European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 1, Issue 8, November, 2023.

MICROCONTROLLERS AND AUTOMATIC CONTROL OF VIBRATION MACHINES

M. O. Khalikova,
PhD. Art. Teacher at the Academy of the Armed Forces of the Republic of Uzbekistan

Abstract
Microcontrollers allow flexibility to manage a variety of electronic and electrical devices. Some models are so powerful microcontroller that can directly switch the relay. In 1990-1991 there were actually 2-5 digital signal type names PAL and GAL, analog digital converters, classic operational amplifiers.

Keywords: microcontroller, electromagnetic vibration motors, vibration machines, dynamic mode, electric drive, scalar control, nonlinear differential equation.

Introduction

In recent years, truly revolutionary changes have occurred, such as:

- the emergence of high-performance digital signal processors, both fixed and floating point;
-the emergence of FPGAs with a capacity of up to 106 or more gates;
-the emergence of modern op-amps with a wide bandwidth of hundreds of MHz; rail-to-rail, supply voltage up to 1.8 V, etc.;
- the emergence of an ADC with a speed of more than 100 MHz and a bit depth of 10–12 bits;
- the emergence of fundamentally new components - digital quadrature downconverters, chipsets for digital radio receivers, LSI interfaces, programmable analog integrated circuits, etc.;
-the emergence of inexpensive mass-produced microcontrollers that make it easy to implement control functions and system interfaces;
widespread adoption of surface mount and high-density interconnect technologies;
widespread use of CAD tools for electronic equipment (EDA - Electronic Design Automotion), including both printed circuit board design tools, modeling and design tools for analog and digital devices, microprocessor development tools, and so on;
the emergence of the system-on-chip (SOC) development ideology.

A microcontroller is essentially a single-chip computer for controlling electronic structures, which combines the functions of a processor and peripheral devices with a random access memory (RAM) or read only memory (ROM) system.

Various modifications of controllers can operate at different frequencies and at different voltages in the power supply network. Energy-saving mode consists of completely or partially turning off peripheral devices and the computing module.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 1, Issue 8, November, 2023.

