IMPROVING EFFICIENCY: POWER FACTOR CORRECTION OF THREE-PHASE PWM AC CHOPPER-FED INDUCTION MOTOR DRIVE SYSTEM THROUGH HBCC TECHNIQUE

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ABSTRACT: This study proposes a novel approach to controlling an induction motor (IM) powered by a three-phase alternating current chopper with variable pulse width. The primary purpose of the proposed control technique is to improve the IM drive system's input power factor correction (PFC) under a variety of operating scenarios. The hysteresis band current control (HBCC) approach is used to replace three-phase supply currents with reference currents produced in phase with the supply voltages. This results in a phase-shift capacitor (PFC). The proposed control scheme consists of two independent loops, known as the inner loop and outer loop. The output of the outside loop is the supply reference current level from the speed or beginning controller. The inside loop's output is the ac chopper's PWM signals. The recommended ac chopper consists of four IGBTs and two PWM gate signals, resulting in fewer active semiconductor switches. So, the method under consideration is very effective, dependable, user-centered, and low-cost. We demonstrate how the power system works and analyze it quantitatively. When designing the elements of the input LC filter, frequency flexibility is taken into account. After modeling the IM drive system in MATLAB/SIMULINK, the lab version was developed and tested exhaustively. The results of the experiments and simulations demonstrate that the proposed control mechanism is effective and trustworthy.

Keywords: IM, PWM, PFC, HBCC

I. INTRODUCTION

The power factor is the cosine of the angle created by the voltage and current in an alternating circuit. Voltage and current are commonly represented by separate phases in an alternating current circuit.The power factor of the circuit is represented by the cosine.

The power factor is the ratio of functional (real) power (kW) to total (as-applied) power (kVA) for a complete electrical installation or an AC electrical device. It measures the efficiency with which electrical energy is converted into productive work. One, or unity, is the ideal power factor. A rating below one indicates that more effort is required to complete the current assignment. With each current flow, supply and distribution system losses occur.

For a given load, a power factor of 1.0 charges the supply most effectively. A capacity with a power factor of 0.8, for example, results in much increased supply chain losses and a higher customer charge. Because losses are proportional to current squared, even a minor improvement in power factor can result in a significant reduction. Regrettably, when the power factor is less than one, reactive power, or the "missing" power, provides the magnetizing field required for motors and other inductive loads to work normally. Reactive power is also known as wattless, magnetizing, or wasted power; it adds strain to the energy distribution system and increases consumer costs. A poor power factor can be caused by a high harmonic content, a distorted current waveform, or a significant phase difference between voltage and current at the load terminals.

A low power factor is usually caused by an inductive load such an induction motor, power transformer, light fixture ballast, welding station, or induction furnace. Discharge lighting, inverters, variable speed drives, switched mode power supplies, and other electronic loads can cause distorted current waveforms. A low power factor induced by an inductive load can be corrected by installing power factor correction equipment. In the case of a low power factor caused by a distorted current waveform, harmonic filters or changes to the equipment design are required.

Inverters may be promoted as having a power factor greater than 0.95 when, in fact, their power factor is between 0.5 and 0.75. The value of 0.95 is determined by taking the cosine of the angle produced by the current and voltage; however, it does not account for the discontinuous character of the current waveform, which contributes to higher losses. An inductive load requires a magnetic field to function; producing one produces out-of-phase current (current lags behind voltage). Power factor correction is the systematic use of capacitors to create a leading current in order to counteract the influence of the trailing current. A usable capacitance is attached in order to bring the power factor as close to unity as possible.

Power factor correction

Since the early twentieth century, a technique known as "power factor correction" has been used to bring the power factor as close to unity as is possible. Typically, capacitors are used in the electrical network to lower supply demand by adjusting for the reactive power requirements of the inductive load. The operation of the apparatus should be unaffected. Power factor adjustment, often achieved using capacitors, is used to counteract a practical amount of the magnetizing current, lowering distribution system losses and electricity costs.

