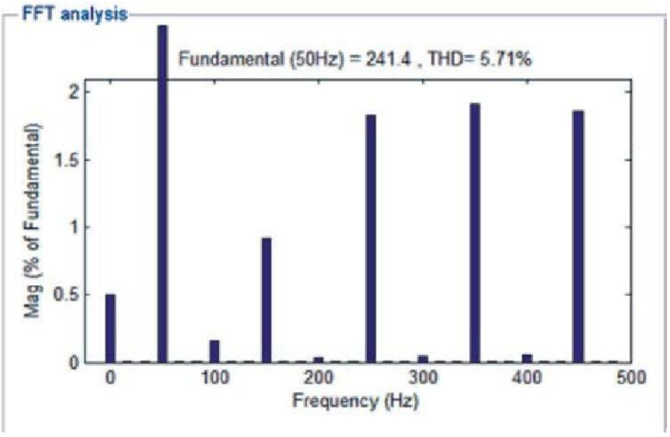

Fig. 15: THD content of Proposed System

Table: Comparison of Existing &Proposed method				
	Existing method (Open loop)		Proposed Method (Closed loop)	
		With Transformer	Without transformer	Without transformer
Parameter	Line Model	4-Switches	2-Level inverter 4Switches	multi-Level inverter 6-Switches
Input Voltage (V)	230V	230V	230V	230V
Real Power (Watts)	124.4	133.2	140.3	142.2
Reactive power (VAR)	19.5	20.96	22.03	22.34
%THD Content	9.20	7.10	6.76	5.71

IV.CONCLUSION

In the existing system we are using the two-level inverter with 4-Switch topology. We can see the results of THD content is reduced from 7.10 to 5.71 and the percentage of reduction is 19.57% from the above table. The Reactive power injection is improved from 20.96 to 22.34 and by percentage of 6.71%. The results are compared in the above table. So, by using Multi-level inverter in UPFC model will improve Reactive Power Injection and reduce THD content.

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