PARAMETER OPTIMIZATION OF FOUR LEG MULTILEVEL CONVERTER USING CURRENT LOOP CONTROL STRATEGY

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Abstract: *The MATLAB/SIMULINK environment was used to complete the modelling. The four-legged inverter model's output findings have been examined, and the control algorithm has been put into practise. An inner control loop controller for improving power quality in a stand-alone power supply system based on a four-leg voltage-source inverter with an output LC filter has been developed in this study. There are two main components to the suggested control scheme. MLIs greatly outperform conventional two level inverters in terms of better output quality, increased efficiency, less harmonic issues, and decreased switching pressures*

Keywords: Inverters, Diode, Capacitors, DC, AC.

I. INTRODUCTION

MLIs greatly outperform conventional two level inverters in terms of better output quality, increased efficiency, less harmonic issues, and decreased switching pressures [1-6]. The two most popular single-phase inverter topologies used for grid connection are half-bridge and full-bridge. Power electronics in half and full bridge inverters switch as a result of their extremely high frequency operation. The conduction losses of a switch are influenced by how much power it can take. Switching loss is influenced by the voltage across the switch, the current passing through it, and the switching frequency. This is when MLIs start to matter. They can reduce the voltage jump that happens during each switching operation, which will increase efficiency and reduce losses in a commendable way.In contrast to half-bridge and full-bridge inverters, MLIs use more parts and switches. Therefore, complexity and performance should be taken into account when building MLIs. It benefits from a smaller filter inductor and lower switching harmonics compared to conventional half-bridge and full-bridge inverters. [7-9].

By connecting it to an inverter, an inverter converts a DC source into AC power in its circuit. inverter basics, inverter basics, inverter basics, and introduction to inverters.

Half and full bridge inverters' power electronics switch as a result of their very high frequency operation. The amount of power a switch can handle affects the conduction losses of that switch. The voltage across the switch, the current flowing through it, and the switching frequency all affect switching loss. MLIs become important at this point. They can lessen the voltage jump that occurs during each switching operation, resulting in an admirable improvement in efficiency and a decrease in losses. Comparing MLIs to half-bridge and full-bridge inverters, additional components and switches are employed. Therefore, when constructing MLIs, complexity and performance should be taken into consideration. In contrast to traditional half-bridge and full-bridge inverters, it benefits from a smaller filter inductor and lower switching harmonics.DC power is used as an input. The application determines the value of the input voltage. While some applications only need 12 volts, others may need thousands of volts of very high power.

Figure 1. **A Model of Inverter**

A. Classification of Power Electronic Devices

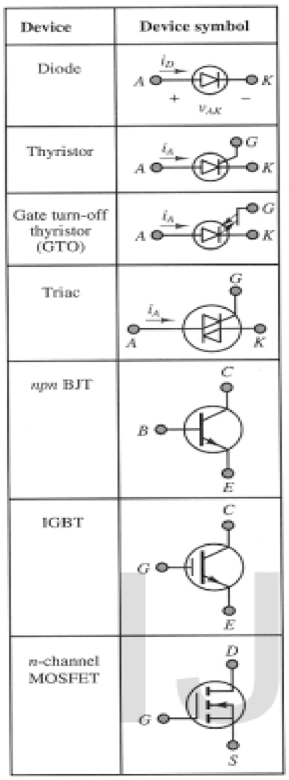

Figure 2 Classification Figure of Power Electronic Device.

A DC input voltage is converted into an AC output voltage by typical two-level conventional inverters. The pulse width modulation switching technique is used to generate the AC output voltage (as shown in figure2). The Multilevel Inverter topology (MLI) concept combines multiple DC voltage levels to produce a more rounded output waveform (as shown in figure3). Less harmonic and dv/dt distortion was found in the output waveform. The circuit design has become more complex as voltage levels have increased.

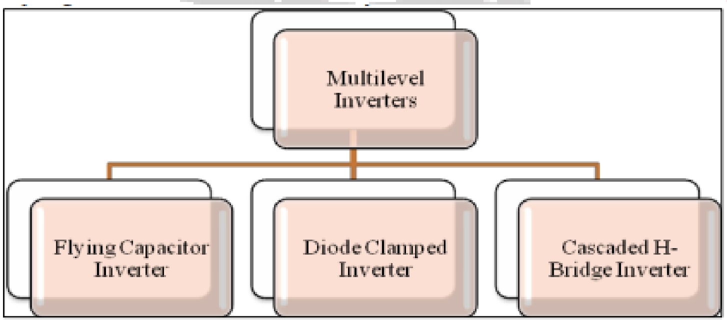

Figure 3 Diagram of Multi Level Inverters.

