FUZZY LOGIC CONTROL OF A THREE PHASE FOUR-WIRE FOUR-LEG ACTIVE POWER FILTER

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ABSTRACT:

The focus of this study is on the performance analysis and design parameters of a Four-Leg based Three-Phase Four-Wire Shunt Active Power Filter (4L3P4W SAPF). To supply electricity to single-phase and/or three-phase loads, the 3P4W electrical distribution system has been widely employed. Harmonics, reactive power load, imbalanced currents, and excessive neutral current are all caused by them. These issues worsen system losses, decrease system effectiveness, and lower power quality. The 3P4W system uses a four-wire shunt active power filter to address these problems. This study simulates a 3P4W shunt active power filter that is based on the p-q theory of instantaneous reactive power and the synchronised reference frame theory. PSIM Version 9.0 was used for all simulation.

Keywords: SPV, IM, MPPT, INC, PMSM, P&O.

1. INTRODUCTION

Numerous researchers are working to increase the quality of the power for various systems, aspects, and regulating systems. The author of this paper put forth a method for managing a shunt active filter for a nonlinear load that is variable in nature. In this essay, the author put out a controlling method that is more precise than an earlier one. The proposed model uses fuzzy logic with a PLL-based shunt active filter. For the proposed three phase, four wire system, a three phase, four leg voltage source inverter is used. The gate signal, which regulates the injected current to reduce harmonic current by a shunt active filter, is fed by various controlling actions, including fuzzy logic with PLL-based controller, hysteresis current controller, and reference current generator. the output of the fuzzy logic controller is then given to the reference current generator, where reference current is generated in the presence of source voltage and load current, is then input to the hysteresis current controller, where it is compared with actual current and gives the gate signal to voltage source inverter, and according to this signal the voltage source inverter will operate. This reduces the harmonic current and enhances the harmonic current reduction side of our power quality. For the purpose of supplying low level voltage in modern buildings such as homes, offices, manufacturing facilities, schools, etc., three phase four wire distribution power systems are frequently used. The typical loads connected to the three phase, four wire power system may be reasonable single phase non-linear loads like switch-mode power supplies in computer equipment, inverter air conditioners, and other power electronic-related facilities, or reasonable three phase non-linear loads like motor drives, power electronics loads, large Uninterruptible power supplies. These loads share a nonlinear input or unbalanced characteristic that could lead to high input current harmonics and extremely high neutral current, among other issues. The persistence of current harmonics in power systems raises line losses, lowers power factor, and introduces timing problems in delicate electronic apparatus. Positive-sequence harmonic currents and negative-sequence harmonic currents are produced by balanced three-phase non-linear loads. However, third order zero sequence harmonic currents are produced by single phase non-linear loads that are connected phase to neutral in a three phase, four wire system. However, In three phase, four wire systems, instantaneous reactive power approaches for harmonic detection require phase-locked-loop (PLL), low-pass filter, and multiple coordinate transformation.

Literature review

Many researchers have worked on controlling shunt active filters and harmonic reduction techniques to improve power quality. The list below includes some of the research related to improving power quality.

Patil et al (2017) The generalised instantaneous power theory for the generation of reference current is presented in this study. The primary concern for the controlling function of a shunt active filter is the reference current. This theory states that for systems with active and reactive components, three phase quantities can be converted into two phase quantities. Generalized instantaneous reactive power theory's fundamental conclusion is used to rectify the power factor in three-phase circuits.

Gotherwal and others (2016) The primary goal of this essay was to distinguish between direct current control and indirect current control methods. using the direct current control method Clarke's transformation transforms the phase components of voltage and current into the alpha beta components. The instantaneous active reactive power components are implied by this two axis frame-based coordinate system. The direct component and the oscillating component are the two parts that make up this power. With the aid of a low pass filter (LPF) with feed forward effect, these components are separated to distinguish the harmonics from the fundamentals of the load currents. The fundamental power formula was then used to compute the reference current. Comparatively to the direct current control technique, the indirect current control technique is easier to use, offers greater performance, and requires less hardware. In this method, the source currents are used as benchmark currents for comparison. Only the average active power component passes through the control scheme, and the reactive power component is zero. Next, switching signal is obtained.

