HIGH PERFORMANCE DIGITAL CONTROL SYSTEM OF AC MACHINES

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ABSTRACT. Using Digital Signal Processor (DSPs) for command and control of asynchronous motors, make these much more important in comparison with direct current motors. The extension of numeric systems is preferable because they improve the performance and the reliability.

ЦИФРОВИ СИТЕМИ ЗА УПРАВЛЕНИЕ С ВИСОКА ПРОИЗВОДИТЕЛНОСТ ЗА ЕЛЕКТРОМОТОРИ С ПРОМЕНЛИВ ТОК

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РЕЗЮМЕ. Използването на цифрови процесори за управление на асинхронни електромотори ги прави далеч по-често използвани от електромоторите с прав ток. Предпочита се използването на цифровите системи, тъй като те подобряват характеристиките и надеждността.

1. Introduction

The industrial processes use actuation systems which help start mechanical systems. To convert different forms of energy (electric, hydraulic, pneumatic, thermal) into mechanic energy, the help of motors is required.

Usually, the electrical actuation is used because of:
– electric power's availability;
– simple connection to energy source;
– electric motors robustness which allows overcharge in large limits for mechanical load;
– very good dynamic performances (short time for response between the moment when the common is applied and the moment of it's execution)
– high energetic efficaciousness
– high reliability
– low price, cost and maintenance cost
– possibility to modify revolution in large limits
– compatibilities between the command systems and electric motors

Electric motors used in actuations may be: DC motors (Direct current motors), AC motors and stepper motors.

DC motors, compared to the AC ones, have much higher performances.
– command circuits are more simple
– large domain for revolution adjustment (between 5%–100% from the nominal revolution)

With all these advantages, DCM have, compared to ACM, some disadvantages:
– have a bigger size and are more expensive for the same developed power;
– need higher maintenance expenses because of the brushes' presence and of the collecting lamellas which deteriorate in time and need to be replaced.

In the last 20 years, the revolutionary development of the electronic systems and of the power semiconductors has been determined by certain requirements regarding rational use of electric energy, reactive power compensation, miniaturized of the electronic systems. In this period new power semiconductor devices appeared and have been improved (modules with power transistors, DMOS and IGB + transistors, other devices with high performance isolated grill, hybrid systems, intelligent modules).

They allowed inventing (building) new types of converters.

Texas Instruments designed the platform TMS320F2812 destined to the command and digital control of electric motors. It ensures a high performance level, and also a low cost for the whole command system, its architecture being built around a DSP microcontroller.

Command numeric systems' expansion is preferred because:
- they ensure an unitary character for information process because only numeric calculus is used;
- increases and reliability of the adjustment systems;

- simplifies the structure of the equipments through elimination of analogical regulators, of digital-analogical converters and of the electric device which measures the angular speed or electric voltage;
- influences of the environmental conditions are substantially reduced, and also the technological dispersions upon static and dynamic performances of the adjustment systems are reduced;
- the performances and reliability of the regulators are improved, the numeric adjustment system is a mathematical relation, adapting or changing the algorithm assumes a simple change of the relation's parameters or of the whole formula and not of the circuit which implements the algorithm;
- the cost price decreases significantly.

2. Description of the system

The performance of the exclusively digital structures are limited by the sampling in duration, which affects the dynamic of the system (response time), and of the sampling in amplitude of the signal, which affects the adjustment precision in amplitude. To compensate these disadvantages, the following measures can be taken:

- designing some performing adjustment algorithms, which must compensate the sampling errors;
- use of fuzzy techniques and of the neural networks;

The use of DSPs offers a supplementary series of advantages:

- higher speeds of operation and higher resolutions;
- there can be used highly competitive adjustment algorithms which make it possible to reduce the number of sensors and transducers that are being used, and implicitly of the decrease of the cost price of the entire actuation system;
- lots of data can be calculated in a short time being gifted with powerful instructions (simultaneous addition and multiplication)
- allow the implementation of the adaptive driving systems, because they have the necessary calculus speed to monitor and drive the actuation system;

