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Speed control of Induction motor drive by using solar based seven level shunt active filters

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Abstract : *The main objective of this paper is to Control the speed if Induction motor drive by solar based sevel level shunt active power filter (SBSLSHAPF). In this paper, a novel topology is suggested where two active filter inverters are connected with tapped reactors to share the compensation currents. The proposed active filter topology can also produce seven voltage levels, which suggestively reduces the switching current ripple and the size of passive components. Here a predictive current regulator is applied to track the harmonic currents, which has the advantages of simple structure and less computational requirement. In our system we employed joint-phase redundant states selection(JRSS) technique is used that gradually reduces overall magnetizing currents.Depends on the joint redundant state selection strategy, and also current balancing algorithm is also presented in order to preserve reactor magnetizing current to be maintain minimum as possible that was shown through Matlab simulation achieve high overall system performance.*

Keywords — *Shunt Active power filters, Total harmonic distortion, Power conversion, Power Drives.*

I. INTRODUCTION

The practice of nonlinear loads at high voltages is growing in industry day-by-day leading to harmonic pollution in the line current, increased losses, poor system performance and efficiency. The orthodox two level active filters have restrictions in medium and high voltage applications due to semiconductor reverse voltage rating limitation, high power loss, high level of dv/dt causing switching noise hence electromagnetic interference with communication system, as well as insulation deprivation in electronic and electrical systems [1]. The expansion of multilevel inverter (MLI) has become the choice for reactive power compensation and power quality improvement. Multilevel inverter topologies such as diode clamped, flying capacitor and cascade H-bridge inverters are presented in the literature [2]. In current years, multilevel converters have presented some noteworthy benefits over outdated two-level converters [3]–[5], specifically for the usage of high-power as wella as high-voltage applications. As we mentioned topologies with very high oredr of voltage levels are also suggested here [6]. Generally here it has been presented that even at additional voltage levels mean lower total harmonic distortion (THD),the gain in THD seems to be very marginal especially for converters with more than seven levels [7]. The idea of the configuration was presented in earlier conference publication [8].

II. ACTIVE FILTER TOPOLOGY

The proposed active filter topology is shown in Fig. 1 that consists of an H-bridge configuration prepared from three-level flying capacitor branches. In essence, we define voltage-source inverter (VSI) with that of capacitive energy storage (C_{dc}) combined by all existed three phases. Consequently a total of eight switching devices are employed at each phase. Finally at that juncture, the line-to-ground voltages will have five distinct voltage levels [9]–[12].

A. Tapped Reactor Model

For the suitability of analysis, the reactor can be separated into two parts.

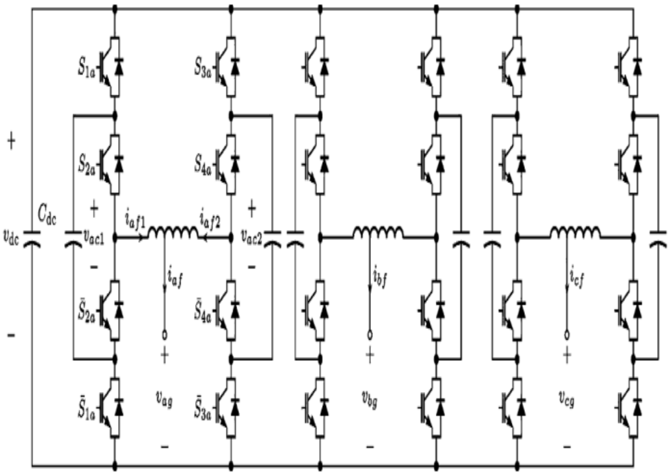


Fig. 1. Proposed seven-level active filter topology.

In Fig. 2, part one, indicated as L1, that consists of the portion from that of terminal x1 to the tap and had a number of turns N1 = N; part two, designated as L2, comprises of the portion from the tap to terminal x2 and has a number of turns N2 = 2N. Here we can say Terminals x1 and x2 are defined as the input terminals on the other hand the tap terminal is well-defined as the output terminal x.

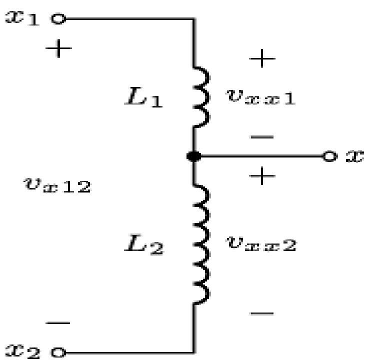


Fig. 2. Ideal tapped reactor model.