Kumar et al (2016) In this study, reference values are obtained using a unit vector template based on a PLL. Phase input voltage is unitized by multiplying with a gain factor equal to its peak amplitude, then sent through a phased-locked loop to achieve the correct phase delay. Unit vector templates are different for each phase. By multiplying the unit factor with a unit magnitude equal to the peak load voltage, reference load voltages can be calculated.

4. Udayasri and co. (2016) This paper explains the operation of a DC link capacitor. To totally reduce the harmonics, the DC-capacitance capacitor's is regulated. This is accomplished by setting the capacitor's capacitance to a value that totally eliminates harmonics, which necessitates compensating for both active and reactive load power. However, eliminating the active load power will cause the dc-

voltage capacitor's to be distorted. As a result, the dc-capacitor absorbs the active load power and reduces voltage fluctuation.

2. A SUMMARY OF THE PROPOSED SYSTEM

Since solar-powered age plants and wind-powered age generators must be connected to the lattice through high-control static PWM converters, sustainable age has an impact on control quality [1]. The fact that intensity ageing is not uniform directly affects voltage standards and causes voltage tampering in power systems. Power conveyance frameworks will need increasingly sophisticated compensation techniques to deal with this new circumstance. Although three-stage four-leg voltage-source inverters (4L-VSI) used in dynamic power channels have just recently been shown in specialist writing [2]–[6], the fundamental commitment of this effort is a foresight control calculation constructed and carried out specifically for this application. Dynamic power channels have traditionally been controlled using pre-tuned controllers, such as PI-type or flexible, for both the current and the dc-voltage circular [7], [8]. While prescient controllers use the nonlinear model, which is closer to actual working conditions, PI controllers must be structured based on the same straight model. Since it can quickly follow the current-reference flag while maintaining a constant dc voltage, an exact model acquired with prescient controllers enhances the performance of the dynamic power channel, especially under transient working situations. Executions of foresight control in power converters have primarily been used in recruitment engine drives up until this time [9]– [16]. Prescient control refers to an exceedingly instinctive control scheme that manages multivariable attributes, reorganises the handling of dead-time pay, and permits beat width modulator substitution due to engine drive applications. However, these uses come with issues related to movements and flimsiness due to ambiguous burden parameters [15]. The suggested calculation has the advantage of fitting well in applications involving dynamic power channels since the power converter yield parameters are significant [17]. These yield characteristics are obtained from the power framework proportional impedance and the converter yield swell channel. The dynamic power channel plan includes the converter yield swell channel, and the power framework impedance is calculated using a widely accepted standard methodology [18], [19]. Due to ambiguous framework impedance characteristics, an exact R-L identical impedance model of the framework can be determined by using an estimating technique [20]. This assignment introduces the 4L-VSI numerical model and the suggested foresight control conspire's activity standards, including the structure system. Additionally shown is the whole representation of the selected current reference generator as it appears in the dynamic power channel. Finally, the viability of the linked and the suggested dynamic power channel.

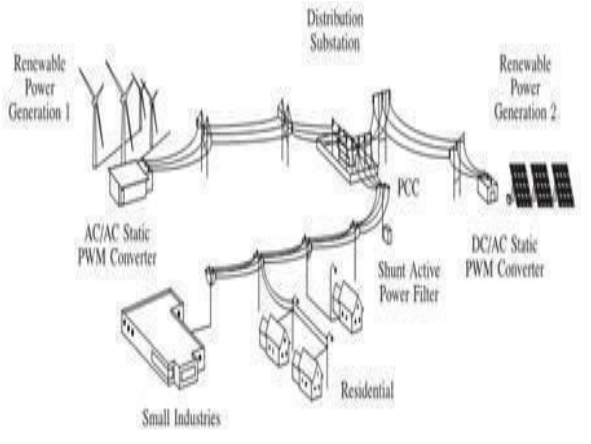

Fig.1. Block diagram.