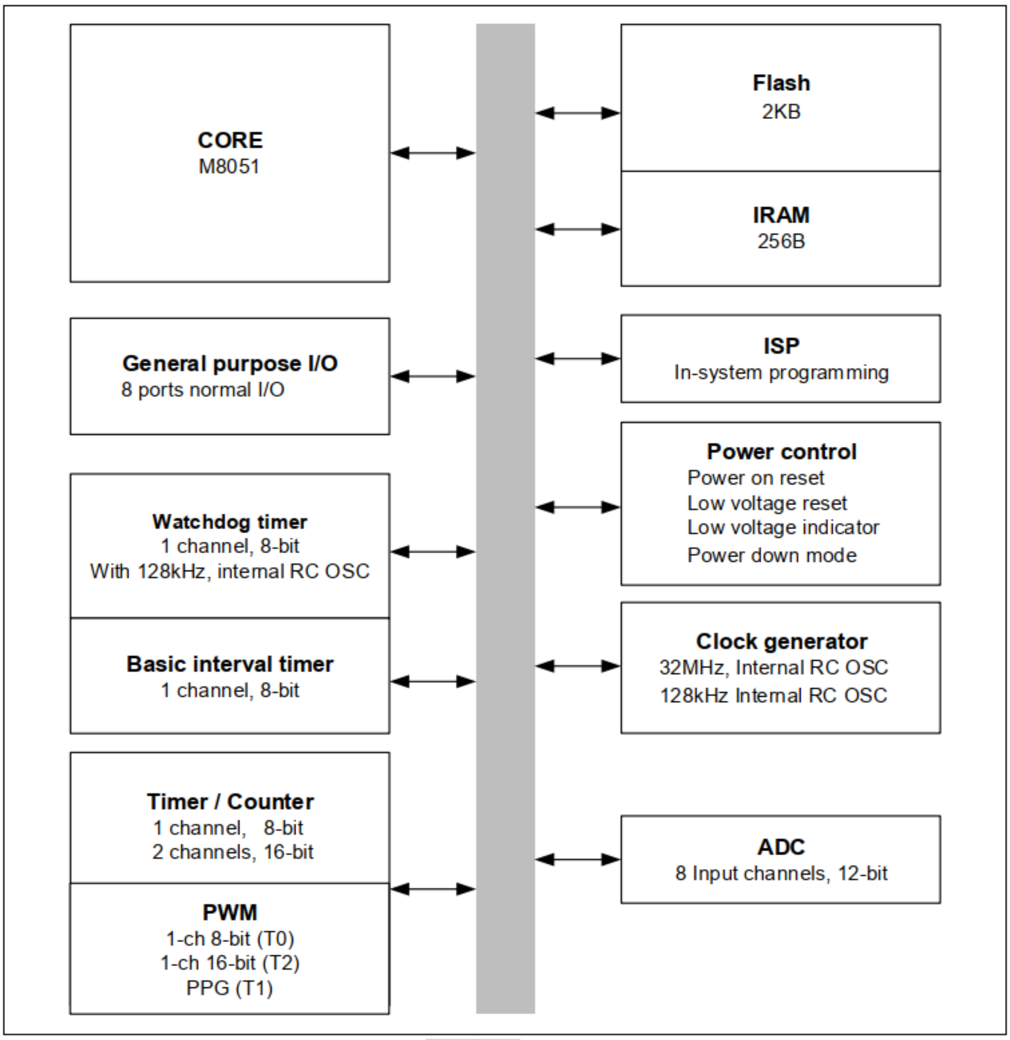

Fig.1. Schematic representation of a microcontroller.

A microcontroller differs from a microprocessor in the ability to integrate additional elements:
• Timer
• Universal digital ports, configurable for input or output
• Various interfaces such as Ethernet, etc.
• Pulse width modulators and analog-to-digital converters
• Comparators
• Clock generator
• Radio frequency receivers and transmitters, etc.

Eight-bit microprocessors have long been replaced by newer, more advanced models, while eight-bit microcontrollers remain in demand. This is due to the fact that the low final cost of an object is often a higher priority than its flexibility or high performance.

Today, there are more than 200 modifications of microcontrollers compatible with the i8051, produced by two dozen companies, and a large number of microcontrollers of other types. Popular among developers are 8-bit PIC microcontrollers from Microchip Technology and AVR from Atmel, 16-bit MSP430 from TI, as well as 32-bit microcontrollers of ARM architecture, which is developed by ARM Limited and sells licenses to other companies for their production.

A microcontroller is characterized by a large number of parameters, since it is simultaneously a complex software-controlled device and an electronic device (chip). The prefix “micro” in the name of the microcontroller means that it is implemented using microelectronic technology. The implementation of modern vibration technologies imposes qualitatively new requirements on electrical equipment, primarily on electric drives of vibration machines. Vibrating machines are widely used in various industries: mining, mining chemical, coal, in the production of building materials and in a number of other industries.

Vibration machines, in which vibrations of the working body are generated by two centrifugal exciters, were studied in detail in the works of I.I. Blekhmana, B.P. Lavrova, R.F. Nagaev, the problems of controlling vibrating machines are covered in the works of A.L. Fradkova, V.M. Shestakova, O.P. Tomchina. Today, the vast majority of vibration machines do not have automatic (or automated) control of vibration parameters. Some regulation of vibration parameters is carried out either by changing the magnitude of the unbalances of the rotating rotors, or by changing the rigidity of the elastic elements. Thus, the great potential possibilities for regulating vibration parameters by controlling electric drives remain unrealized.

The narrow ranges of existing control methods hinder the currently required expansion of technological modes and limit the area of effective application of vibrating machines. A significant expansion of these ranges and an increase in the manufacturability of vibrating machines can be achieved through automatic control of motion parameters by electric drives. Thus, an urgent task is the development of closed-loop control systems for electric drives of vibrating machines, based on modern advances in control theory and the emergence of highly efficient power electronics, instrumentation and computer technology.

