562. An Idea of the Electronic Control System for the Multifunctional Hydraulic Machine

Jaroslaw Stryczek[1,a], Piotr Antoniak[1,b], Michal Banas[1,c]
[1]Wroclaw University of Technology, Insitute of Machine Design and Operation,
ul. Lukasiewicza 7/9, 50-371 Wroclaw, Poland
E-mail: [a]*jaroslaw.stryczek@pwr.wroc.pl,* [b]*piotr.antoniak@pwr.wroc.pl,* [c]*michal.banas@pwr.wroc.pl*

Abstract. The paper presents an electronic control system for application in mobile hydraulic systems. Key components of the system and its advantages have been discussed. A multifunctional hydraulic machine, its design and operation principle have been presented. The concept of control work machine with the electronic control system has been developed. The benefits of integration of these systems have been highlighted.

Keywords: mechatronic systems, mobile electronics, controller

Introduction

Microelectronic systems are currently widely used in drive systems and the share has been systematically increasing. Electronic systems have many advantages, primarily used in controlling. Thanks to microcontrollers, it is possible to easily change the control strategy, its parameters and characteristics. Although mainly used in mobile hydraulics [1], these systems improve and modernize the industrial hydraulic systems as well.

It is crucial for the multifunctional hydraulic machines (MHM) to be able to operate as different devices in the drive systems. The machines are particularly interesting because of their compact structure and reduced necessity of using additional machinery. Electronic control systems allows to fully exploit the advantages of the machines.

Electronic control system

Electronic control systems can take various forms. One way is to assemble the system including the controller, sensors and remote controls produced by different manufacturers, which is the way primarily used today. An alternative to this solution which would cause disruption in cooperation between elements of the system is to use an integrated system with a dedicated set of devices. An undoubted advantage of this solution is the single source, which also provides greater correctness of cooperation and expansion of the system.

An example of such complete system is BODAS provided by Bosch Rexroth (Fig. 1). The main unit of this system is a microcontroller integrated and covered in the robust body. The system contains, except for the microcontroller, mechanical and hydraulic sensors, joysticks, displays, tools and software. All the elements come from one source, so their cooperation is very good and provides full exploitation of possibilities.

The periphery devices include sensors of mechanical parameters such as speed, angle of rotation, force, displacement, but also pressure and temperature of the fluid [2]. Joysticks control two or more axes and enable on/off switch. Parameter values can be presented on a

329

color display, with a full customization of the interface. It supports the connection of a camera for the operator to observe the work area of the machine. All devices can be connected to the controller, process input signals and control selected mechanical as well as hydraulic components of the drive system.

Fig.1. Microelectronic control system BODAS [1]

Software creation is accomplished by means of special tools, which are universal thanks to various ways of entering the controller codes. In addition, predefined programs such as the fan drive, are developed. The complete system includes additional tools for diagnosing the system, programming, testing and numerous other actions, supporting the system implementation as well as its operation.

The CAN bus for connecting system components simplifies the electric connection and makes hardware and software easier to diagnose and correct the operation, or even facilitates further expansion of the system.

Multifunctional hydraulic machine with the electronic control system

Design and operation of MHM. Fig. 2 illustrates a drive system with the MHM. The system consists of the electric motor (1), MHM (2), the driven machine (3) and the fluid power system. There are two important units in the MHM. The first one is the three-gear pump (15), and the second one, the rotary spool valve (16). The MHM is joined to the fluid power system, which has been simplified to two components: the flow control valve (4) and the relief valve (5).

WMHZ can perform various tasks in the drive system, such as functioning as a pump, engine or speed changer. Each task requires a separate hydraulic system configuration. Fig. 2 represents the configuration of the hydraulic system to be operated as a speed changer.

When the MHM works as a speed changer, the electric motor (1) drives the gear pump, which sucks oil from the tank through the inlet line and presses it through the outlet line and the flow control valve (4) back into the tank. The body of the pump (15) rotates with the speed

330

resulted from the delivery of the pump. It causes the rotational movement of the rotational spool valve (16) and the working machine (3).