The majority of power factor correction devices use capacitors to generate a leading power factor. The addition of capacitors to a circuit with a nominally trailing power factor results in a proportional reduction in delay. In general, the corrected power factor is estimated to be 0.92–0.95. For example, some power distributors punish customers when the power factor falls below 0.9, while others provide incentives. While other methods exist for identifying this, the client is eventually advised to use power factor correction to reduce energy waste inside the distribution system. Currently, many network operating organizations punish power factors of less than 0.95 or 0.9.

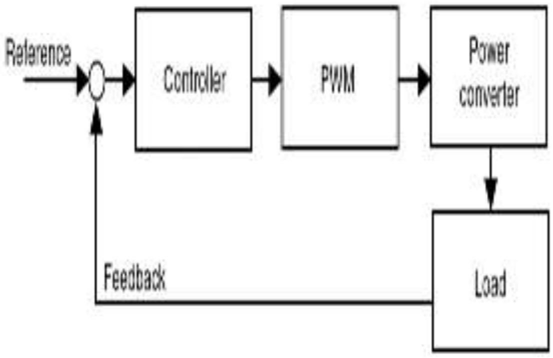
PULSE WIDTH MODULATION (PWM)

In the event that the external excitation recurrence differs slightly from the intrinsic reverberation recurrence, the PEI within a dynamic electromagnetic energy collector framework should be able to align its data impedance with the reaper's interior impedance in order to track the maximum force point.

Once again, our investigation identified the topology with the highest force point following (MPPT) capabilities. Nonetheless, the primary goal of this project is to offer a circuit architecture capable of fulfilling the voltage requirements of an electronic burden (3.3 V). A voltage input control circle is used to adjust the accumulation voltage V. Figure 4.1 depicts the controller and force stage in their reduced arrangement. The converter will most likely function in DCM mode. A dormant low-pass channel filters the yield voltage before it is advanced to the controller's sophisticated converter (ADC).

The PI computation is used to compute and correct for the difference between the planned voltage and the ADC output, resulting in a moveable obligation cycle signal. The information's excessive voltage affects signal transmission between S1 and S2. A sign indication highlights the voltage extremity of information.

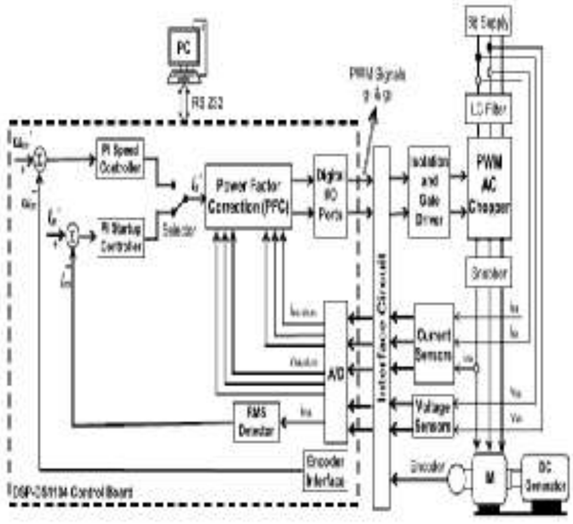
The Mega-16 Atmel This study employs a controller that includes a basic comparator, an on-chip coordinated A DC, and the ability to interface with a sign indicator. The sign finder is made up of an on-chip fundamental comparator, a voltage reference, and an operating amplifier. The operation amp augments the information voltage with a DC bias (voltage reference), similar to a simple viper. The extremity is determined by comparing the sign summation to the voltage reference. The bearer flag and reference signals are used to generate the direct current voltage required for pwm methods.



