MICROPROCESSER AND CONTROLLERS GOVERNING OF INVERTERS FOR AC DRIVES

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Abstract

The microprocessor is a computer processor that integrates the functions of the central processing unit (CPU) on a single integrated circuit (IC) or at most a few integrated circuits. The microprocessor is a digitally-integrated, register-driven, multifunctional, clock-based circuit that accepts input binary data, processes it according to instructions stored in its memory, and provides output results. Microprocessors include combinational logic and sequential digital logic. Microprocessors use numbers and symbols that are represented in the binary numbering system.Using the recent improvements of power transistors as well as microprocessors it is now possible to develop high-dynamic-performance AC drives of moving contacts using synchronous or asynchronous motors. Each schemes acquire particular strengths. A general control principle, depending on field or even rotor orientation, is explained which has been recognized with a sophisticated microcomputer, wherever all the signal processing, such as modulation from the inverter, is completed by software. Extensive tests have been performed with motors to compare the actual characteristics in the various types of drives.

Keywords: Microprocessor, Induction Motor Drive, Microcomputer control.

I. INTRODUCTION

Controlled electrical drives with high dynamic performance are today almost invariably dc drives fed by power electronic converters. At larger ratings and in stationary applications the converters are of the line-commutated type, presenting an acceptable compromise between dynamic performance, efficiency, and cost. The dc motors, with their transparent control structure, are well suited for high-performance duty: the separately excited field affords flexibility and permits an enlarged speed range at reduced torque, similar to a continuously variable gear.The field winding is usually replaced by permanent magnets, thus excluding the possibility of field-weakening. To minimize motor inertia, which is important for rapid acceleration, two types of dc-servo motors have evolved: the slim-drum type motor of otherwise conventional design and the disk motor, having an iron-free armature and axial magnetic field. The first is often used for machine tool feed drives, while the second is preferred on robots because of its compact design and short axial length.

The motor is normally coupled to the mechanical load through gears because, with an electrical drive, a large power to weight ratio calls for high rotational speed. Of course the mechanical commutator sets a limit, often at 3000 min-; furthermore there are restrictions on temporary torque overload, particularly at very low speed or standstill, which is a frequent mode of operation with position-controlled servo drives.

II.AC Drive with transistor Inverter and Microcomputer control

The tasks of electromechanical power and ac/dc conversion, which are jointly carried out in the armature of a dc motor, areseparated in the ac drive, resulting in greater flexibility withregard to motor design. The magnetic flux necessary forproducing torque is set up either by permanent magnets in therotor or by magnetizing current in the stator windings. Thussynchronous or induction motors result, both of which can bedesigned as slim-drum or short-disk type motors.

Synchronous motors with permanent-magnet excitation may be further classified in those having an approximately sinusoidal flux distribution in the airgap and sinusoidal stator currents and the so-called brushless dc motors with built-in positionsensor, having a trapezoidal flux distribution and a currentsourcedc link. Only the synchronous motor with approximately sinusoidal stator currents (below voltage limit) and the induction motor will be discussed here. Both are supplied from a voltage-source transistor inverter with pulsewidth modulation; best dynamic performance is obtained by employingconstant link voltage. Both drives permit field-weakening and four-quadrant operation, even though the power generatedduring dynamic braking is usually absorbed in a ballastresistor to simplify the line-side converter.

A digital pulsewidth modulator may be directly coupled to the microcomputer controlling the drive. If the samplingfrequency at which the complete control algorithm is repeatedis identical with the pulse frequency of the power inverter,there is the additional benefit that the ripple on the currentsignals may be greatly reduced without the need for smoothingfilters.

To arrive at a valid comparison of the different types of drives, the same inverter and microcomputer hardware will be used for all the tests. The control algorithm is identical, withthe exception that the synchronous motor is controlled in rotorcoordinates while the induction motor control is performed in field coordinates, based on rotor flux. This calls for a flux model, which is bypassed in the case of the synchronousmotor. Obviously, when designing a control scheme for exclusive use with synchronous motors, the program could besimplified or a slower processor would suffice.

Experimental Program

The feasibility of implementing microprocessor based control of a controlled slip drive was verified in a 2 hp laboratory breadboard system. The induction motor is rated at 2 08/22 0 V, three phase 60 Hz and develops 2 hp at the nominal full load slip frequency of 2 Hz. The motor is powered by a three-phase bridge inverter using six Darlington power transistors.