The following suppositions are prepared:

1) Due to small magnetomotive force to format the flux the core of the reactor is highly permeable.
2) As mentioned core does not exhibit any eddy current or hysteresis loss.
3) The resistance of the reactor seems to be negligible.

B. Active Filter Interface

As shown in Fig. 3, the active filter is linked to the power system through a three-phase inductor Lf .

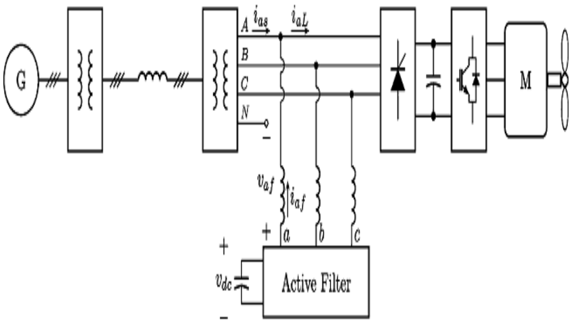
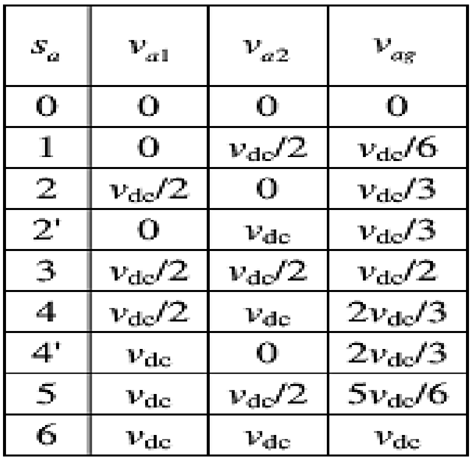


Fig. 3. Active filter connection to a shipboard power system.

Generally filtering function is accomplished by injecting small amount of compensating harmonic current into the point of mutual coupling of the utility–load interface, which in turn to be as the secondary side of the rectifier load transformer. The reference harmonic currents are detached from the load currents subsequently the sum of the load currents and the injection currents has a THD that encounters mandatory specifications. The seven level inverter can yield an output voltage that comprises very tiny switching frequency ripple than a tradational two-level inverter; as a result, the generated injection currents are smoother and the coupling inductor can be shortened.

Meant for each phase, there are nine different switching states, analogous to nine terminal voltage combinations. These amalgamations can produce a line-to-ground voltage at the output terminal that has seven distinct voltage levels. For phase a, these states are detailed in Table I.

TABLE I
Active filter line-to-ground voltages



s_a	v_{a1}	v_{a2}	v_{ag}
0	0	0	0
1	0	$v_{dc}/2$	$v_{dc}/6$
2	$v_{dc}/2$	0	$v_{dc}/3$
2'	0	v_{dc}	$v_{dc}/3$
3	$v_{dc}/2$	$v_{dc}/2$	$v_{dc}/2$
4	$v_{dc}/2$	v_{dc}	$2v_{dc}/3$
4'	v_{dc}	0	$2v_{dc}/3$
5	v_{dc}	$v_{dc}/2$	$5v_{dc}/6$
6	v_{dc}	v_{dc}	v_{dc}

III.ACTIVE FILTER CONTROL

To meritoriously compensation the load harmonic currents, the active filter controller must be designed to meet the succeeding three goals:

1) extract and inject load harmonic currents;
2) preserve a constant dc capacitor voltage;
3) Avoid producing or absorbing reactive power with that of fundamental frequency components.

A. Total harmonic distortion

Furthermost of the common harmonic currents for diode or thyristor rectifier loads are of the 5th, 7th, 11th and 13th order. Even though a high-pass filter can be used to extract these components directly from the line currents, it is not possible to get high attenuation at the fundamental frequency due to the high current amplitude. In general, the more voltage levels converter has the less harmonic and improved power quality it delivers the more voltage levels mean it shown less total harmonic distortion. Nevertheless, the increase in converter difficulty and number of switching devices is a major concern for a multilevel converter.

Low-pass filters are then used to extract the dc components, which correspond to the fundamental frequency components of the load currents.