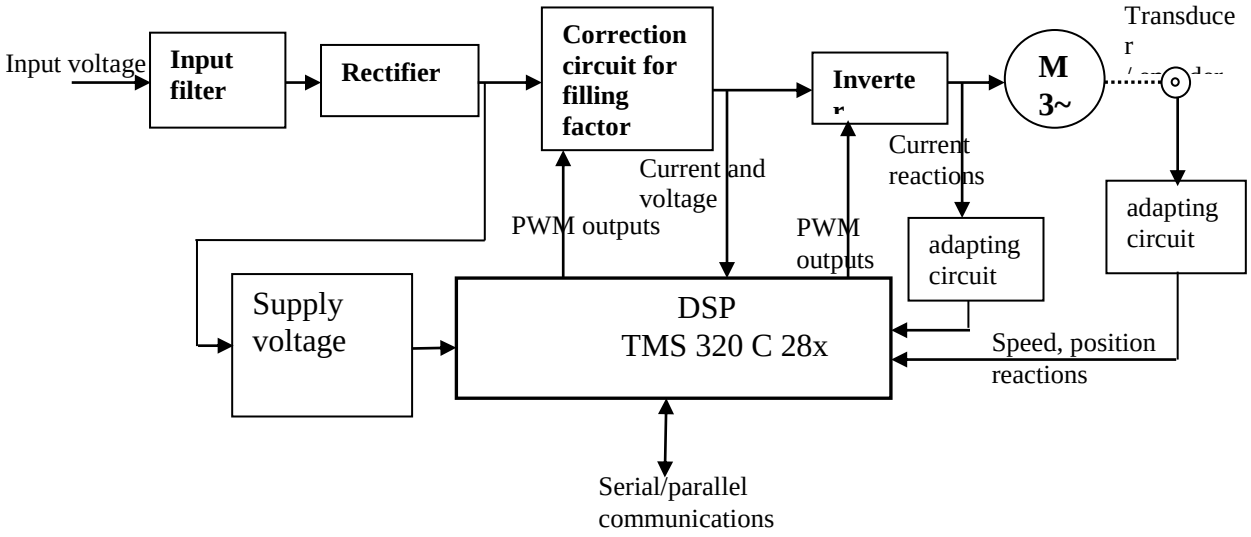

Fig. 1

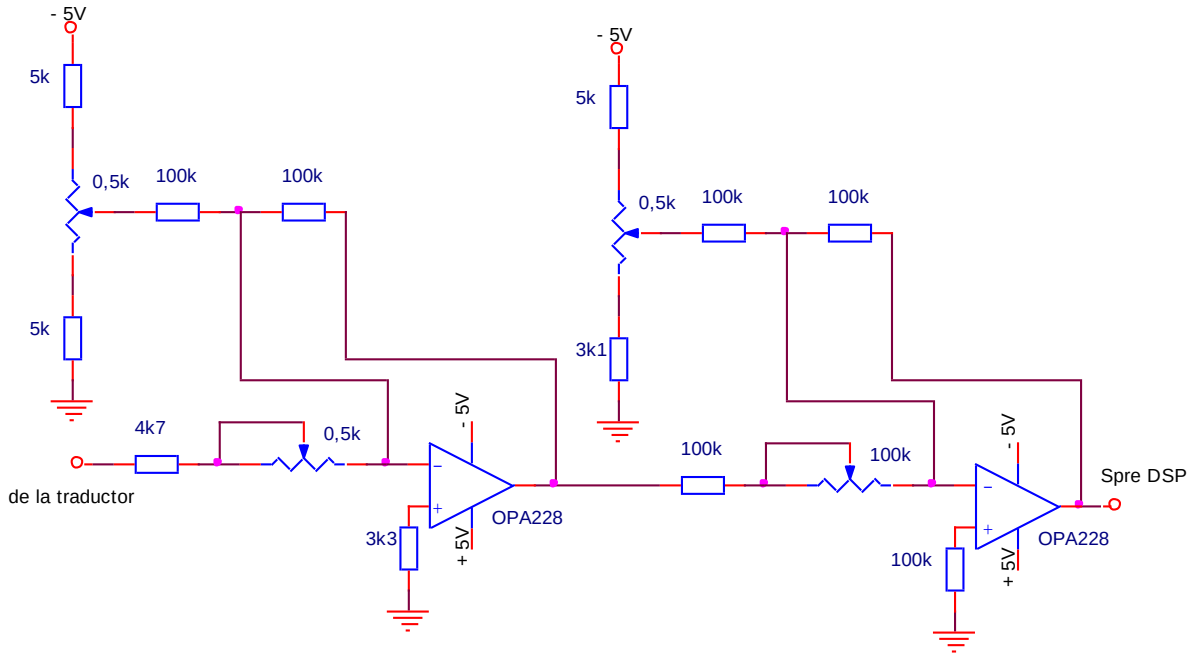

Fig. 2

- can monitor the frequency specter of the mechanic vibrations through use of spectral analysis and of the fast Fourier transform and, on this basis they can make a diagnosis, meaning that they can predict, in incipient phases, the damage states;
- allow the synthesize of the narrow band absorption filters with which the mechanic resonance (which may determine an instability of the adjustment system) is avoided.

In fig. 1 (below) is presented the block diagram of the speed of a AC motor from an adjustment system:

The current through the motor is measured with the help of two Hall transducers, mounted on two phases. The signal output from the transducers is adapted with the help of circuit in fig. 2.

The current transducers are LTS 25-NP type (LEM) with Hall effect and has the transfer characteristic:

$V_{out} = f(I_p)$, as in fig. 3

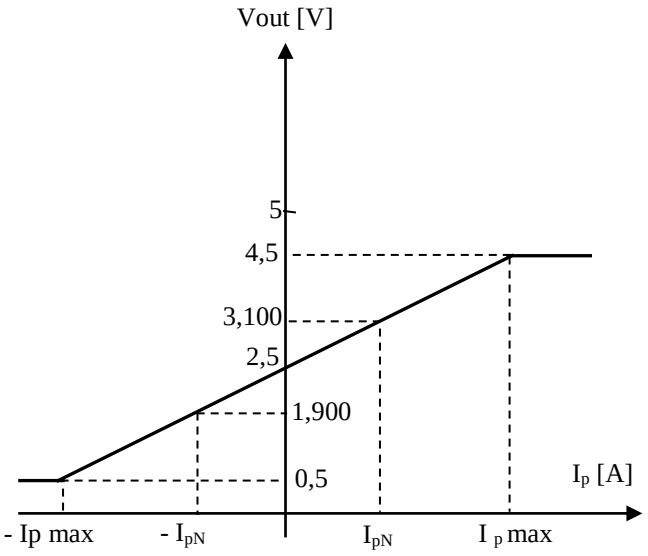

Fig. 3

For a certain pin connection, the effective nominal current from the primary circuit,

$I_{pN} = 8A$,

and the nominal output voltage is

$V_{OUT} = (2,5\pm0,600)V$.

In this application, the nominal current of the motor is 0,6A and the maximum value of the current through the motor is 1A. In this case, the maximum output voltage from the transducer is:

$V_{OUT} = (2,5\pm0,6/8)V = (2,5\pm0,075)V$

with a 75 mV variation.

The Operational Amplifiers (OA) from the adaptation circuit must have the offset voltage as low as possible, or even zero.

The first OA eliminates the 2,5V level, and eventually the offset, and the second one concentrates the signal to 1,5V because the DSP allows on the analogical inputs signals of 0÷3V.

The DSP's analogical-digital converters are on 12 bits and the signal will have to be adapted to 2,8672V for $F_p = 1A$.

The signal at DSP's input will have maximum variation (1,5±1,3672)V with 0,7V/quantum.

To adapt the output signals into PWM and the digital input ones, logical circuits, open collector type, are used.

3. Conclusions

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4. References

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