# REVIEW OF STUDIES ON MICROPROCESSOR CONTROL OF INVERTERS FOR AC DRIVES

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## Abstract

Microprocessor technique enables us to apply different control methods in today's control systems, including control of electric drives. In the drive controller, the signal processors with inbuilt analogue-digital converters, timers, pulse-width modulators and other devices, which simplify drive control, are commonly used.The various control strategies are used to control the drives but the development in semiconductor technology boosted the use of power devices in the drives. The demand for compact, reliable and automated drives existed and the development of drive has taken place in the right direction in variety of applications like power supply, tractions, vehicles, etc. which has no boundaries for the development. Personal computer made the control techniques easy but beyond that the microprocessor based single phase drives are demanded in the remote areas. Demand of control of power existed for many years which led early development of drives. Power handling capabilities and switching speed of power drives has been increased with development in semiconductor technology.The recent developments in electrical drive technology are motivated by the increasing requirements of industrial applications for higher performance, better reliability, and lower cost. They are due to the advances in several areas in particular power electronics, control theory, and microprocessor technology.

**Keywords**: Microprocessor, **Induction Motor Drive, speed sensing,** Variable Speed Drive

## I. INTRODUCTION

During the last two decades, power electronics has gained significant advances in several sectors. New power switches with better characteristics have been introduced (GTOs, MOSFETs, IGBTs), and new converter configurations as well as efficient commutation schemes (resonant converters) have been studied and experimented. Numerous advanced control algorithms for AC drives (self-controlled synchronous motor, field-oriented control, etc.) have been developed. Today, power electronic systems have attained an unusual high degree of complexity so that their control becomes more and more sophisticated.

The control of a power electronic system requires several functions of a different nature: signal filtering, regulation, drive signal generation, measurement, monitoring, protection, and so on. For a long time, the implementation of these functions has relied mainly on analog technology using a hardwired approach. Control circuits were built using operational amplifiers (op amps), nonlinear integrated circuits (ICs), and digital les. The last were used especially to implement sequential and combinatory logic functions in converter control circuits. The development of microprocessors has promoted the use of digital technology in the control of power electronic systems using a software approach that provides greater flexibility and better performance.

## II. LITERATURE REVIEW

Paresh.C.Sen et.al have proposed a microprocessor based control of an induction motor with flux regulation. In this they have developed the speed control system of an induction motor drive using a Motorola 6800 microprocessor and they have shown that motor current-slip frequency relationship for constant flux control is nonlinear and is difficult to implement using hardwired logic circuitry, so such a nonlinear function can be conveniently implemented by using a microprocessor control system by storing the nonlinear function as a look-up table in the computer memory. From the testmodel and experimental results, they have justified that microprocessor-control system is flexible and it allows a wide range of operating speeds.

K.S.Rajashekara and Joseph Vithayathil have proposed a microprocessor based sinusoidal PWM inverter by DMA transfer. In this they have discussed the implementation of three phase sinusoidal pulse width modulated inverter control strategy using microprocessor. In this to save CPU time, the DMA technique is used for transferring the switching pattern from memory to the pulse amplifier and isolation circuits of individual thyristors in the inverter bridge.

## III. SYSTEM DESIGN DETAILS AND CONTROL OF DRIVE

Fig.1 shows the detailed system diagram to control the drive of the single-phase induction motor powered by the inverter. The power electronics include an improved method for PWM control. There is an immediate control based on the microprocessor. Improvements in the PWM controlled process minimize the highest current loss of the transistor and motor with better sinusoidal waveforms. The system controller generates the appropriate frequency and amplitude signal of the stream using the microprocessor. Figure 2 shows the single-phase transistor bridge inverter. The triggering of the transistor sequence is 1-4 and 2-3, which supplies energy to the induction motor.

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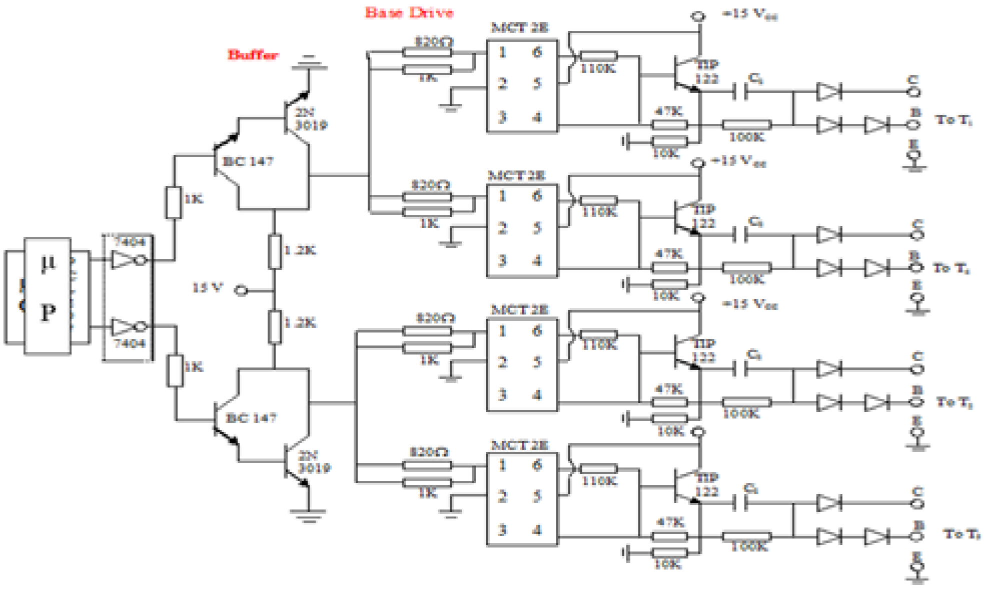


