Harmonics Elimination in Power Generation Using Active Power Filter

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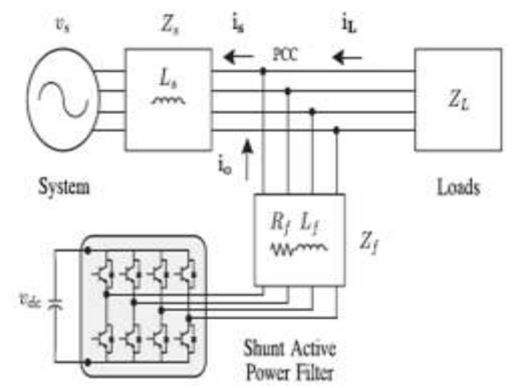
***Abstract*- In distribution systems, the load has been a sudden increase or decreases and it is like as nonlinear loads so the load draw non-sinusoidal currents from the AC mains and causes the load harmonics and reactive power, and excessive neutral currents that give pollution in power systems. Most pollution problems created in power systems are due to the nonlinear characteristics and fast switching of power electronic devices. Shunt active filter based on current controlled PWM converters are seen as a most viable solution. This paper presents the harmonics and reactive power compensation from 3P4W micro-grid distribution system by IP controlled shunt active. The technique which is used for generate desired compensation current extraction based on offset command instantaneous currents distorted or voltage signals in the time domain because compensation time domain response is quick, easy implementation and lower computational load compared to the frequency domain.**

***Index terms*- micro grid, level inverters, renewable energy sources**

I.INTRODUCTION

Renewable generation affects power quality due to its nonlinearity, since solar generation plants and wind power generators must be connected to the grid through high-power static PWM converters [1]. The non-uniform nature of power generation directly affects voltage regulation and creates voltage distortion in power systems. This new scenario in power distribution systems will require more sophisticated compensation techniques. Although active power filters implemented with three-phase four-leg voltage-source inverters (4L-VSI) have already been presented in the technical literature [2]–[6], the primary contribution of this paper is a predictive control algorithm designed and implemented specifically for this application. Traditionally, active power filters have been controlled using pre tuned controllers, such as PI-type or adaptive, for the current as well as for the dc-voltage loops [7], [8]. PI controllers must be designed based on the equivalent linear model, while predictive controllers use the nonlinear model, which is closer to real operating conditions. An accurate model obtained using predictive controllers improves the performance of the active power filter, especially during transient operating conditions, because it can quickly follow the current-reference signal while maintaining a constant dc-voltage. So far, implementations of predictive control in power converters have been used mainly in induction motor drives [9]–[16].

In the case of motor drive applications, predictive control represents a very intuitive control scheme that handles multivariable characteristics, simplifies the treatment of dead-time compensations, and permits pulse-width modulator replacement. However, these kinds of applications present disadvantages related to oscillations and instability created from unknown load parameters [15]. One advantage of the proposed algorithm is that it fits well in active power filter applications, since the power converter output parameters are well known [17]. These output parameters are obtained from the converter output ripple filter and the power system equivalent impedance. The converter output ripple filter is part of the active power filter design and the power system impedance is obtained from well-known standard procedures [18], [19]. In the case of unknown system impedance parameters, an estimation method can be used to derive an accurate R–L equivalent impedance model of the system [20]. This paper presents the mathematical model of the 4L-VSI and the principles of operation of the proposed predictive control scheme, including the design procedure. The complete description of the selected current reference generator implemented in the active power filter is also presented. Finally, the proposed active power filter and the effectiveness of the associated control scheme compensation are demonstrated through simulation and validated with experimental results obtained in a 2 kVA laboratory prototype.