Figure 4 depicts the circuit of a common three-level inverter. A three-level inverter generates the three voltage levels (Vdc/2, 0, and -Vdc/2) with each phase leg. The three-level inverter can be distinguished from a conventional two-level inverter by clamping diodes between the two valves and a connection to the neutral between the two capacitors. To function as DC bus voltage sources, each capacitor is charged to a voltage of Vdc/2.

B. Topologies With H-Bridge

Gui Jia Su et al. introduce the MLDCL inverter for the CHB (multiple level DC link) [16]. An MLDCL inverter with two dc sources as inputs is shown in Fig. 5. It consists of "n" cascading half-bridge units, each of which includes two series switches and a single DC source. These cascaded units are supposed to constitute the "levelgeneration" part of the inverter, which produces a stepped dc voltage waveform. An H-Bridge is used to switch the output voltage's polarity in order to produce a complete multi-level ac waveform. Comparatively speaking, the MLDCL uses less switches than traditional MLIs at the same output voltage levels. [2]. Asymmetric source placement is a benefit of this architecture. The low-power range (LPR) includes applications such as permanent-magnet (PM) motor drives.100 kWInsulated-Gate Bipolar Transistor semiconductors can be utilised for the polarity generation portion of the leveller scheme, while Metal Oxide Semiconductor Field Effect Transistor (MOSFET) semiconductors with quick switching capabilities can be used for the leveller scheme (IGBTs)

II. LITERATURE REVIEW

Baiju,et,al(2005) Due to the recent explosive expansion of high switching frequency power electronics, voltage source inverters are being utilised more frequently in the generation of AC power. This necessitates the use of a modulation approach with a lower overall harmonic distortion, smaller switching losses, and a wider linear modulation range. Space vector pulse width modulation (SVPWM) approaches are preferable to the more popular PWM or sinusoidal PWM (SPWM) techniques because they have a simpler digital realisation and better DC bus utilisation. Two goals are the goals of this essay. One is to base an SVPWM methodology on a reduced computation method, which is quicker and simpler to utilise than conventional approaches. In the other, a practical space vector PWM inverter design is presented. a low-cost microcontroller implementation to circumvent many of the issues with the conventional methods.

B.Urmilaet,al(2010) Reduced harmonic distortion without the need for a transformer and use in high power and high voltage applications are two benefits of the multilayer inverter structure. This study uses a nine level diode clamped inverter to compare the impact of switching frequencies for sinusoidal Natural Pulse width Modulation and sinusoidal Sinusoidal Pulse width Modulation.

Samir Kouro (2008) Reduced harmonic distortion without the need for a transformer and use in high power and high voltage applications are two benefits of the multilayer inverter structure. With nine levels of diode clamped inverters, this study analyses the effects of switching frequencies for sinusoidal Natural Pulse width Modulation and sinusoidal Sinusoidal Pulse width Modulation.

S. Alepuzet,al(2006) This study offers a novel approach for connecting renewable energy sources to the electrical grid. Due to the enhanced power capacity of the available generation systems, a three-level three-phase neutral-point-clamped voltage-source inverter is selected as the brain of the interface system. An application of a multivariable control law serves as the regulator because of the system's built-in multivariable structure. A current source (simulating a general renewable energy source) is connected to the grid using a three-level converter in order to verify the efficacy of the suggested technique. The large- and small-signal d-q state-space averaged models of the system are used to calculate the multivariable controller based on the linear quadratic regulator technique. This controller balances the dc-link neutral-point voltage, the dc-link voltage, and the mains power factor (electricity is sent to the grid at unity power factor) (to operate at the maximum power point of the renewable energy source). Using the model and regulator that are given, a precise switching strategy is not required to regulate the dc-link neutral-point voltage. The recommended controller can be used for any application because of its nature, which allows it to control any system variable. The effectiveness of the suggested interface strategy is proven in steady-state and transient operation by simulation and testing using a 1-kW neutral-point-clamped voltage-source inverter prototype, where the controller is developed using a PC-embedded digital signal processor board.