**Fig. 1. Complete circuit diagram of Induction Motor Drive**

PWM signals from the microprocessor are applied to the inverter, the buffer will help to increase the current capacity required to drive the transistors, and the isolator will isolate the power circuit from the control circuit. The TIP 122 settings help to provide the proper phase and amplification, but these signals are used as base signals to trip the transistor on the bridge. Based on the proposed control system, the microprocessor is used as a control element. The microprocessor provides high or low digital control data at its port.The period of remaining the data high is controlled by using the assembly language programming. The fixed interval of which the pulse remains high at the port and also remains low for fixed interval of time. The Time period over which is kept high depends on the delay time. This output of the port is used to drive the base of power transistor and hence the proportional power is controlled by using this technique. The proportional power gives open -loop control scheme has been formulated for the speed control of the induction motor drive feed formation from the voltage source inverter. The speed of the induction motor depends on the pulse width given to the base of the power transistor.The larger the pulse width more the speed and vice versa. The closed loop technique is not employed in this because the microprocessor if self-controls the pulse width through programming and hence speed is controlled.

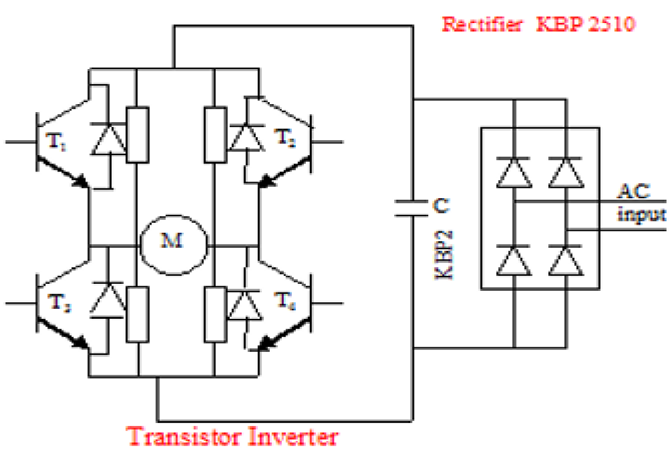


**Fig.2. Transistor Inverter Bridge**

A. Rectifier Module

A rectifier module is a combination of diode bridge and capacitor bank. The bridge is formed by combination of 4 power diodes (1N4006) which converts AC signal to DC. A dc filter capacitor bank is connected across the input to the inverter and serves to filter the input voltage and provide a low impedance path for the high frequency currents generated by the inverter during PWM switching.

B. Snubber design

The snubber circuit consists of simple method using register, capacitor in parallel with power module and parasitic inductance is placed in series with power module. The snubber circuit is effective during the turn-off of the transistor and snubber inductance is effective during turn-on.Snubbers are required because transistor have safe operating area limitations during turn-off to avoid catastrophic second breakdown failure.With inductive load transistor transfers the load current to the opposite oncoming feedback diode in same phase of inverter. When the transistor current falls opposite diode can begin to conduct load current. The snubber inductance in the inverter phase now generate an overshoot voltage which appears across the transistor during the transistor fall time and collector voltage begins to rise. The snubber capacitor begins to charge. The charging current is from the transistor charging the capacitor to be maximum. At the same time feedback diode begins to conduct and current is transferred from snubber to diode. The choice of snubber capacitance limits the peak overshoot which helps to reduce turn-off losses.

## IV. SIGNAL CONDITIONING

A. Speed Sensing

The basic block diagram of speed sensing is shown in Fig.3. The opto-interrupter device is used for speed measurement with the help of which two pulses were generated within one revolution of motor. These pulses were feed to the frequency to voltage converter (F to V). The output of the F to V converter is scaled in between 0 - 5 V for speed range of 0-1400 rpm, which is read through the A/D converter and scaled properly through software to display correct speed. The response of speed sensor is nonlinear at initial stage (i.e. at very low speed) and then it followslinearity.

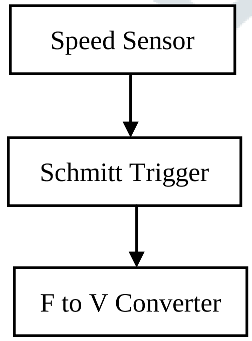


**Fig. 3. Block diagram of speed sensing**

B. AC Voltage Sensing

The AC voltage measurement was carried out by using the peak detector circuit. The variation in the voltage of the peak detector according to the line voltage changes fed to one of the ADC channel and is further converted to actual voltage by scaling the output voltage of peak detector through software

**CURRENT SENSING**

For current measurement simple technique is used, which consists of step up transformer whose primary is short-circuited by the shunt wire and the current through the shunt is given to the motor. The voltage drop across the shunt wire is proportional to the current passing through it, which is the current of the motor and secondary voltage is proportional to the motor current. The output voltage varies from 0 to 5 volt for variation of current from 0 to 5 ampere. There is linear relationship between input current and output voltage. The scaling is only essential.

