International Journal of Engineering & Extended Technologies Research (IJEETR)
|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |
| Volume 8, Issue 2, March - April 2026 |
DOI:10.15662/IJEETR.2026.0802325

Three-Phase Parallel Multilevel Inverters using Fuzzy Logic Technique

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Publication History: Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03. 2026; Published: 28.03.2026.

ABSTRACT: Series converters make use ofPulsewidth modulation (PWM) strategies for multilevel inverter has developed.The proposed paper is applied for parallel multilevel inverter with fuzzy logic technique.The simulation result of the proposed system well suited to reduce the current ripple and also reduce the current imbalance problem.

KEYWORDS: Interleaved converters, Fuzzy logic technique, multilevel inverters, Three-phase inverters..

I. INTRODUCTION

A Medium voltage drives hasdeveloped for introduction of series multilevel inverter.These inverters allows to reach higher dc bus voltages. Five main types of topology are used to successively introduced: M2C, neutral point clamped, flyingcapacitor, polygonal and cascaded and sparc[1].

Three-phase drives are a hugemarket to operation of multilevel three phase voltage source inverter(VSI),but multi-level conversion is not a priorilimited to voltage source inverter In fuzzy techniques have been thoroughly investigated,and resulting to the zero sequence components.

The proposed system are interest for parallel connection of commutation cell has developed. Depending on the application, increasing the efficiency, increasing power, using standard modules, , or using smaller magnetic components can be the motivation. but due to the development of multilevel inverters, generally interleaved switching is considered. Interleaving the switching signals of parallel cells reduces the output current ripple and increases the dynamic performance of the inverters[11].

Thenormal inductors is not recommended due to the increase of the current ripple in each cell.So coupled inductors to be used since currents in all cells are magnetically coupled and reducing their amplitude and increasing the frequency[12]. Most types of power converters are applied by paralleling methods. such as: flyback converter, ac choppers,boost converters. Paralleled inverters using coupled inductors to restrain the loop current caused by disparity of amplitude and phase.

This paper has developed a three-phase bidirectional inverter using a three-cell coupled inductor to provide significant reduction in harmonic distortion and the focused on a multilevel discontinuous space vector pulse width modulation (PWM) method for a three-level three-phase PWM VSI using a three-phase split-wound coupled inductor.

II. THREE PHASE PARALLEL MULTILEVEL INVERTER

A. General description
Duality rules show that the multilevel output voltage of series multicell converters transposes in the form of a multilevel input current in parallel converters. As an example, in the series multicell topology of a four-level voltage waveform at 3Fs can be generated across the current source using phase-shifted control signals, and in the parallel multi cell a four-level current at 3Fs is taken from the voltage source. The corresponding waveforms are given for a duty cycle ramping from 0 to 95%. However, an even better solution for paralleling commutation cells is obtained using star-connected inductorscarrying equal currents. The most obvious advantage of this topology is that it generates four-level waveforms at 3Fs on both sides.
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The system to be analyzedin Fig. 1. It is composedof two three-phase inverters connected in parallel. Each phase (U,V,W) is composed of two commutation cells (a and b)which are connected in parallel through coupled or uncoupled inductors. These inductors (La and Lb) have self-inductance Land mutual inductance Mab. The load was chosen to be a passive RLcircuit, although the analysis may be also performed toan RLE circuit, which may represent a machine.

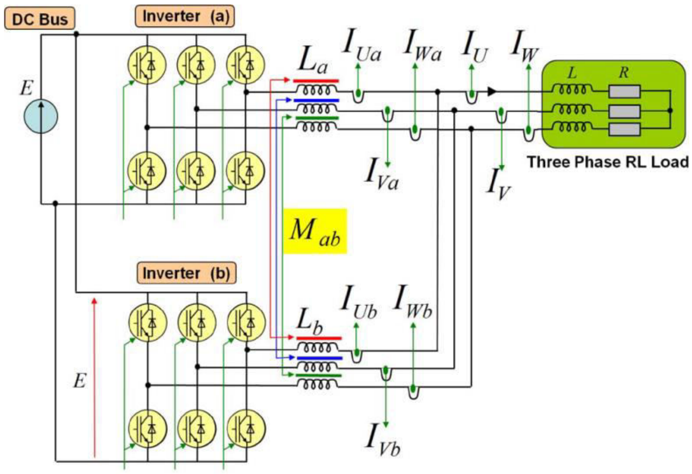

Fig.1 circuit of Three Phase Multilevel inverter .

B.coupled inductors

A load current is the result of the voltage waveform (Va+ Vb)/2 and the filtering effect of (L +Mab)/2.So the current flowing in the each inductors in the result of the filtering effect of(L−Mab) and the load current and the differential current which is a consequence of the differential voltage waveform (Va−Vb).