Opiyo, N. (2016) The power electronics used in PV power generation systems are reviewed and modelled in this paper. PV systems need converters to track the maximum power point, condition power, step up or step down voltage as necessary, and regulate storage charge. Inverters are necessary for both AC loads and utility grid interconnection. The four basic DC-DC converters that are typically used with PV systems have been reviewed and modelled. The most cost-effective and efficient architecture for PV-based community grids is the two-stage DC-AC inverter with the point of common coupling (PCC) at the inverter input.. Different operational architectures and DC-AC inverter types have also been researched. There is just one inverter required for the entire system as opposed to one for each string of modules in systems with PCC at the AC terminal, which results in improved efficiency, reduced costs, and lower harmonic distortions. Getting the maximum power possible from the PV system while, if necessary, inverting it at a level as close to 100% as is achievable is the aim of power conversion and inversion. Highlights include the need for DC-DC converters for PV system power conditioning, DC-AC inverters for AC loads and utility grid interconnection, and the control of PV system functioning while linked to the grid.

C. Zhang, et.al(2013) Currently, high-speed serial fiber-optic ring net communication is primarily used to accomplish the distributed control network topology and control mode. Due to the topology's inherent network transmission delay, synchronisation between nodes has become a significant issue that needs investigation. Current synchronisation methods mainly rely on the complex communication protocol. This paper has therefore proposed a method for automatically measuring and adjusting synchronisation delay, and has carefully scrutinised both its operational theory and implementation procedure. The results of the trials show that the proposed methodology is reliable, effective, and practicable..

III. METHODOLOGY

A high-performance language for technical computing is called MATLAB. In a simple-to-use interface, it mixes computation, visualisation, and programming while expressing issues and solutions using well-known mathematical notation. Application development, including the creation of graphic user interfaces, are examples of typical uses.
The MATLAB/SIMULINK environment was used to complete the modelling. The four-legged inverter model's output findings have been examined, and the control algorithm has been put into practise.

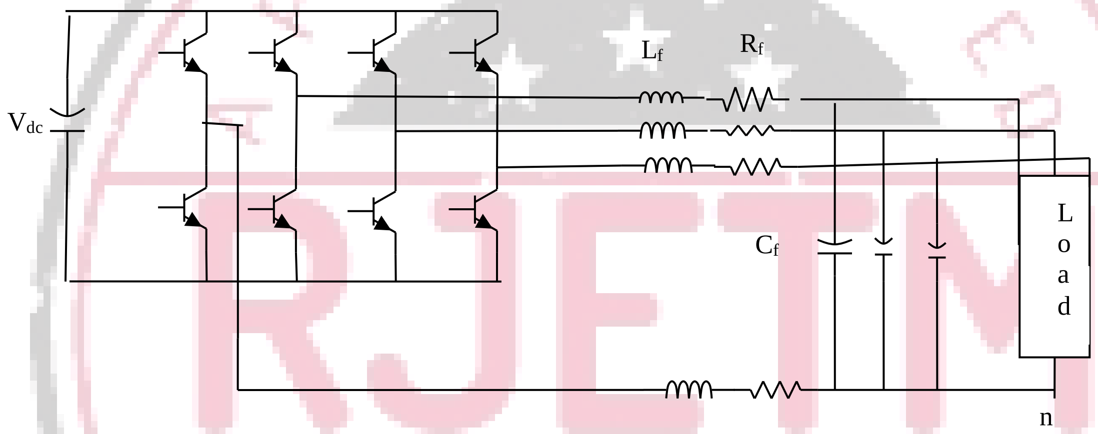

Figure4 Four Leg Inverter Topology

A. Internal Loop Controller

For improving power quality in a stand-alone system based on a four-leg inverter, an effective control technique is suggested. Internal loop control mechanism for harmonics attenuation is the foundation of the suggested controller.

