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CONTROL OF THREE-PHASE ASYNCHRONOUS MOTOR WITH PROGRAMMABLE LOGIC CONTROLLER

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ABSTRACT
This paper is presenting a control system equipped with programmable automation TWIDO for star-delta starting of three-phase asynchronous motors with short circuited rotor. For programming the TWIDO programmable logic controller (PLC), the program TWIDO-SOFT.EXE is used. The control system is composed of: TWIDO programmable logic controller, high voltage contactor for the asynchronous motor supply, interface for controlling the contactor coils, control buttons and signal circuits. The star- delta automatic start-up of three-phase asynchronous motor is provided.
Keywords: asynchronous motor, programmable logic controller, star-delta

1. INTRODUCTION
The control systems with finite states can be built in wired logic or programmed logic. The wired logic systems are characterized through: - The function being performed depends on the connection between modules; i.e. on the wiring; – Any change of the function applied to the control system requires hardware changes. A fundamental approach, different from the synthesis of the finite states control systems is known as programmed logic. This category is including all systems whose functioning is based on a program stored into a memory. The systems functioning through a program are universal, because any functions can be implemented without requiring hardware changes. In such a case, for any design theme, the activity consists of programming the system memory. The program – based systems include: - The central unit that performs the program instructions, - The memory, storing the program, - Interface circuits through which the control system communicates with the process. The programmed logical systems can solve high complexity problems for which a high amount of data is processed, through complex algorithms. This study is presenting a control system equipped with the TWIDO type programmable logic controller, for star-delta start-up of a three-phase asynchronous motor (MAT) with short-circuited rotor.

2. CONTROL SYSTEMS OF THE THREE-PHASE ASYNCHRONOUS MOTOR
2.1 Electrical Diagram of a MAT Control, Built in Wired Logic.
The electric diagram for controlling the Star-Delta start-up of the three-phase asynchronous motor, built in wired logic is shown in Fig. 1. When pushing the start-up button, S_1 (normally open, with resetting) the coils of the contactor C_λ and time relay K_{1T} are supplied at the same time. The star connection of the phase windings of the three-phase asynchronous motor is done through the contacts of the power circuit *32* of the contactor C_y. Simultaneously, the auxiliary contact of the contactor C_y in the circuit 4 (Fig. 1), [1]. Thus the coil of the line contactor C is supplied, the contactor will close its self-retention contact C in the circuit 5, as well as the main contacts C in the power circuit *31*, connecting the stator of the three-phase asynchronous motor to the mains supply. The motor will start in Star connection and, after a time t_p previously adjusted, the contact K_{1T} (in the circuit 2) will open,

thus interrupting the supply of the C_λ contactor coil. Its contact C_λ, in the circuit 6 will close, thus allowing the supply of the C_Δ contactor coil. This will close its main contacts C_Δ in the circuit *33*, connecting the stator winding in Delta. It is obvious that, along with cutting the supply of the C_λ contactor coil, its main contacts in the circuit 32 opened, so the motor will continue running in Delta connection. The start-up time t_p of the time relay K_{1T} is adjusted so that the switching from Star to Delta connection to be done at the moment when the rotation speed (rpm) being reached is approx 95% of the speed at stationary duty. Noncompliance with this condition leads to occurrence of important current and torque shocks that annul the advantages specific to this start-up method. Upon pushing the button S_2 (normally closed, with resetting) the three-phase asynchronous motor stops. Through the usage of this method, the start-up current will be decreased three times [2]:

$$I_{p\lambda} = \frac{I_{p\Delta}}{3} \tag{1}$$

The torque during Star start-up will also be three times lower than the torque at Delta start-up:

$$M_{p\lambda} = \frac{M_{p\Delta}}{3} \tag{2}$$

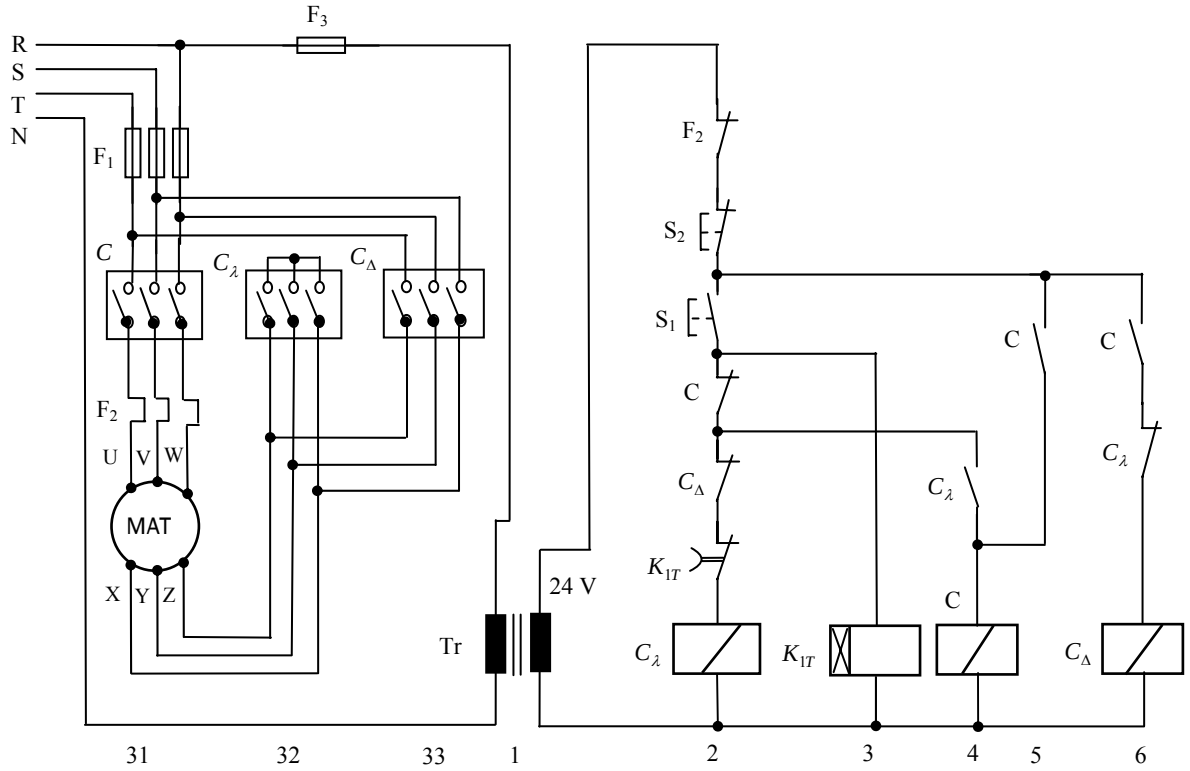

Figure 1. Electric diagram of a MAT control, built in wired logic.

2.2 Electrical Diagram of a MAT Control, Built in Programmed Logic

The block diagram of the control system of a MAT, built with the TWIDO type PLC is shown in Fig. 2. The control system is composed of: TWIDO programmable logic controller, high voltage contactor for the asynchronous motor supply, interface for controlling the contactor coils, control buttons and signal circuits. The TWIDO PLC is manufactured by Schneider and is composed of three modules [4]: The module I that includes the central unit and has 12 digital inputs and 8 digital outputs, the extension module II that has 8 digital inputs and the extension module III that has 8 digital outputs.