Drive control Techniques

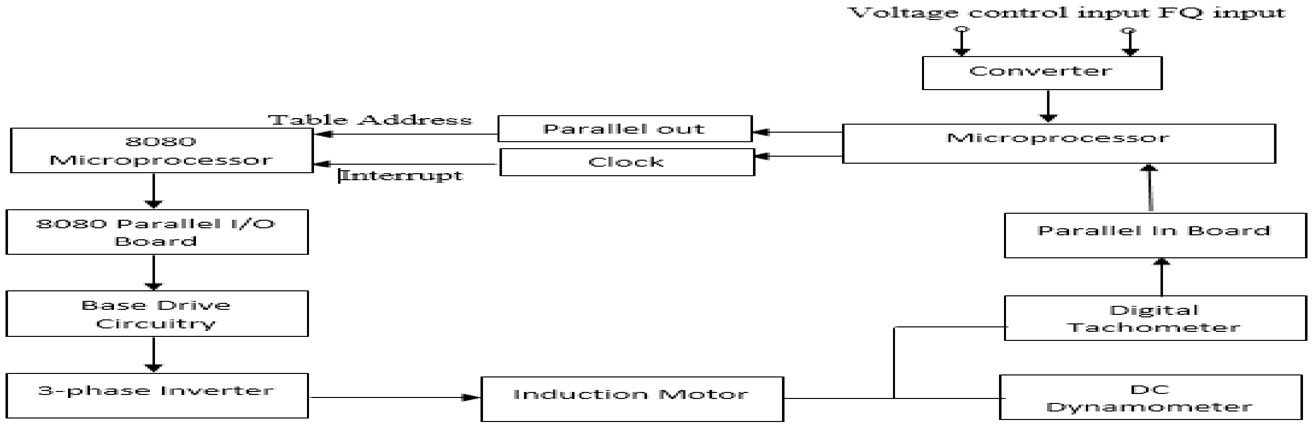

Figure 1. Block diagram of the microprocessor-Based controlled inverter drive

In a traction application the I.M can be operated at constant slip frequency or at controlled slip frequency. Figure. 1 is a block diagram of the control circuit configuration for implementing these techniques. When the constant slip frequency approach is used, the slip frequency is set at a fixed value which is high enough for the motor to develop sufficient torque. The accelerator pedal would be linked to a potentiometer which determines the inverter output voltage and hence controls motor torque. In the second technique, the demanded slip frequencyis controlled by the accelerator pedal depression up to a limiting value which is less than the breakdown slip frequency. The stator voltage is programmed to vary with stator frequency so that the required torque/speed characteristic is developed. Figure 1 Shows a Microprocessor acting as a host processor to control the 8080 system. The LSI-11 was, in fact, incorporated in a PDP 11/03 microcomputer. The 11/03 is a sophisticatedmicrocomputer with 28K of memory and multiple A/Dconverters on board. Many of its facilities werenot required in the present investigation but it formed a convenient means for developing the required microprocessor configuration.

In the controlled-slip mode of operation, the program continuously cycles through a loop which executes the following sequence of events:

The motor speed is read from the digital tachometer and is converted to a rotational frequency in hertz. The resulting value is saved.

The demanded slip frequency, as determined by a potentiometer linked to the accelerator pedal, is read by an A/D converter and fed to the LSI-11 microprocessor.

The slip frequency is added to the motor rotational frequency to determine the desired motor frequency.

This computed frequency is used to determine an offset into the voltage table. The address of the voltage pattern appropriate to the applied frequency is thus determined.

The computed frequency, which is adjustable in 2048 discrete increments, is used to program the clock so as to generate interrupts for the 8080 at intervals of one degree throughout the ac cycle.

The address of the appropriate voltage pattern is passed to the 8080.

The program branches to the top of the loop and repeats the entire process.

For fixed-slip operation, the sequence of events is essentially the same except that a potentiometer linked to the accelerator pedal defines the demanded voltage. The potentiometer setting is read by an A/D converter which determines the offset into the voltage table, and passes the appropriate address to the 8080.

Motor speed is detected by counting the pulses developed by a toothed wheel and optical encoder during a precisely controlled time period. The toothed wheel generates 240 pulses per revolution of the motor shaft and these pulses comprise the clock for a twelve-bit binary counter which is under the control of the LSI-11 microprocessor. When the counter has been read, a pulse is transmitted to initiate another count. The counter is cleared to zero and then begins counting for 125 ms. this sampling time gives a speed accuracy of 2% at 100 rpm, corresponding to a rotational frequency of 3.33 Hz. The accuracy at higher speeds is correspondingly better.

CONCLUSION

The feasibility of implementing a microprocessor based control system for a controlledslip drive has been demonstrated. The flexibility of a microprocessor system has proved highlyadvantageous for the comparison and evaluation of different control strategies but the processing speed of currently-available microprocessors has proved to be a limitation in some aspects of the control.

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