The speed of the working machine is controlled by the flow control valve (4). The speed can be changed by closing this valve, from zero by the opened valve, to the highest speed possible by the closed valve. When the valve is opened, the pump works with its full delivery and the output shaft does not rotate. When the valve is closed, the pump operated without delivery only to supply fluid for the leakages and the speed of the working machine achieves its maximum value. The relief valve (12) limits the highest pressure in the hydraulic system and the highest torque that the electric motor can be loaded with. Operating of the MHM in other functions was presented in [3].
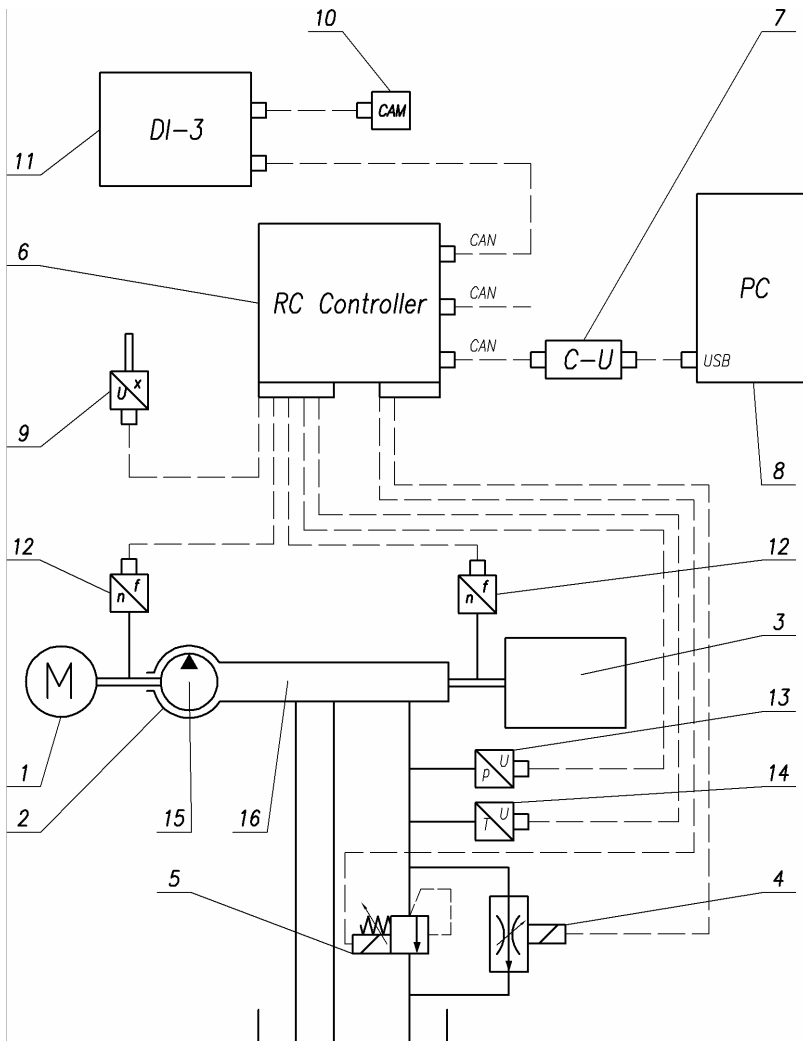

Fig. 2. Drive system with the MHM controlled by the BODAS system

Integration of MHM with the electronic control system. A concept has been developed for integrating the multifunctional hydraulic machine with the BODAS system, which enables to make the machine more powerful and to implement new functions.

Fig. 2 shows the electronic control system using BODAS system in which the main unit is controller RC (6). The machine speed is set with joystick (9), which additionally allows us to start and stop the machine and switch the automatic and manual mode of the speed control. The input and output shaft speed of MHM (12), pressure (13) and temperature (14) of fluid are transmitted to the controller. Speed signals are used as feedback for the control signals. Observation of the pressure protects the electric motor from overload and the temperature of working fluid from overheating on long-term work at overload. Speed control can be done by changing the flow control valve settings (4) and the value of maximum pressure is changed by controlling relief valve (5).

The display (11) shows the main operating parameters of the drive system and the direct preview of the machine operation with the use of the camera (10).

Implementation of the software and upload to the controller, as well as the control parameter settings, or modifications of the code are performed in the computer (8) connected through a converter USB/CAN (7) to the controller RC (6).

Use of the BODAS system enables better use of WMHZ. The actual output speed will closely correspond to the preset speed. It will be possible to simply switch from the manual mode, when the speed is controlled by the joystick, to the automatic mode, when the speed is controlled by the electronic system. The working time at the full load will be longer, since the system will monitor the parameters of the working liquid preventing its overheating and in the continuous way will limit the maximum pressure in the system.

Summary

The paper presents an electronic control system, lists its key features and discusses the components. The use of this system for controlling of the multifunction hydraulic machine has been proposed. A concept scheme of the system has been developed and the main aspects of operation have been discussed.

Application of the electronic control system has increased the capability of the presented MHM. It improved its controllability and increased its operational safety by using additional signals. BODAS system enables flexible adjustment of the working parameters for the drive systems of various machines and provides monitoring over the function changing process of the MHM.

References

[1] **C. von Reibnitz.** *BODAS – The System for Mobile Electronics*, Mobile 2006, International Mobile Hydraulics Congress, Ulm (2006).

[2] Product Catalog Mobile Hydraulics, RE 90005-02/07.06.

[3] **Banas M., Stryczek J.** *The design and modelling of the drive system with multifunctional hydrostatic machine*, Proceedings of 5th International Fluid Power Conference, Aachen (2006).