**10th International Research/Expert Conference**
**"Trends in the Development of Machinery and Associated Technology"**
**TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006**

# THE CONTROL WITH PROGRAMMABLE AUTOMATION OF THE INDUSTRIAL ROBOT RBH2

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## ABSTRACT
*The driving system of the industrial robot RBH2 is hydraulic. It is composed of a hydraulic unit with a drive power* $P = 2.5$ *KW and 12 solenoid valves. The control system of the industrial robot is composed of: a) TWIDO programmable automation made by the firm Schneider, b) interface for controlling the solenoid valves, c) supply source for solenoid valves, d) solenoid valves, e) position sensors. The TWIDO programmable logic controller (PLC) has the following features: 20 numerical inputs, 16 numerical outputs. The numerical signal from the position sensors of the industrial robots are taken over programmable automation. The numerical signals for controlling the solenoid valves are transmitted from programmable automation to the solenoid valve control interface. Depending on the technological process where the robot is used a control program for the solenoid valves of the robot driving circuit is issued. For each control algorithm of the industrial robot required by the technological process one program is to be issued that will be performed by means of the programmable automation.*
**Keywords:** industrial robot, programmable automation, solenoid valves.

## 1. INTRODUCTION
Various control systems are applied to the industrial robots, beginning with simple cyclical systems and finishing with complex systems with artificial intelligence elements. The choice of a control system for an industrial robot establishes, at an important extent, its degree of universality, its programming speed for performing another processing cycle, as well as its adaptability to different driving systems of the robot motions [1]. Beside this, the control system must provide the synchronizing of the automatic working cycle of the robot to the automatic working cycle of the technological equipment it services. Most of the industrial robots are equipped with automatic control systems. On 95% of these, the control is based on electrical or electronic principles, 3% on pneumatic principles and 2% on hydraulics. The pneumatic and hydraulic controls, interesting as principle and techniques, that are suitable for wide experimental researches, are only used for robots and manipulators of a simple design, working in explosive environment, [2]. This study is presenting a control system of the industrial robot model RBH 2, equipped with the programmable logic controller TWIDO.

## *2.* STRUCTURE OF THE CONTROL SYSTEM OF THE INDUSTRIAL ROBOT RBH 2
The driving system of the industrial robot is hydraulic. This is composed of a hydraulic group having a driving power $P = 2.5$ KW and 12 solenoid valves. The block diagram of the industrial robot control system is shown in Fig. 1. This is composed of: a) computer, IBM-PC compatible b) Programmable logical computer, model TWIDO manufactured by Schneider; c) Interface for controlling the solenoid valves d) Supply source for solenoids; e) Solenoid valves; f) Position sensors. The programmable logic controller (PLC) TWIDO model has the following features: 20 digital inputs, 16 digital

outputs [3]. From the position sensors, located on the industrial robot, the digital signals are taken over by the PLC. The control digital signals of the solenoid supply are transmitted from the PLC to the interface for solenoid valve control. In function of the technological process where the industrial robot is used, a control algorithm for the solenoid valves of the hydraulic circuits is issued. For each control algorithm of the industrial robot, imposed by a certain technological process, a program will be issued which will be performed by the PLC. The PLC is programmed with the help of the IBM – PC compatible computer, through the program TWIDO-SOFT. EXE.

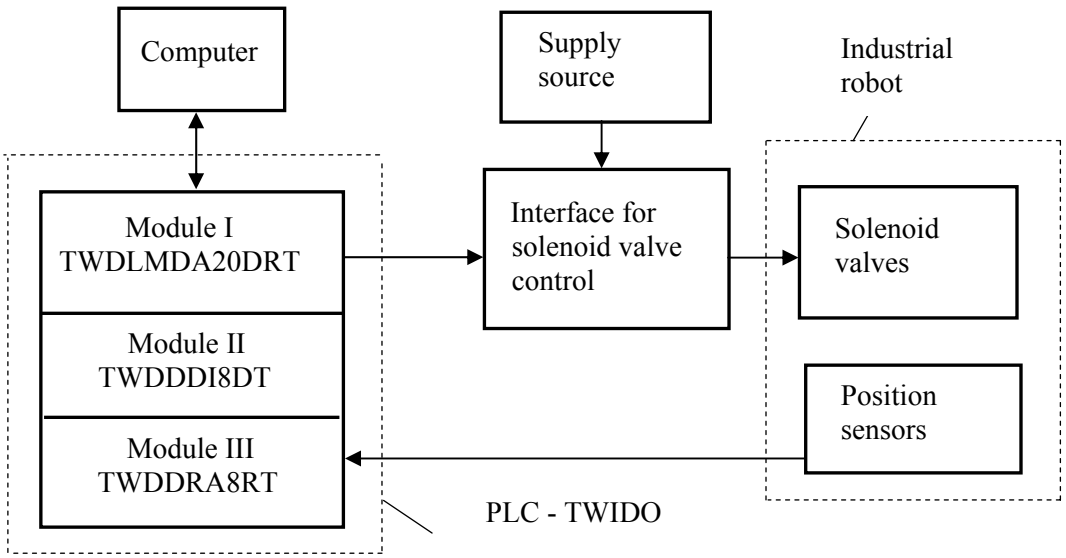


*Figure 1. Structure of the control system of the industrial robot RBH 2*

*The D. C. supply source* provides a maximum power of 100 W, a D. C. voltage of 24 V for supplying the solenoid valves as well as a stabilized voltage of 5 V D.C. for supplying the control modules of the solenoids. Fig. 2 is showing the diagram of a solenoid valve control module. The interface for the solenoid valve control is composed of 12 modules.