FOUR-LEGCONVERTERMODEL

The configuration of a typical power delivery system with sustainable power age is shown in Fig. 1. It consists of many types of burdens and various intensity age units. Renewable energy sources like wind and sunlight are frequently used to generate electricity for residential customers and small businesses. The two types of intensity ages use battery banks for long-term energy storage and air conditioning/air conditioning and dc/air conditioning static PWM converters for voltage transformation. These converters carry out the best power conversion process in order to focus the maximum amount of wind and solar energy. Because the electrical energy conduct is eccentric and erratic, it may be single- or three-stage, level or uneven, straight or nonlinear. For the aim of normal coupling, a functional force channel is connected in parallel to compensate for current sounds, current unbalance, and receptive power. As shown in Fig., it is made up of an electrolytic capacitor, a four-leg PWM converter, and a first-request yield swell channel. The power framework equal impedance Zs, the converter yield swell channel impedance Zf, and the heap impedance ZL are all taken into account by this circuit. Fig. 3.3 shows the four-leg PWM converter topology. This converter topology is similar to the conventional three-stage converter with the addition of a fourth leg for the framework's impartial transit. The fourth leg improves control adaptability and yield voltage quality [21], changes states from 8 (23) to 16 (24), and is reasonable for the present lopsided pay.

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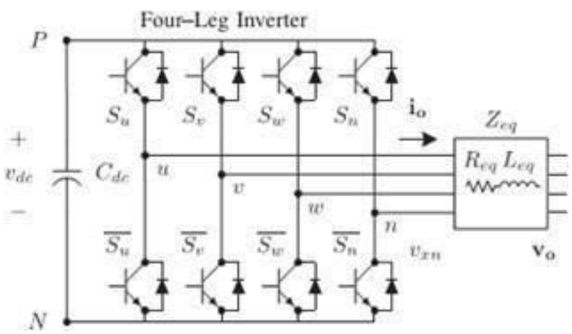

Fig.2. Four leg 3 phase inverter.

SIMULATION RESULTS:

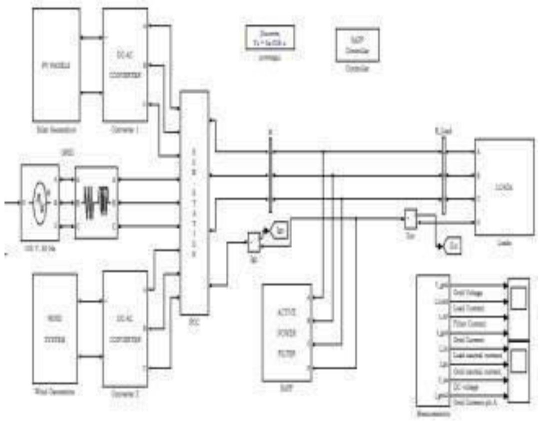

Fig 3. Hybrid power generation system with a shunt active power filter.

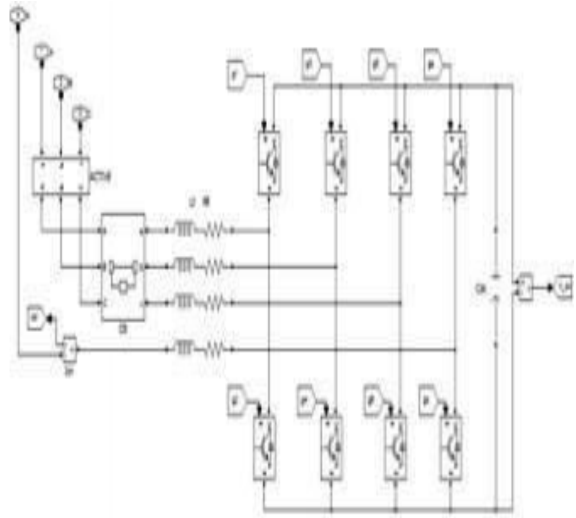

Fig 4. circuit of the proposed shunt active power.