B. DC Capacitor Voltage Control

For the active filter to operate efficiently, it is significant to preserve the dc capacitor voltage at a predetermined constant value. In the meantime the active filter topology is essentially indistinguishable to that of an present active rectifier, alike control strategies for the active rectifier are associated. The DC capacitor voltage is directly affected by the condition of real power that is transferred through the active filter. Now to keep the voltage constant, preferably, no real power should be transferred. However, due to losses in switching devices and other components, a small amount of real power is needed. Similarly in the synchronous reference frame with that of q-axis aligned with the voltage at the point of mutual coupling, the real power transferred can be stated earliier.

C. Reactive Power Control

In utmost cases, a unity power factor for fundamental frequency components is obligatory at the active filter terminals.

IV. MULTILEVEL INVERTER TOPOLOGY

A cascade multilevel inverter made up of from series connected full bridge inverter, each with their own isolated dc bus. The seven level voltage source modulations are able to matching the duty cycles with a set of six carrier waveforms. This is exemplified for phase a shown in fig 4.

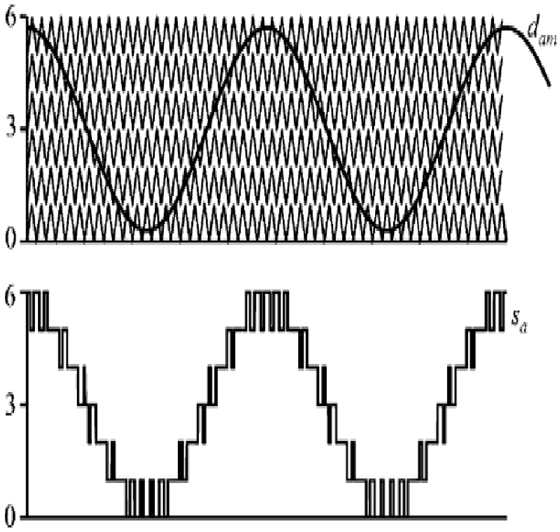


Fig.4 seven-level voltage source modulation

A. Multilevel Voltage-Source Modulation

The seven-level voltage-source modulation is accomplished by relating the duty cycles with a set of six carrier waveforms.This is demonstrated for phase a in Fig 7. The resultant switching state is the number of triangle waveforms that the duty cycle is greater than. As a result, the switching state has a range of 0–6, and this is in contract with Table I.

B. Capacitor Voltage Balancing

Later carrying out the modulation, the switching states for each phase need to be fragmented out into transistor signals.

V. SIMULATION RESULTS

Numerical simulations have been conducted in the Advanced Continuous Simulation Language (ACSL) to confirm the proposed topology. The example naval ship power system has a rated line-to-line voltage of 4.16 kV and a three phase six-pulse diode rectifier. A three-phase PWM inverter is connected to the rectifier dc bus, and supplies power to a permanent-magnet synchronous motor load. The rated dc capacitor voltage of the active filter is 6800 V. The three-phase tapped reactor has a leakage inductance of Ll = 50 µH, winding resistance r = 0.1 Ω, and mutual inductance LM = 1H. The active filter interface inductance is Lf = 0.1 mH.