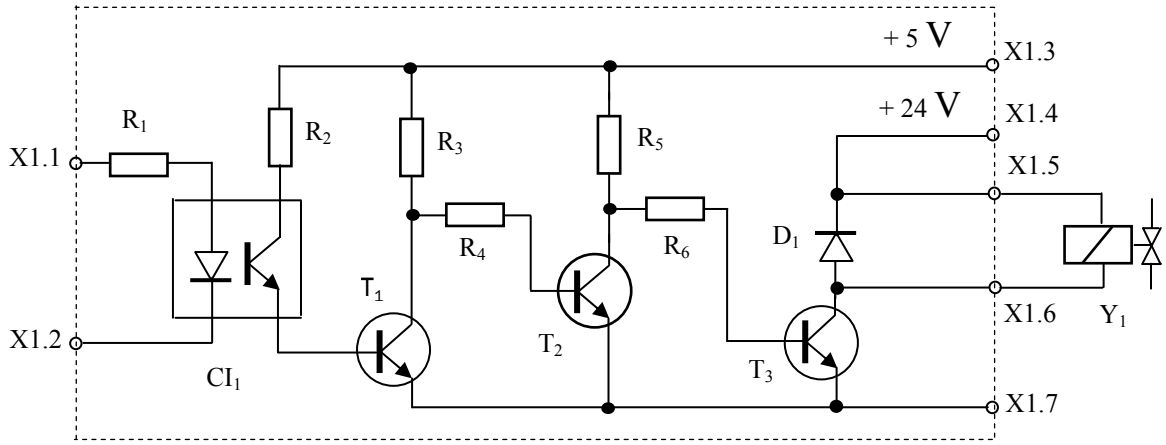


*Figure 2. Control module of a solenoid valve*

The signal coming from the PLC has to be amplified in order to convey the suitable power to the solenoid valve. In general there are many amplifying steps. Usually, stages with power transistors, directly coupled and thyristors are used for higher currents. The main problem of the control modules consists of the polarity of the voltage applied to the solenoid valve coils. From this point of view, the control modules are designed for single pole supply and bipolar supply [4]. Fig. 2 is showing a single

pole control module, for one solenoid valve. The PLC signal is applied through the opto-connector $CI_1$ to the base of the transistor $T_1$. The saturation of the transistor $T_1$ implies the blocking of the transistor $T_2$ and saturation of the transistor $T_3$ that will make a way of current from the voltage supply of the solenoid valves through the solenoid/coil to the groundmass. When the PLC signal is zero, the transistor $T_1$ is blocked. This saturates the transistor $T_2$ and blocks $T_3$. The diode $D_1$ limits the over voltage upon the transistor blocking, due to the leak current that closes through the solenoid and the respective diode. This diode is also known as suppressor diode.
*The solenoid valves* are supplied at 24 V. D.C. and have their rated power is 40 W.
*The position sensors* are 2-position micro switches. They are limiting the travels and the position of the gripping double mechanism of the robot. The industrial robot RBH-2 has a cylindrical working space, featuring two translation axes and one rotary axis. Its orientation motions are composed of one rotation motion and one translation motion.

## 3. THE SOFTWARE STRUCTURE OF THE CONTROL SYSTEM

The control algorithm of the solenoid valves of the robot drive hydraulic circuit requires the following stages to be attended:
- Control of the hydraulic unit start-up.
- PLC supply
- Editing the functioning program with the help of the program TWIDO-SOFT.EXE
- Transferring the program from the computer to the memory of the TWIDO PLC.
- Staring up the program performance.

## 4. EXPERIMENTAL FINDINGS

For the industrial robot RBH-2 located in the production workshop of the Engineering Faculty – Bacau, the control system was built, with the TWIDO type PLC whose structure is presented in Fig. 1. Several versions of motions have been established, for various technological processes within the complex systems for metal parts machining. These motion versions have a role in students training as well. For each motion algorithm a program was issued for the TWIDO PLC. These programs have been implemented and validated on the RBH-2 industrial robot but they can be used for other industrial robots as well. Various functioning modes of the robot have been verified. .

## 5. CONCLUSIONS

This paper presented a control system of an industrial robot, with the TWIDO type programmable logic controller (PLC) manufactured by Schneider. The hardware structure of the control system is composed of a IBM –PC compatible computer, the TWIDO PLC, an interface for solenoid valve control, a supply source for solenoid valves, solenoid valves and position sensors. In function of the technological process for which the industrial robot is used, control algorithms have been issued for the solenoid valves of the industrial robot drive hydraulic circuit. Based on these algorithms, programs have been issued for the PLC that have been implemented and validated on the industrial robot model RBH-2.

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