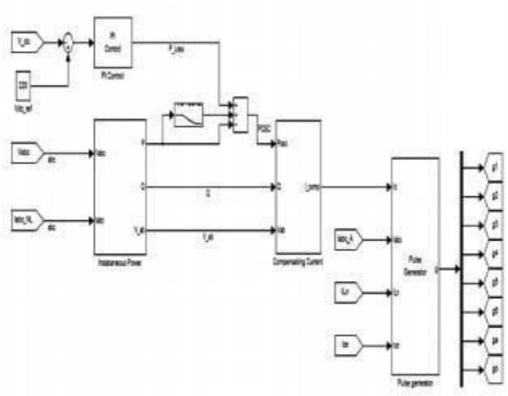

Fig 5. dq-based PI currentcontroller.

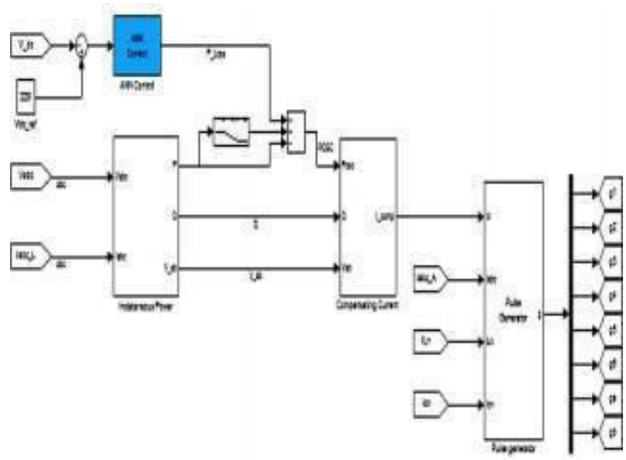

Fig 6. ANN based current controller.

The Schematic description The control plot is acknowledged by theANN-based current controller in Figure

11. The actual capacitor voltage is compared to a predetermined reference value. The ANN controller receives the error flag. The ANN controller's yield has been regarded as the best estimate of reference current. In order to obtain the reference currents, it is also duplicated by the unit sine vectors (USA, USB, and USC) in stage with the source voltage (isa,isb,isc). To produce the exchanging signs of the PWM converter, these reference flows and real flows are fed into a hysteresis-based, bearer-less PWM current controller. Activity switches are selected based on the contrast between reference current layout and real current.

TABLE-1. %THD of Source Currents using PI And ANN Controllers

Controller	Nonlinear Load1	Nonlinear Load2	Unbalanced Load3
PI	2.53%	4.18%	2.75%
ANN	1.04%	2.97%	1.75%