II. METHODOLOGY

The fundamental goal of static power converters is to deliver an air conditioner output waveform from a dc power supply. These are the kinds of waveforms required in customizable speed drives (ASDs), uninterruptible power supplies (UPS), static var compensators, active filters, adaptable air conditioning transmission systems (FACTS), and voltage compensators, which are just a couple of uses. For sinusoidal air conditioning outputs, the size, frequency, and phase should be controllable. As per the kind of air conditioning output waveform, these topologies can be considered as voltage source inverters (VSIs), where the autonomously controlled air conditioning output is a voltage waveform.

$$\text{THD} = \frac{\sqrt{V^2{}_2 + V_3{}^2 + V_4{}^2 \ldots\ldots V_n{}^2}}{V_1}$$

FOUR-LEG CONVERTER MODEL

Fig. 4 shows the configuration of a run of the mill power distribution system with inexhaustible power generation. It comprises of different kinds of power generation units and distinctive sorts of loads. Inexhaustible sources, such as wind and sunlight, are ordinarily used to generate power for private clients and little enterprises. Both sorts of power generation utilize air conditioning/air conditioning and dc/air conditioning static PWM converters for voltage change and battery banks for long haul vitality stockpiling. These converters perform most extreme power direct following toward concentrate the greatest vitality conceivable from wind and sun. The electrical vitality utilization behavior is random and eccentric, and therefore, it might be single-or three-phase, adjusted or unequal, and straight or nonlinear. An active power filter is associated in parallel at the purpose of common coupling to remunerate current harmonics, current unbalance, and reactive power. It is formed by an electrolytic capacitor, a four-leg PWM converter, and a first-arrange output ripple filter, as shown in Fig. 1.2. This circuit considers the power system proportionate impedance Zs, the converter output ripple filter impedance Zf, and the load impedance ZL.

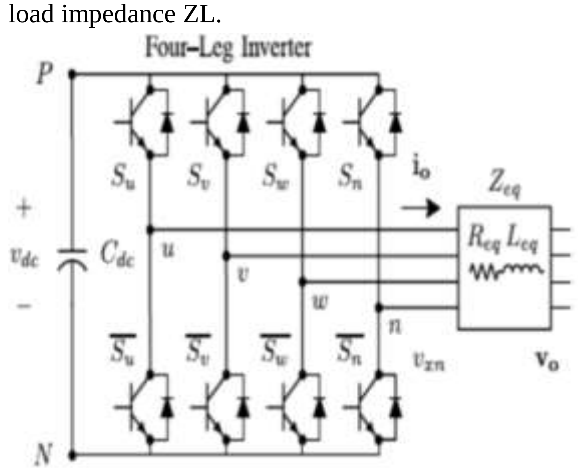


Fig. Two-level four-leg PWM-VSI topology.

The four-leg PWM converter topology is shown in Fig. 5.1. This converter topology is like the conventional three-phase converter with the fourth leg associated with the impartial bus of the system. The fourth leg expands switching states from 8 (23) to 16 (24), enhancing control adaptability and output voltage quality, and is reasonable for The voltage in any leg x of the converter, measured from the neutral point (n), can be expressed in terms of switching states, as follows:

$V_{xn} = S_x - S_n V_{dc}$, x = u, v, w, n (1)

The mathematical model of the filter derived from the equivalent circuit

$v_{o} = v_{xn} - R_{eq}\, i_o - L_{eq} \frac{dio}{dt}$ (2)

Where Req and Leq are the 4L-VSI output parameters communicated as Thevenin impedances at the converter output terminals Zeq. Therefore, the Thevenin proportional impedance is dictated by a series association of the ripple filter impedance Zf and a parallel course of action between the system equal impedance Zs and the load impedance ZL

$$Z_{eq} = \frac{Z_s Z_L}{Z_s Z_L} + Z_f \approx Z_s + Z_f \qquad (3)$$

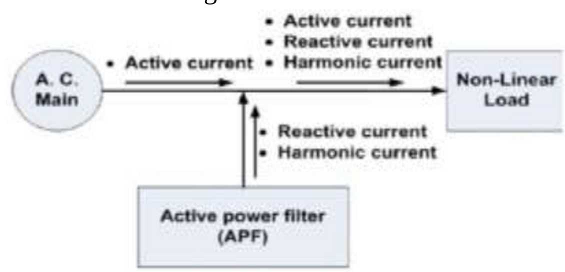
For this model, it is expected that ZL »Zs, that the resistive piece of the system's comparable impedance is ignored, and that the series reactance is in the scope of 3– 7% p.u., which is a satisfactory guess of the genuine system. At long last, in (2) $R_{eq} = R_f$ and $L_{eq} = L_s + L_f$