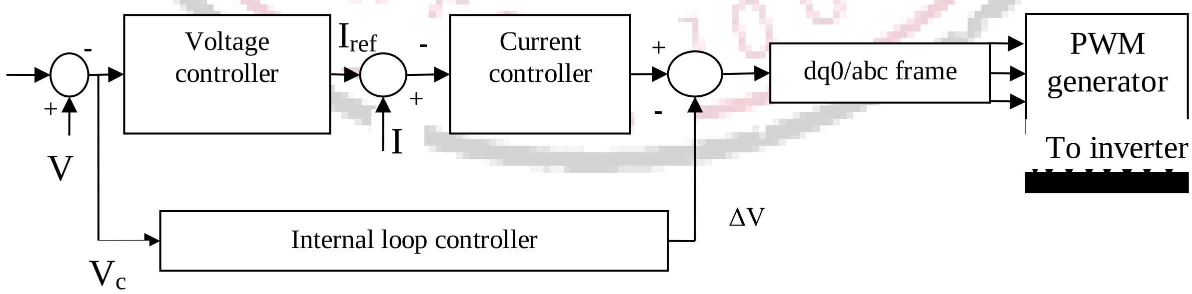

Figure 5 Control Algorithm To Generate Pulses

Table: 4.1 Values of the Parameters Considered While Modeling

PARAMETER	VALUES
Dc voltage	700 volts
L_f	3 μ H
C_f	1 mH
L_n	1.2 mH
R_l	40 ohms
L_l	1 mH

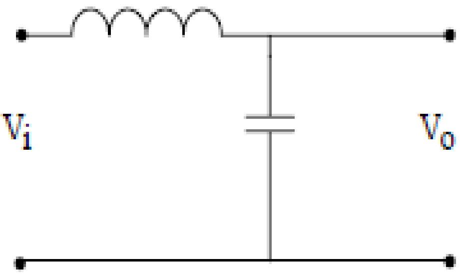

Figure 6 Lc Filter Configuration

IV. RESULTS

The MATLAB/SIMULINK environment was used to analyse the model. MATLAB blends a programming language that natively expresses matrix and array mathematics with a desktop environment optimised for iterative analysis and design processes. It enables simulation-based graphical programming to create your system.