Consider the inductor's design, the value of (L +Mab)/2 is usually chosen by the application, depending on the desiredoutput current ripple. In this case, the great advantage of usingcoupled inductors (instead of uncoupled inductors) is the factthat, by choosing a negative mutual inductance Mab, it ispossible to significantly reduce the current ripples in each phase

[12].Then the leads to fewer copper losses in the inductor and the switches.

And the design of the coupled inductors is a tricky task, and it was described[[13].To calculate the flux inside the magnetic core of coupled inductors, we may assume that the core reluctance is much smaller than the equivalent leakage reluctance. For applications where the load has strong inductive characteristics, such as electrical machines, the inductor's flux (φ) depends basically on the current flowing through each winding (Iaand Ib), the number of turns of eachwinding (N), and the core reluctance (RelCore), as shown in the following equation:

$$\emptyset = \frac{\mathrm{NIa - NIb}}{\mathrm{RelCore}} \qquad (1)$$

To Neglecting the series resistances of the coupled inductors, the flux is depending the integral of the voltage between each phase. So the mutual and self-induction of the coupled inductors are

$$\emptyset = \frac{\mathrm{N}}{\mathrm{RelCore}} \frac{\int(\mathrm{Va - Vb})dt}{\mathrm{L - Mab}} (2)$$

Equation (1) and (2) are order to reduce the flux inside the magnetic component and to consequently reduce the magnetic component design, the current difference Ia– Ib must be controlled and reduced.

C. control technique

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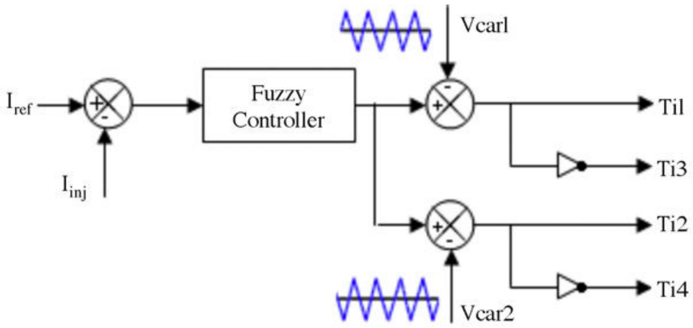

Fig.2 PWM synoptic diagram of current control .

This control implements a fuzzy logic controller which starts from the difference between the injected current (active filter current) and reference current (identified current) that determines the reference voltage of the inverter (modulating wave). This standard reference voltage is compared with two carrying triangular identical waves shifted one from other by a half period of chopping as shown in fig.2.

The control of inverter arm constituting the filter is summarized in the two following stages.

Determination of the intermediate signals Vi1 and Vi2.
If error≥carrying 1⇒Vi1 =1.
If error < carrying 1⇒Vi1 =0.
If error≥carrying 2⇒Vi2 =0.
If error < carrying 2⇒Vi2 =−1.

• Determination of control signals of the switches Tij(j=1, 2, 3, 4).
If (Vi1 + Vi2)=1⇒Ti1 =1, Ti2 =1, Ti3 =0, Ti4 =0.
If (Vi1 + Vi2)=0⇒Ti1 =0, Ti2 =1, Ti3 =1, Ti4 =0.
If (Vi1 + Vi2) =−1⇒Ti1 =0, Ti2 =0, Ti3 =1, Ti4 =1.[15.]

The band transition from the positive to the negative band at time t = tchange. Before tchange, sampling is synchronized at signal "sampling A/PD," and cycle kis regular, starting at Akand reaching Ak+1, which have the same amplitude. At t = tchange, since the modulating signal changes the sign, a transition in ΔIUis imposed (cycle k + 1) until point Ak+2, which introduces a continuous level to the current difference. After cycle k + 1, we observe a regular cycle (cycle k + 2) which starts at Ak+2 and reaches Ak+3, which have the same amplitude. It is possible to develop a transition compensation strategy by adding a double commutation in the state machine. we can include a connection between states S1 and S2. Passing from state S1 to S2 or vice-versa does not disturb the output voltage since both states represent the same output level. This double commutation must imperatively be inserted at the half period following the sign change of the modulating signal. Fig. 10 shows the effect of the double commutation, where the correction occurs at cycle k + 1so that ΔIU is the same at Ak+1 and Ak+2.