A. Steps in flow generation

1. Initilization of ports of 8255
2. Clear port
3. Keep port A pin low for given delay
4. Store data in any register and decrement till it become zero.
5. Make port A pin high and keep it high for given delay
6. Store data in any register and decrement till it becomes 1
7. Continue this process.
8. For changing speed, vary pulse width at port A.
9. Continue with the changed width and speed.

**V.PLC 207 DAC-ADC INTERFACING CARD**

The PLC-207 AD/DA card is used for ADC or DAC purpose [9]. The card I low cost high performance analog interface card shown in fig. 4 which uses successive approximation method. This provides 25 thousands samples per sec. acquisition rate It is a 12 bit card with accuracy of 0.015 %. This provides fast output channel settling time 30 µS with high accuracy. It can accept 8 inputs and 12 monolithic multiplying DA output channel with 0-5V. The PCL207 provides powerful software driver which is very easy to use for routine programes.

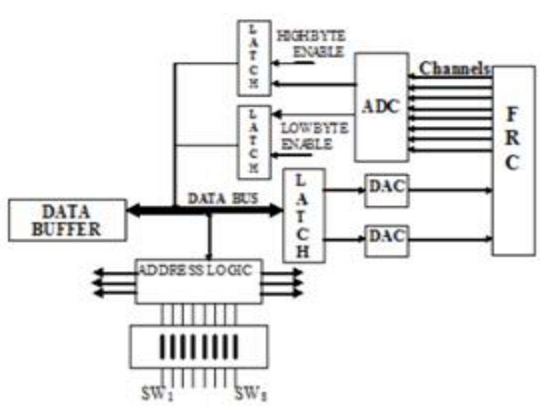


**Fig.4. Block Diagram of the PLC 207 Card**

## VI. SYSTEM PERFORMANCE

The system performance is tested for constant load and it is found that the speed of the system remains constant. With the help of the tachometer the speed of the system is measured at constant load. Keeping the constant load the pulse width of the firing of the transistor is varied with the help of the software. It is found that if pulse width is more the speed of the drive is also more and vice-versa. However, the system is open loop and any change in the load that may deviate from the desired speed. This system is quite suitable for the constant speed operations. The tachometer reading shows that there is no deviation of speed limits of the drive at least as well as highest pulse width. The performance is studied with the help of simulated technique for the different pulses. The fig.5 shows the graph of speed Torque characteristics for the different PWM schemes. From the graph it is seen that initial starting torque is higher and as the speed increases the torque decreases which gives strong support for the designed drive. The similar characteristics behaviour is observed with the simulation characteristics. After comparison it is found that the results of speed-torque characteristics of the designed drive using microprocessor gives the result almost similar performance to that of simulation. The speed efficiency characteristics are shown in the fig.6 for simulation drive as well as for designed drive. From the characteristics it is found that experimental drive has less efficiency due to the losses in the machines otherwise designed drive and simulated drive efficiency remains almost same.

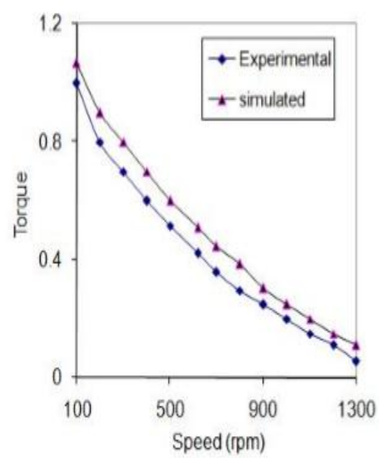


**Fig 5. Speed-Torque character for the simulated and Experimental drive**

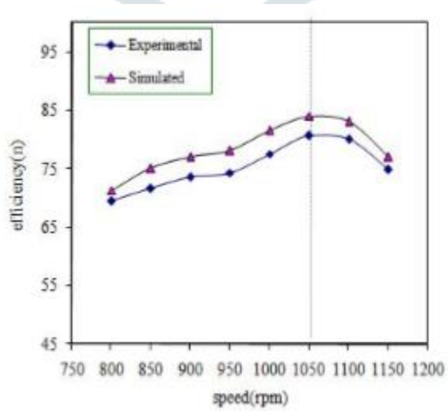


**Fig.6 Speed - Efficiency characteristics for the simulated and experimental drive.**

## CONCLUSION

The use of a Variable Speed Drive for a speed control application usually offers an energy efficient and economical solution. PWM inverter drives, are available for applications where the speed control accuracy is required. This compact inverter had its hardware reduced to a minimumthrough the use of H-bridge inverter. The variable speed drive with variable frequency and voltage control method will offer new, low-cost solutions for light commercial and consumer applications.

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