Block diagram of pwm

II. PROPOSED CONTROL STRATEGY

The proposed control approach has three primary objectives: smooth start, speed management, and input power factor correction (PFC). This approach uses an AC chopper to adjust the voltage provided across the IM wires. Figure 3 depicts a diagram of the proposed control method. There are two control systems there. The inner control loop uses HBCC to match the chopper's real current signals to its command current signals, allowing for input PFC. The outer control loop, on the other hand, selects the reference current value from either the starting or speed control modes. That is, the outer and inner loops determine the size and phase of the chopper currents, respectively. The gentle starting mode is switched off, and the speed control mode is enabled by sending a switching pulse to the selection switch. The soft starting mode is functional from the beginning



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Block diagram of the proposed control circuit

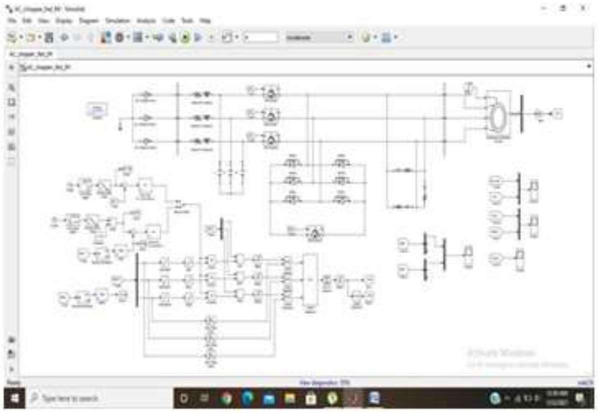
III SOFTWARE USED

MATLAB

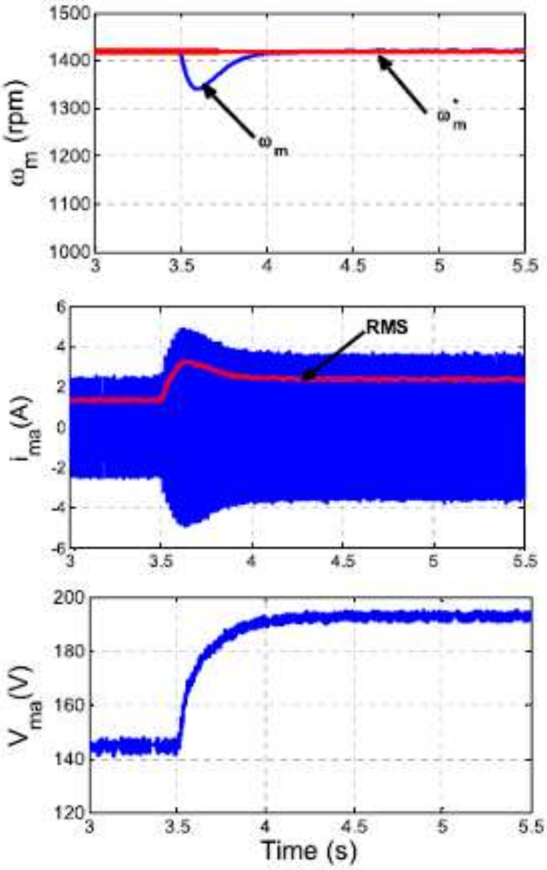
Matlab outperforms other applications when it comes to executing certain computations. It integrates arithmetic, graphics, and programming in an easy-to-use environment that displays problems and answers in well-known numerical format. Some common examples are: Addition and subtraction How have computers changed? Ensuring information security. Creating copies, models, and prototypes. Looking for, evaluating, and presenting facts Graphical user interfaces are part of the process of developing tools to enhance scientific and creative works.

A dimensionless cluster serves as the foundation for the intuitive Matlab technique. Many complex computer issues can be solved significantly faster than if a system is built using a linear, difficult-to-understand programming language such as C or Fortran. This is particularly true for network and vector planning challenges.