The purpose of this article is to increase the operating efficiency of vibration machines by expanding technological modes. The expansion of technological modes includes: the ability of the vibrating machine to switch from one technological mode to another, using electric drive controls and increasing the roughness of operating modes. One of the ways to achieve this goal is to develop a control system for electric drives of vibrating machines.

Control systems for electric drives of vibrating machines to improve the efficiency of vibrating machines. The control system must ensure the fulfillment of the following conditions: achievement of specified modes, the ability to overcome resonant zones, while ensuring proper safety of the vibration installation; expansion of technological modes of vibrating machines, ensuring vibrations of the working body within the range of 10-25 Hz; stabilization of vibration parameters of the working body when the mass of the processed material varies; increasing the efficiency of vibrating machine operating modes by using the dynamic features of vibrating machines.

To synthesize the control laws, we distinguish three modes in the operating cycle of the vibrating machine: start-up, acceleration of electric drives to near operating speeds, and technological mode with a given oscillation frequency of the working element. The requirements for the control system in these modes are largely contradictory, namely: during start-up and initial acceleration, it is necessary to impose motion dynamics on the rotors from the drives, further acceleration should be carried out taking into account the vibration machine’s

own dynamics, and in the technological mode it is advisable to make maximum use of the system's own dynamics.
The main difficulty in developing such a control system lies in: the nonlinearity of the dynamic characteristics of the mechanical part; oscillator

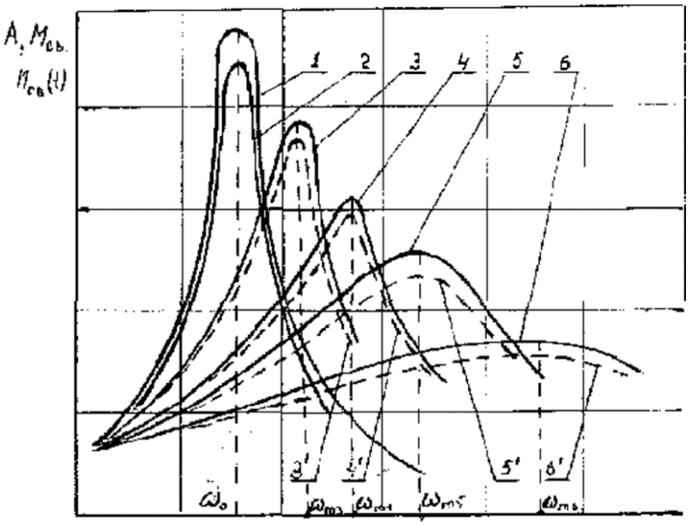

Fig.1. Static and dynamic mechanical characteristics of the VM at various ε> 0.

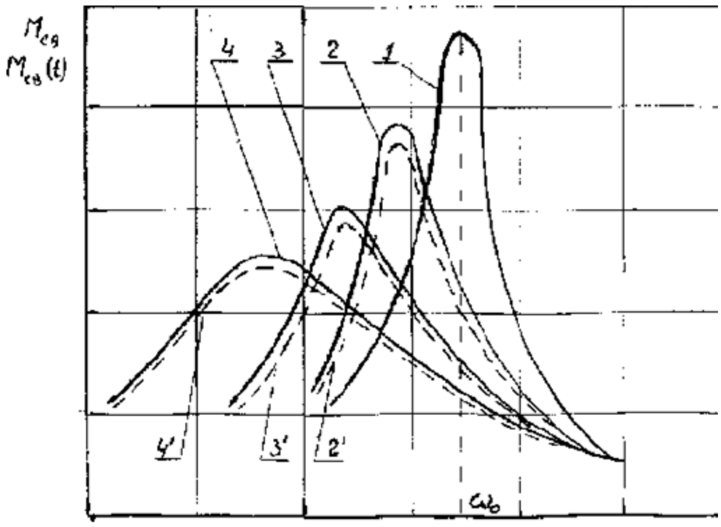

Fig.2. Static and dynamic mechanical characteristics of VMs for various ε<0.