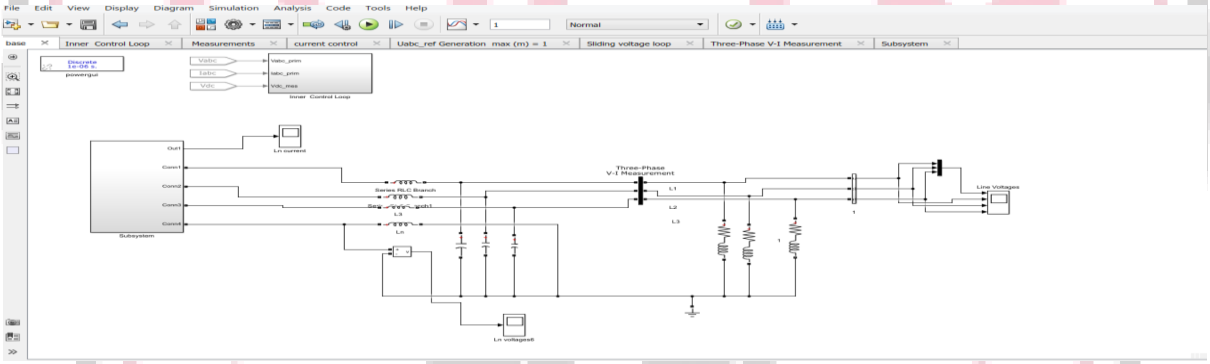

Figure 7 Modeled Four Leg Inverter Feeding Three Phase Static Load

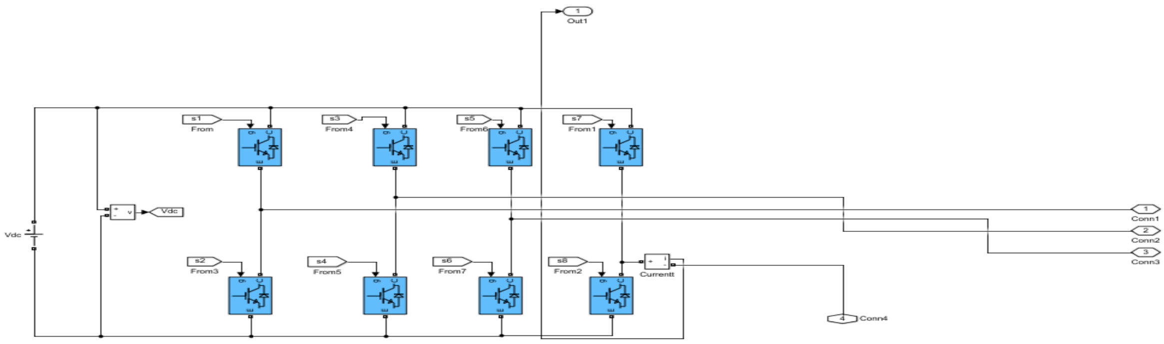

Figure 8 Modeled Four leg inverter

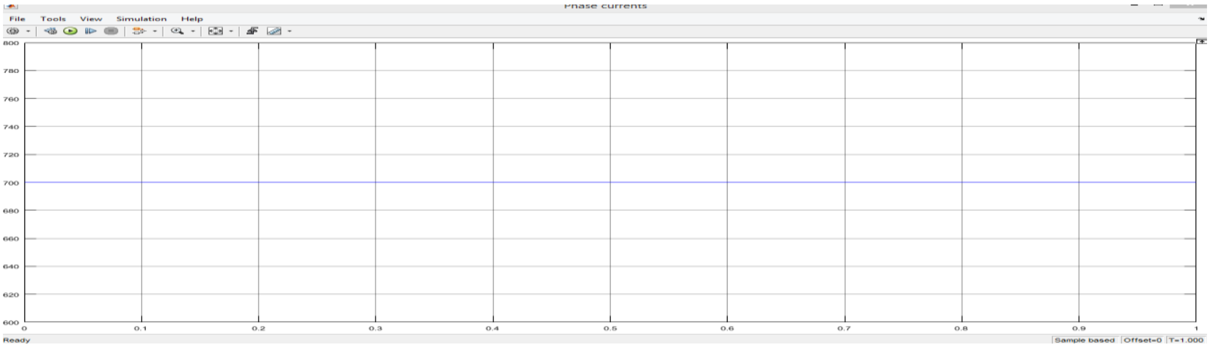

Figure 9Input DC Voltage

A. Control System

To convert the voltage from the abc/0dq frame, the output AC voltage is sent to the first measurement block. The voltage regulator's reference voltage is held constant at 100 volts. The inner control loop receives the error voltage, which is the difference between the input voltage and the reference voltage, for additional calculation.