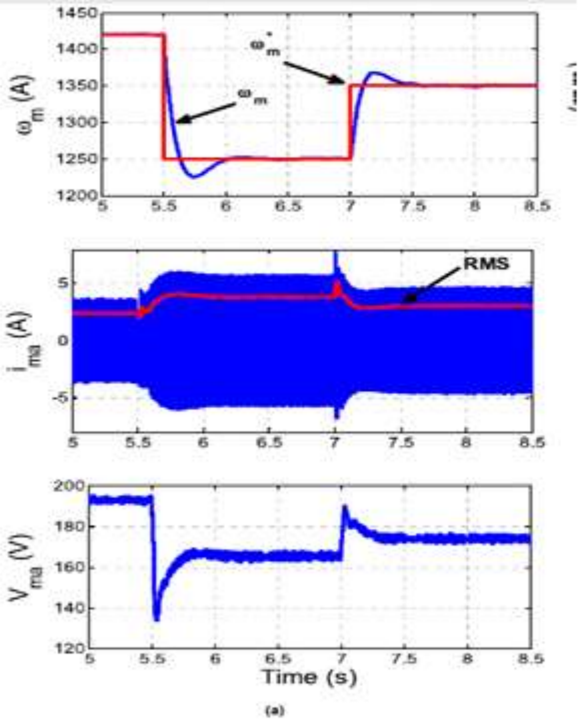
IV RESULTS



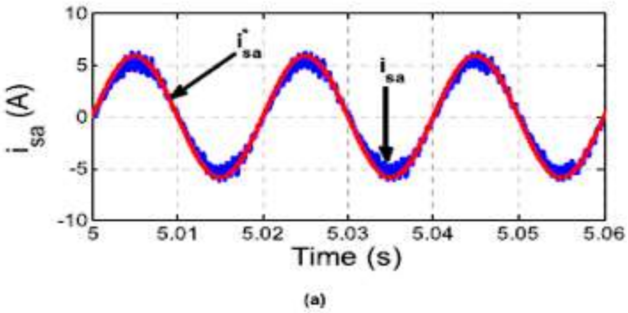
Matlab model



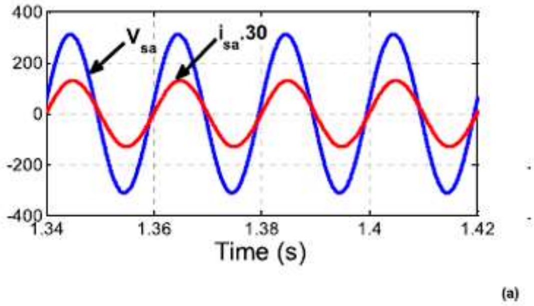
Variation of the motor speed, current and phase voltage at step change in the load torque. (a) Simulation.

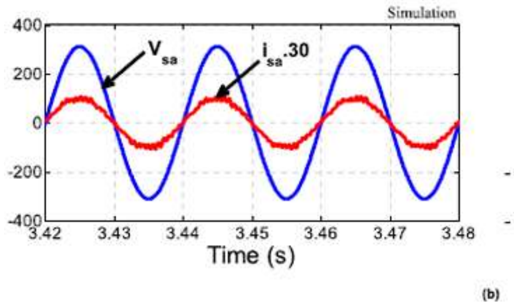


Variation of the motor speed, current and phase voltage at step change in the reference speed. (a) Simulation.



Reference and measured currents of the supply. (a) Simulation





Supply voltage and current at different testing cases of the proposed system. (a) Case 1. (b) Case 2. (c) Case 3.

V CONCLUSIONS

A novel three-phase squirrel cage induction motor powered by a pulse-width modulation (PWM) AC chopper was simulated and built in a laboratory using a dSPACE (DS1104) control board. The primary goal of control is to rectify the power factor of the input in various operational scenarios involving the induction motor drive system. The HBCC approach achieves input Power Factor Correction (PFC) by synchronizing the chopper's real currents with their reference currents, which are in phase with the input voltages.

The proposed control technique activates the AC chop's active switches with only two PWM pulses. The suggested technique is distinguished by its simplicity, reliability, and cost, as it only requires four IGBT switches. The mathematical analysis and operational concept for the proposed system are thoroughly defined. The facility was developed, and the system was simulated in MATLAB/SIMULINK.

The effectiveness of the proposed control technique was evaluated by varying the initial position, desired velocity, and applied torque. Empirical research and computational simulations support the proposed control approach's efficacy across all testing situations. The suggested Power Factor Correction (PFC) technique is compared to the system without PFC utilizing three test scenarios. The corrected power factor (PF) applied using the suggested power factor correction (PFC) approach improves the system's effectiveness, as seen by data comparison.

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