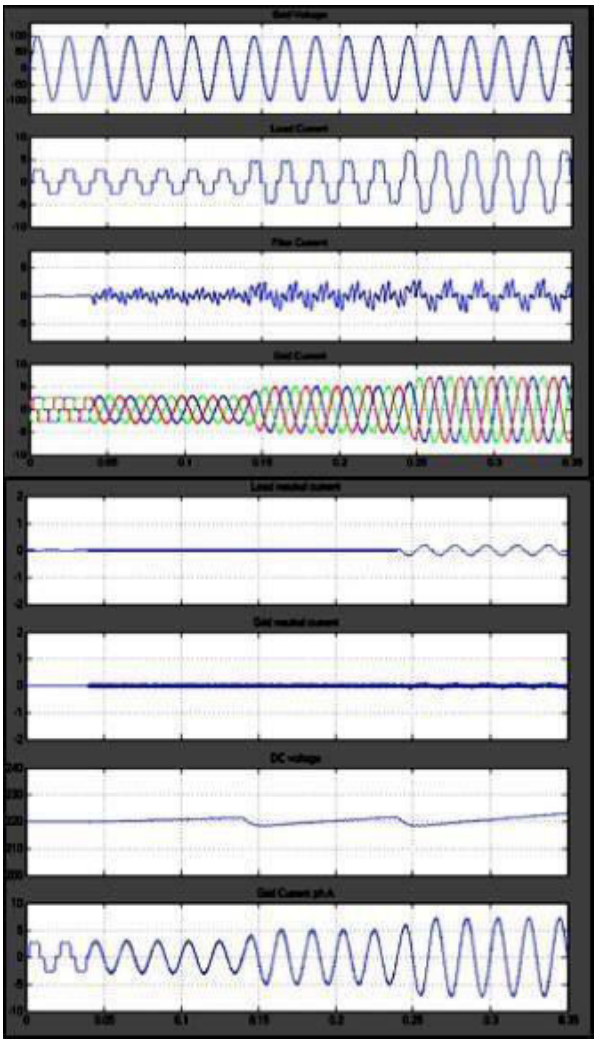

Fig 7. Simulated waveforms of the proposed control scheme (a) Phase to neutral source voltage (b) Load Current (c) Active power filter output current (d) Load neutral current (e) System neutral current (f) System currents. (g) DC voltage converter (h) grid current

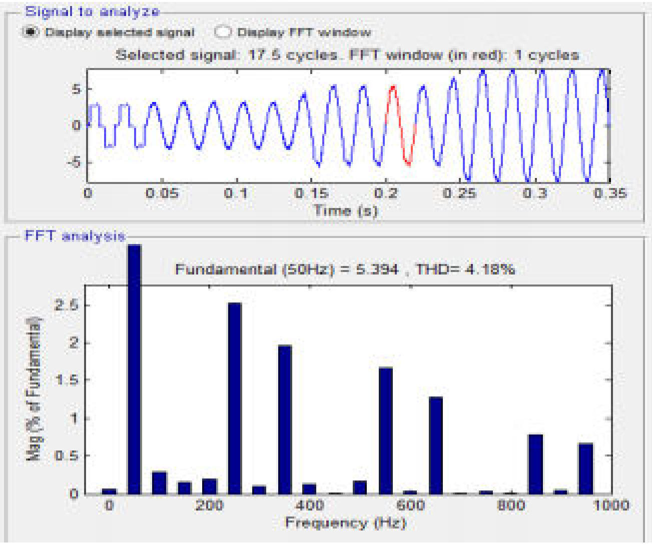

Fig 8. %THD using PI controller.

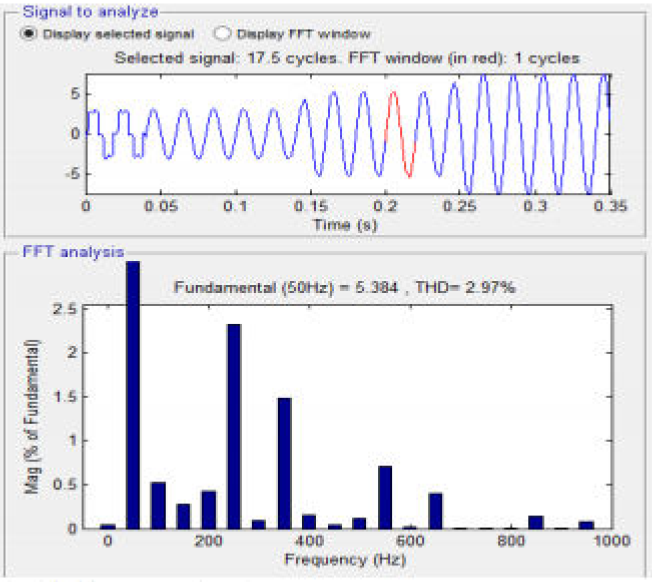

Fig 9. % THD using ANN controller.

3. CONCLUSION

The dynamic power channel built on a free-forward ANN controller has been updated in MATLAB/Simulink. The several results are given to show the versatility of the intended ANN controller. Dynamic power channels using PI controllers have a source current THD of 4.18 percent, whereas those using ANN controllers have a source current THD of 2.97 percent. Under various nonlinear load situations, the constructed ANN controller for dynamic power channel is tested, and its numerical results are listed in the table. By eliminating sounds and compensating for non-straight loads with receptive power, the dynamic power channel improves the power nature of the appropriation framework.

Therefore, it can be concluded from the results of the recreation that ANN controller is more effective than PI controller.

4. REFERENCES

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