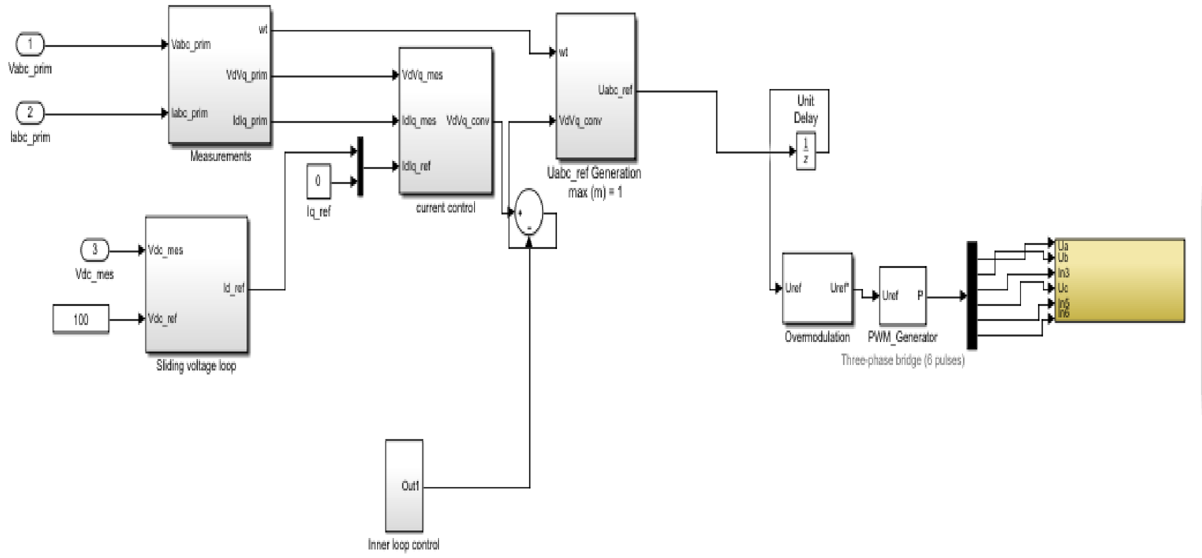

Figure 10 Modeled Control System to Generate Pulses

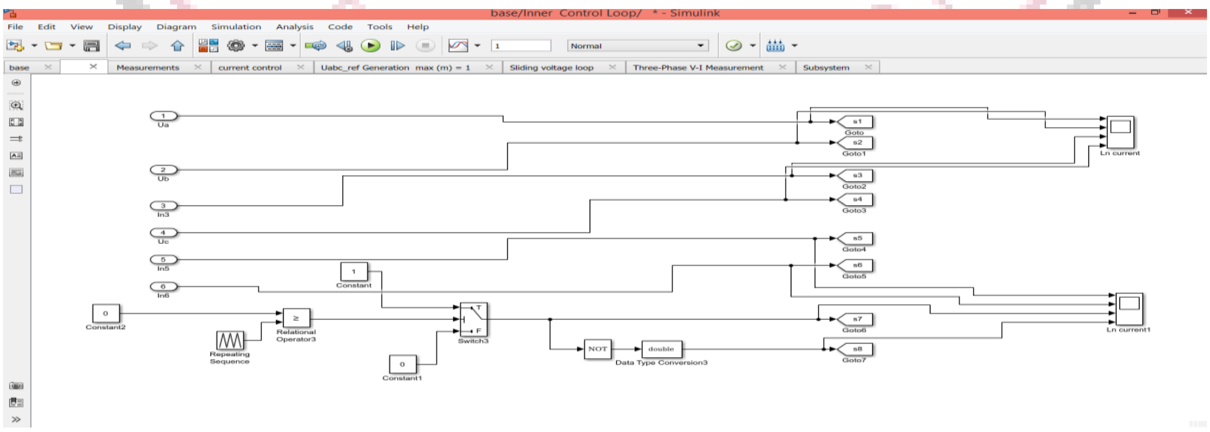

Figure 11Eight Pulses Generation To Be Fed To The Inverter

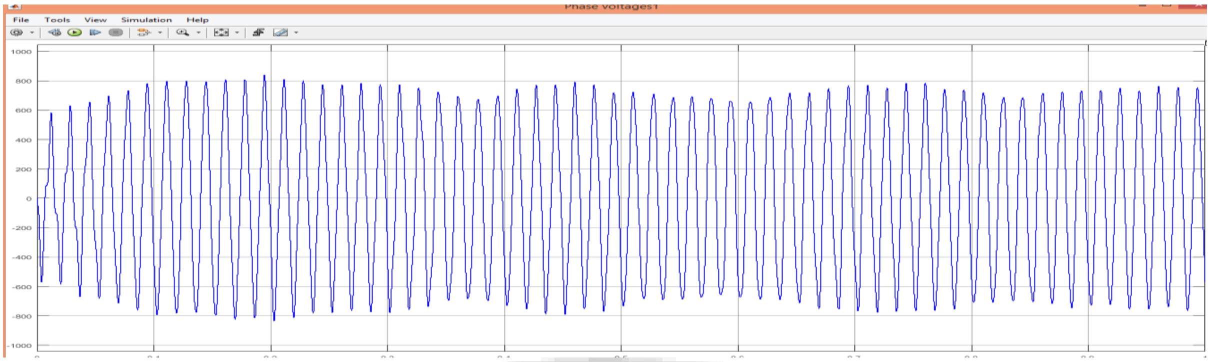

Figure 12 Phase a voltage with THD%= 5.5%

B. Validation

The THD level of the phase voltage has significantly improved from the two cases on adjusting the controller's parameters. This can be summed up as follows:Table 5.2: Comparison between the changes seen after modifying the parameters of the controller

Phases	θ=1, β=0.1 and π=2	θ=0.002, β=0.5 and π=2
	THD%	THD%
Phase a	5.5%	3.5%
Phase b	1.6%	0.5%
Phase c	0.5%	0.3%

If we only take into account phase a, the THD% number in the first scenario has decreased from 5.5% to 3.5%. This is when the previous cycle feed back gain is altered from 1 to 0.002, and the forgetting factor's value is changed from 0.1 to 0.5.

When the THD% value was decreased from 1.6% to 0.5% in the first case, it was exclusively for phase B. for similar adjustments.

V. CONCLUSION

An inner control loop controller for improving power quality in a stand-alone power supply system based on a four-leg voltage-source inverter with an output LC filter has been developed in this study. There are two main components to the suggested control scheme. The main inverter input control is delivered by a cascade of voltage and current sliding controllers, while an inner control loop serves primarily as extra support for the principal controller in the event that disrupting loads occur.

When the system is susceptible to disturbances such the presence of non-linear and unbalanced loads, the proposed approach enables for improving the power quality, as shown by the supplied simulation and experimental findings.

In conclusion, the suggested controller's capabilities may be appropriate for industrial applications where the power

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