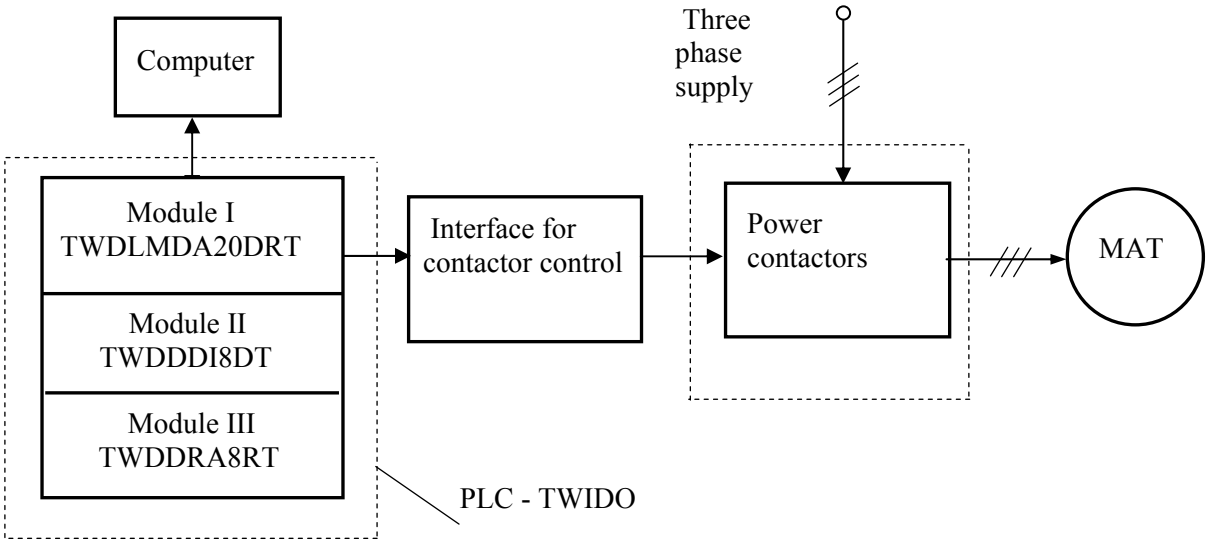

Figure 2. The electrical diagram of a MAT control, built with a PLC.

The electrical diagram of a MAT control, built with TWIDO PLC is shown in Fig. 3. On the inputs I_1, I_2 and I_3 of the PLC, the signals from the start-up and stop push buttons S_1, S_2 are applied, as well as the normally closed contact (NC) of the overload protection relay on the power supply circuit of the MAT.