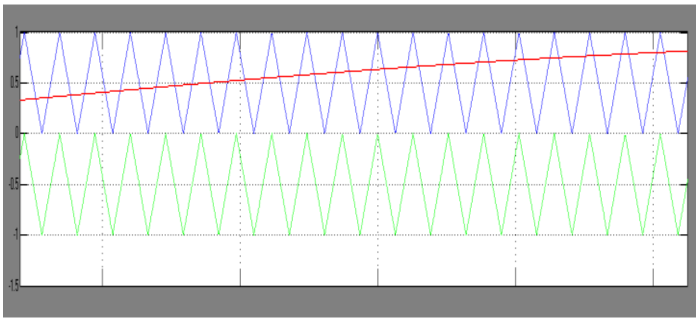

Fig 3.Compensation of the band transition in the Fuzzy logic

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III. SIMULATION RESULTS

To describe and validate the capabilities of proposed control strategy, simulations are carried out for the toreduced the current ripple and to increasing the dynamic performance of the system in a MATLAB/Simulink. The schematic diagramand principle of the proposed control technique is shown in Fig. 4

MATLAB figures contain the three phase parallel multilevel inverter and it's fuzzy logic technique.

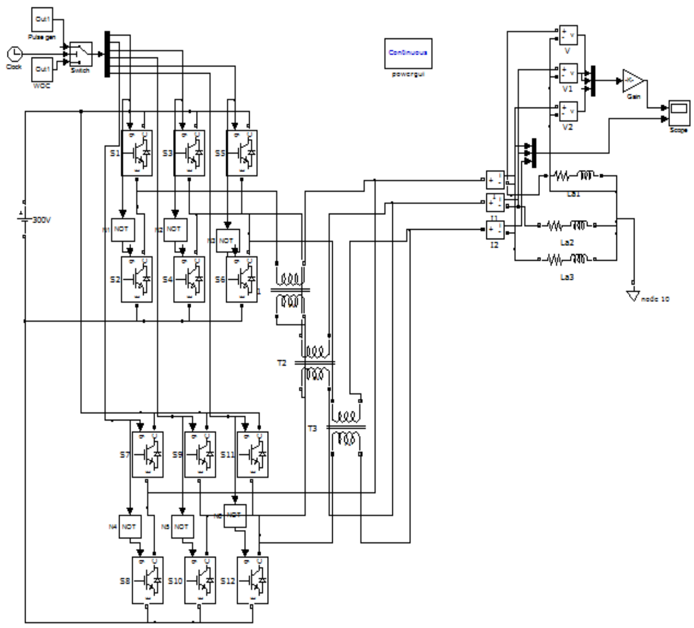

Fig.4. Simulation diagram of proposed diagram

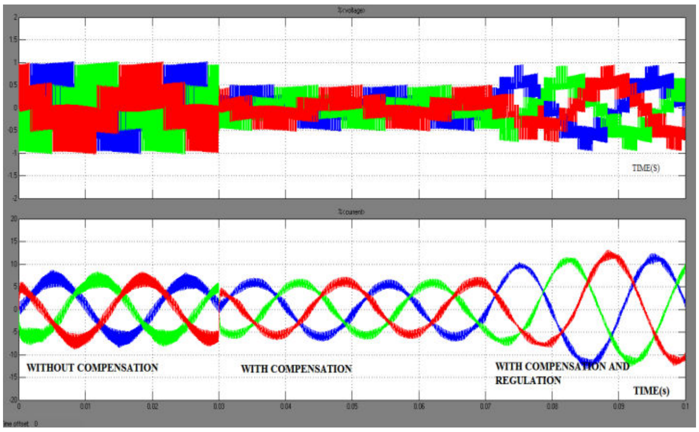

Fig 5.simulation result of proposed system

The output are divided into three parts,showing the system behaviour without compensation, with compensation and with compensation and regulation of band transition, and also with the control of the average value of ΔIU, as shown in Fig.5. From t = 0 to t = 40 ms, transitions are not compensated, and we can clearly see a high irregular ripple of the current difference in the two currents of each phase. From t = 40 ms to t = 80 ms, compensation of band transitions is activated, and we can note that all irregularity is suppressed and stable and that a controlled ripple is observed. The zoom of ΔIU at around t = 70 ms shows that compensation control adds an extra commutation. Above the t= 80 ms, we activate the control of the average value of ΔIU. In this time period that the dc values of the current difference of the three phases are regulated.

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PARAMETERS

Parameter	value
E	300V
L	1mH
R	10Ω
F_s	7800Hz

IV. CONCLUSION

The work developed in this paper has shown that it is possible to obtain the best method of fuzzy logic is coupled to compensates the band transitions of the differential mode. This compensation adds a double commutation of the switches, which allows us to replace two different states of the state flow having the same output voltage level. And the output current ripple are reduced and also reduced the current imbalance. The simulation result are are clarified the proposed control system.

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