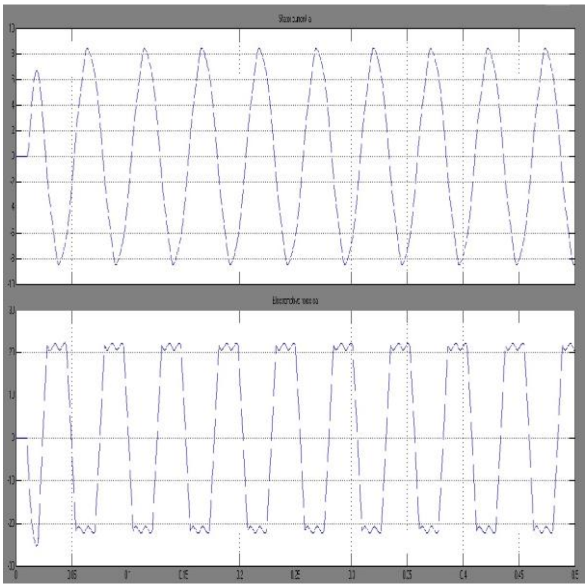


Fig.5 Machine parameters

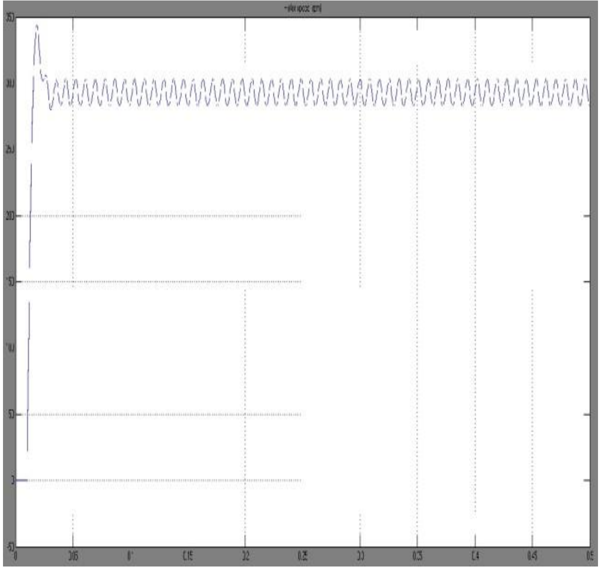


Fig.6 Rotor speed

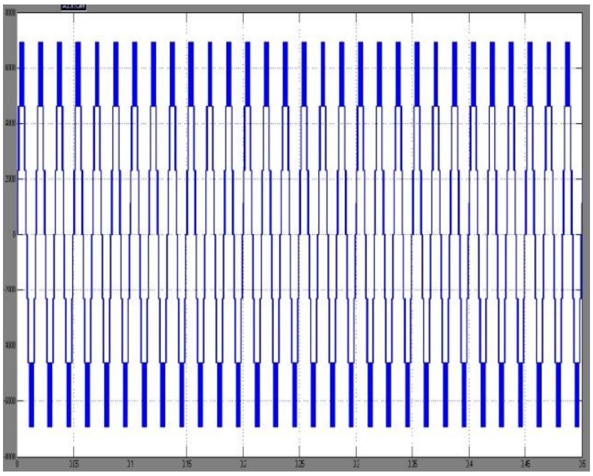


Fig.7 Sevel level output

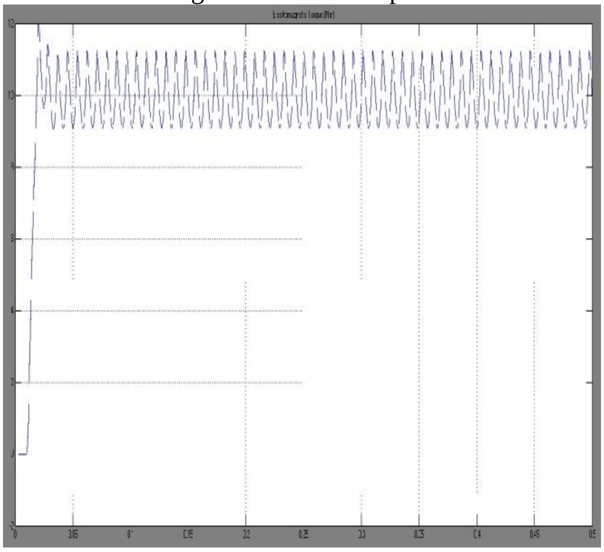


Fig.8 Torque

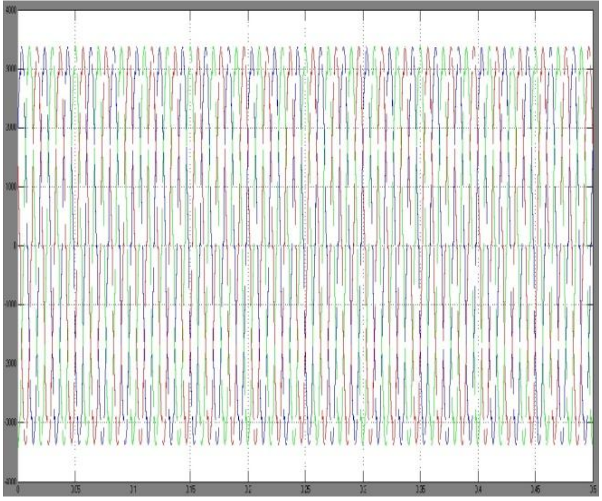


Fig.9 Vlabc

VI.CONCLUSION

A different type of power converter has been presented in this paper. Here in our scheme the converter is depends basically on parallel connection of phase legs through the particular inter phase reactor. On the other hand, the reactor offers an off-center tap at one-third causing in an increased number of voltage levels. Similarly, two three-level flying capacitor phase legs are paralleled in such a way so as to form a equivalent seven level power converter. So therefore the converter is utilized in an active filter application as,well as the switching control have been presented over here. The control confirms reactor current sharing a swell as basic flying capacitor voltage balance.

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BIODATA

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