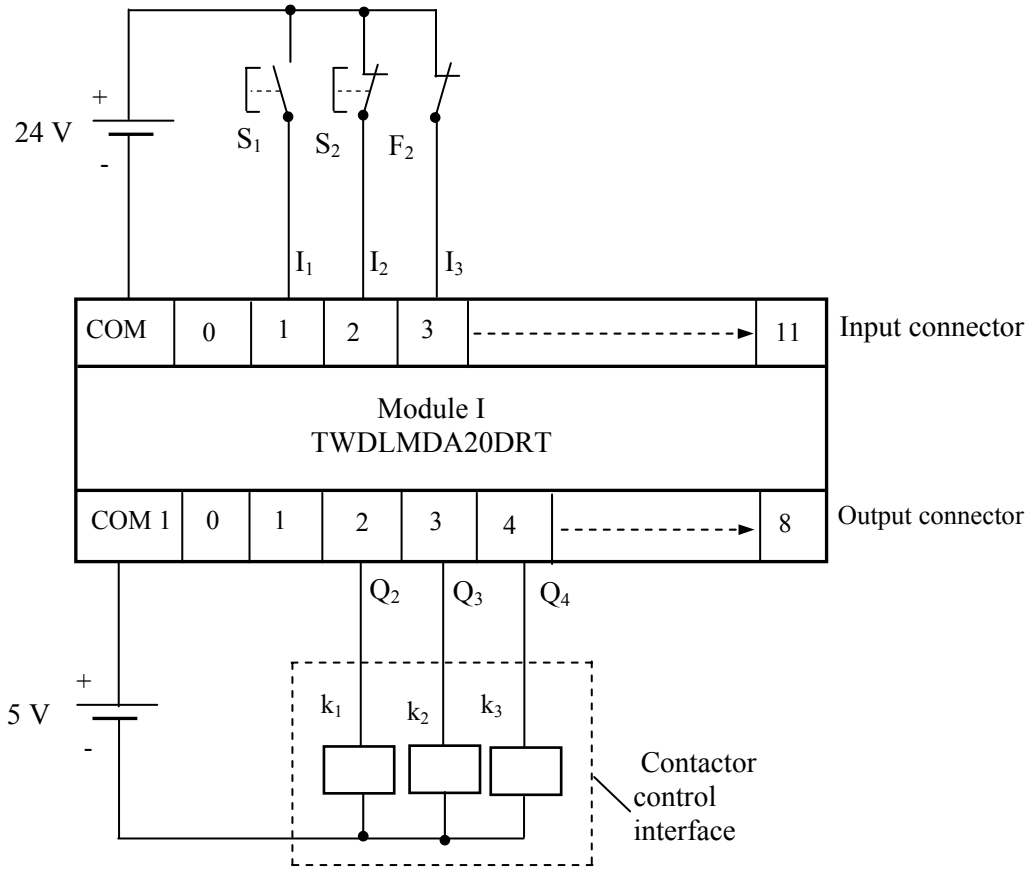

Figure 3. The electrical diagram of a MAT control built in programmed logic.

On the outputs Q_2, Q_3 and Q_4 of the PLC the miniature relays k_1, k_2 and k_3 are connected, that are the interface for the control of the power contactors in the supply circuit of the three phase asynchronous motor. The contacts of these relays are used for controlling the supply of the C_y, C and C_Δ contactor coils, as per Fig. 4. Through the usage of the TWIDO PLC a control system of better performance is obtained, featuring a higher reliability as well.

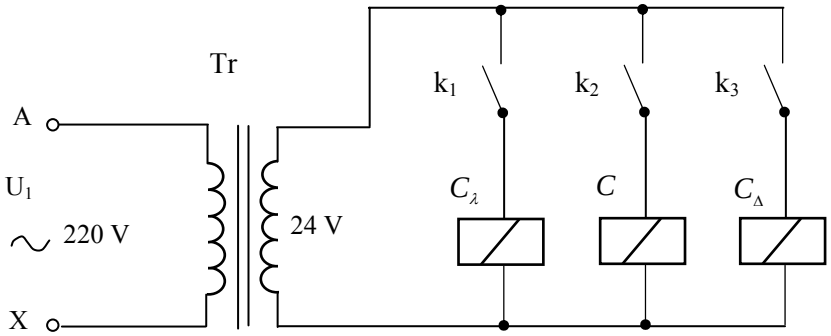

Figure 4. Control diagram of the power contactors supply.

3. EXPERIMENTAL FINDINGS

Within the Electrical Machinery Laboratory of the Bacau University, the control systems with wired logic and programmed logic for Star-Delta start-up of a three phase asynchronous motor have been built. For the PLC the application program has been produced, using the language based on diagrams with contacts, [5]. The running program has been edited with the help of the program TWIDO.SOFT.EXE installed on a IBM.-PC compatible computer. The program has been transferred from the TWIDO PLC memory by means of special connection cable. The program has been implemented and validated for a three phase asynchronous motor with short circuited rotor, having the following features: $P_n = 1.5$ KW, $n_n = 930$ rpm, $U_{l\Delta} = 220$ V.

4. CONCLUSIONS

This paper is presenting a control system for Star-Delta start-up of the three phase asynchronous motor with short circuited rotor, built in both wired logic and programmed logic. The control electric diagram in programmed logic was built with a programmable logical controller (PLC), TWIDO type, manufactured by Schneider. Through the usage of the TWIDO PLC a control system having better performances and reliability is obtained, compared to the wired logic control system.

5. REFERENCES

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