ACTIVE POWER FILTERS AS SOURCE CONVERTERS

The active power filter topologies are often used as a voltage source converters. The topology depicted in Figure 1, converts a dc voltage into an ac voltage by appropriately gating the power semiconductor switches. A single pulse for each half cycle can be applied to synthesize an ac voltage. For the purposes of dynamic performance, pulse width modulation is the most commonly used in active power filter. PWM techniques are applied to control the VSI that chop the dc bus voltage to produce an ac voltage of an arbitrary waveform.

Voltage source converters are preferred because have higher efficiency and lower initial cost than the current source converters [3, 4, 9-11]. They can also be expanded in parallel to increase their combined rating and their switching rate can be increased if they are carefully controlled so that their individual switching times do not coincide.

Therefore, higher-order harmonics can be eliminated by using converters without increasing individual converter switching rates.



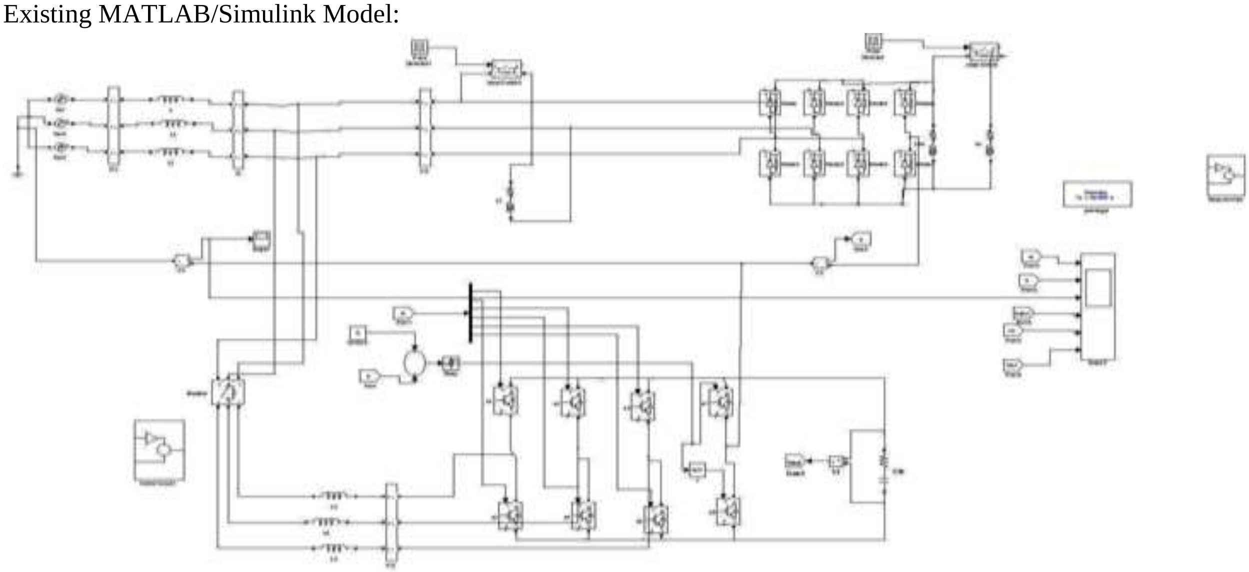
IV. RESULTS

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include-

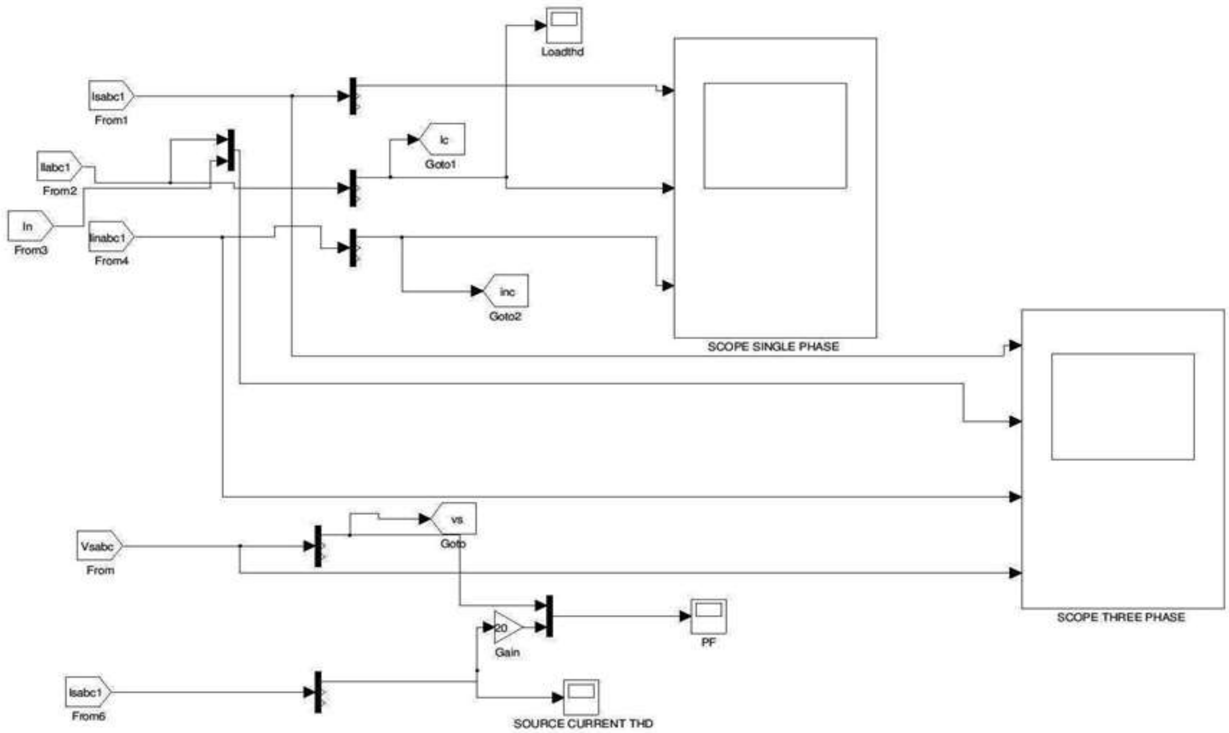
- Math and computation
- Algorithm development
- Data acquisition
- Modelling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows solving many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or FORTRAN.

Existing MATLAB/Simulink Model:

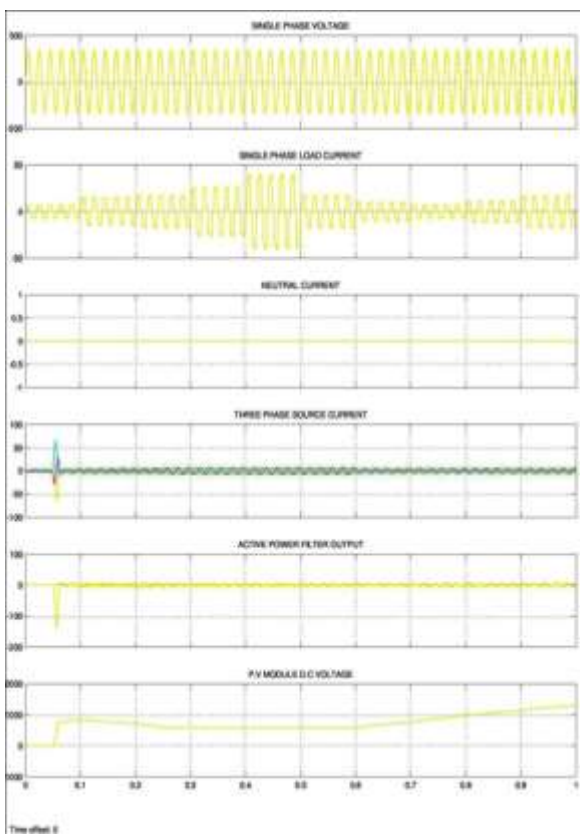


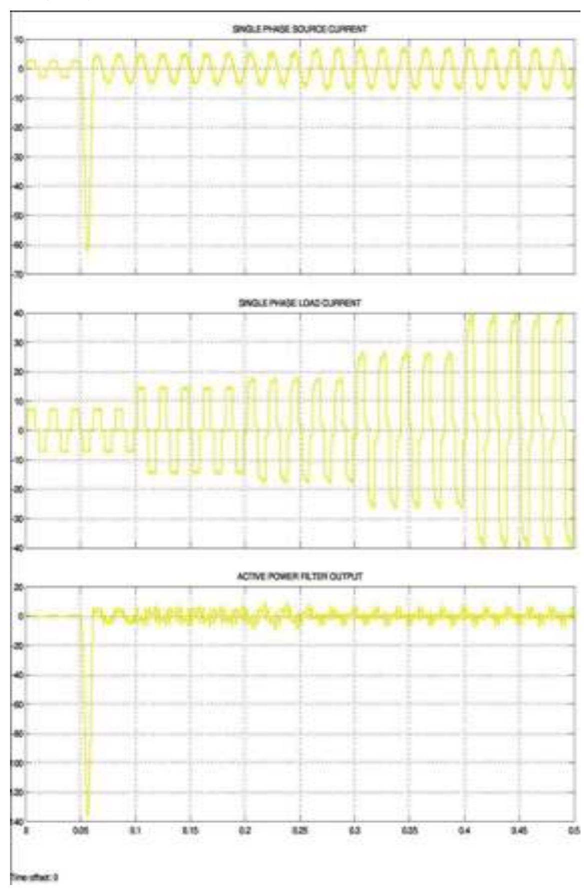
Proposed Model In Simulink

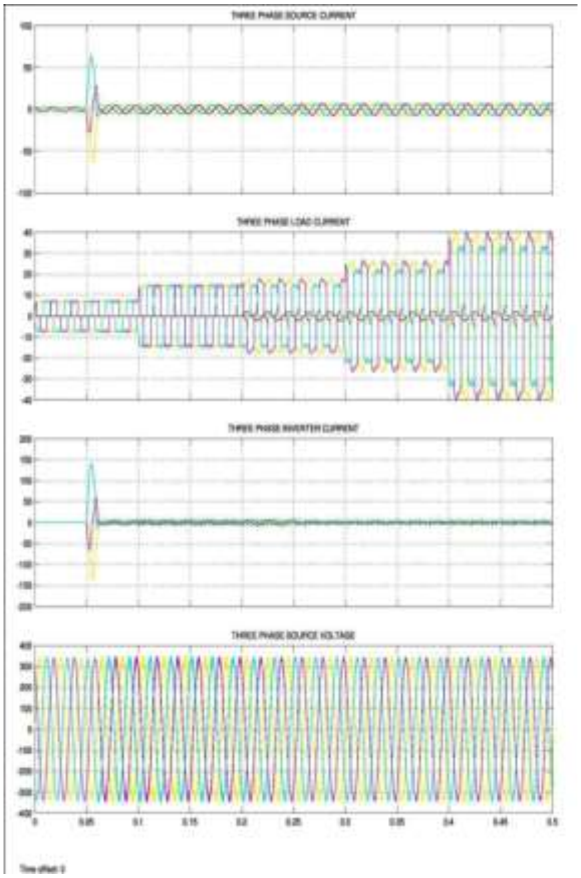


Measurement Model in Simulink

OUTPUT WAVE FORMS RESULT







V. CONCLUSION

Improved system performance is observe red after the introduction of P.V module as an input to active power filter which includes the compensation of reactive power, and current harmonics by numerically reducing the total harmonic distortion of the source current from 30% to 6% on average. Resulting in surge of the quality of power in distribution system to a good extent. The predictive algorithm is proved a better alternate to conventional converters in handling nonlinear and unbalanced load because of its simplicity.

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