When studying starting modes, dynamic stability, studying the quality of transient processes and other dynamic indicators of asynchronous vibration motors, they use the static mechanical characteristic of the production mechanism or the static moment of resistance
Recent research in this area has shown that in order to implement effective control, it is also necessary to take into account the relationship between the dynamics of mechanical and electromagnetic processes, that is, consider the vibration installation as a mechatronic object.
The design of an automatic control system is based on an approach to the study of multi-motor electromechanical systems with complex kinematics. It is advisable to call this approach

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 1, Issue 8, November, 2023.

mechatronic, since it includes methods for constructing highly adequate models of system dynamics, taking into account the inextricable connection of mechanical and electromagnetic processes in the system, the results of control theory and vibration mechanics, as well as modern microcontroller controls.

Currently, microprocessor control systems (MCS), including electromechanical objects, have become widespread. They carry out software and hardware control using programmable microcontrollers, which makes it possible to organize flexible control of the object and allows you to implement complex control laws through appropriate programming of the ISS. Due to the presence of a large range of microcontrollers from the simplest PIC controllers to relatively complex single-chip microcomputers, they are used in both systems with simple and complex structures.

According to their structure, automatic control systems (ACS) are divided into single-circuit and multi-circuit.

A single-circuit system contains a regulator and a control object with transfer functions Wreg(p) and Woy(p). The system provides stabilization of the controlled variable y(t) and processing of the simplest types of influences g(t) in the presence of disturbance; *□(t).* The functions of the controller include converting error information *□□g-y* into a control signal; u in accordance with the control algorithm (law) *u=u(□).*

The simplest controller is a proportional controller (P-regulator), for which *W(p)= KП, u(p)=KП□(p), u(t)=KП□(t)* .

The most common in electromechanical control systems is the proportional-integral control law (PI controller), which has a transfer function of the following form

$$W(p) = K_П + \frac{1}{T_И p} = \frac{T_И K_П p + 1}{T_И p} ,$$

and implementing the following control law.

$$u(t) = K_п \varepsilon(t) + \frac{1}{T_и} \int_0^t \varepsilon(t)\, dt .$$

One of the features of microcontroller control systems is the presence of time quantization with a period T, which is shown in the diagram in Fig. 1.2,b is represented by the presence of pulse elements (IE) and a digital controller that sets the angle of rotation φ_z for each time slice T. The choice of the quantization period depends on the requirements for the dynamic properties of the control system and the speed of the computing part of the microcontroller system. Typically, in electromechanical systems, the period T is a few milliseconds (1-5 ms), which places fairly high demands on the performance of control computers. The quantization cycle in the vibration exciter control system is quite small compared to the dynamics of the drive, since the CI67CR-LM microcontroller has sufficient performance. For small quantization cycles T0), equation (3.19) can be transformed into a difference equation using discretization, which consists of replacing the derivative with a first-order difference and the integral with a sum. Continuous integration can be replaced by integration using the method of rectangles or trapezoids

ISSN (E): 2938-3617
Volume 1, Issue 8, November, 2023.

The level of development of control theory, oscillation theory, and electric drive theory achieved today, in conjunction with the level of technical controls, electronics and electrical machines, allows us to assert the reality of creating vibration machines with adjustable parameters by means of automatic control.

References

1. Toirov O.Z, Khalikova M.O Applications of nonlinear electrical circuits for control and energy efficiency improvement electromagnetic vibration exciters // International Journal of Advanced Research in Science, Engineering and Technology. 2022. Vol.9, Issue 4. P. 19187-19193.
2. . Toirov O.Z, Khalikova M.O. Development of a mathematical model of a frequency-controlled electromagnetic vibration motor taking into account the nonlinear dependences of the characteristics of the elements // Engineering. Vol. 2022, https://www.journals.elsevier.com/engineering.
3. Герман-Галкин, С.Г. Виртуальные лаборатории полупроводниковых систем в среде Matlab-Simulink. Санкт-Петербург: Лань, 2013. 243 с.