MATEC Web of Conferences **112**, 05004 (2017) DOI: 10.1051/matecconf/201711205004
IManE&E 2017

The network control system of high-bay warehouse

Julian Malaka, *Andrzej* Wróbel*, and *Marek* Płaczek

Silesian University of Technology, Faculty of Mechanical Engineering, Institute of Engineering Processes Automation and Integrated Manufacturing Systems, Konarskiego 18A, 44-100 Gliwice, Poland

Abstract. Presentation of developing a method of automation of the storage process using electric drives with frequency converters, logic control and communication in industrial networks was the main purpose of this article. A connection structure was proposed to exchange information between devices that are part of a high-storage warehouse. It was assumed that modern communication protocols are used to synchronize the drives and to create a central control and information center in the PLC. The results of theoretical considerations were applied in practice by performing a laboratory model of a high storage warehouse with a developed automatic control system. Benefits of the proposed solutions was shown in the conclusions.

1 Introduction

The work was focused on the aspects of control and automation of traffic in a high-bay warehouse. Before the research, the character of the devices was known. It was necessary to consider the automation of the process in question with the use of hardware solutions, which was the subject of research. It was expected that a high-storage warehouse model would be created, with the implemented control system developed during the study.

2 Choice of hardware and communication solutions

Taking into account the speed of processing and information exchange, functionality as well as device compatibility, hardware solutions and the structure of the control system were proposed to allow for the achievement of the intended objectives.

2.1 Drives

Linear motion in two perpendicular axes in the plane was the main assumption of motion. Horizontal displacement was achieved by a mechanism consisting of a wheelchair moving along a track coupled to a belt gear belt. The gear wheel is driven by a gearmotor with an electric three-phase asynchronous motor, equipped with an incremental encoder. The

* Corresponding author: andrzej.wrobel@polsl.pl

MOVIDRIVE® MDX61B frequency converter from SEW EURDRIVE was selected for motor control. On the carriage is mounted to the gear system comprising a screw-rolling, and an electrical actuator with single-phase motor. It corresponds to the vertical displacement of the gripper for the storage of items. The servo drive is controlled by B & R's ACOPOS 8V1016.50 2 frequency inverter. Frequency inverters have been selected for control of both drives to operate over a wide range of rotational speeds and with high positioning accuracy. In order to perform the intended tasks, both frequency inverters must be equipped with additional modules - encoder cards and communication cards (for MOVIDRIVE® MDX61B - for Modbus / TCP protocol, for ACOPOS 8V1016.50-2 - for POWERLINK protocol).

2.2 Master Control

It was assumed that the master control unit in the proposed system is to be a programmable logic controller. In addition to supporting various communication protocols, and input and output signals PLC allows to establish a connection with process visualization on the screen synoptic device HMI or SCADA system. An important aspect is collecting data in the control unit on the state of the drives that based on them to send signals to the actuators, triggering the corresponding movement sequences. The parameter transmitted by the network, which determines the possibility of positioning and synchronizing the motors to the current position, determined using the encoder.

2.3 Main idea of network connection

In Figure 1 diagram of the network connection, on which are marked the path and direction of flow of information is shown. Due to the configuration of the hardware to communicate with their inverters from various manufacturers, all with different network cards, it was selected two protocols: Modbus and POWERLINK. In both cases, the connection is realized via Ethernet. You can also use it to communicate with the HMI device driver, and SCADA system with a computer, thanks to the OPC Unified Architecture. Connection of industrial equipment via Ethernet becoming general practice because of switches, hubs or routers can be easily added to the network further objects participating in the exchange of data.

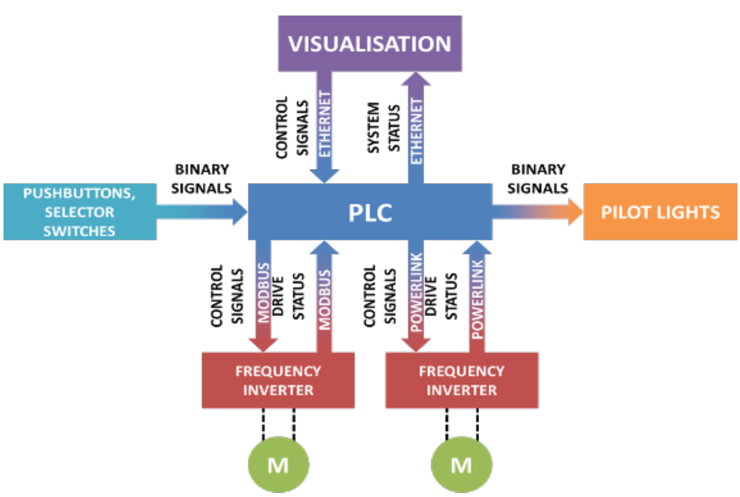

Fig. 1. Diagram of the network connection in the project high-bay warehouse.

3 Application of developed solutions in practice

In order to accomplish the intended tasks, the frequency inverters had to be equipped with additional modules - encoder cards and communication cards (MOVIDRIVE® MDX61B for Modbus / TCP protocol, ACOPOS 8V1016.50-2 for POWERLINK protocol).

Fig. 2. View of the front panels used frequency converters with attached modules, where: A - communication card DFE11B; B - DEH11B Encoder card; C - communication card AC114; D - Card Encoder AC120.

The system uses an X20CP1584 B & R controller with two Ethernet connectors - one for POWERLINK communication and the other for configuring the device to exchange information using the Modbus protocol. A network switch was used to connect the PLC, MOVIDRIVE® MDX61B frequency inverter and computer [1, 2-4].

3.1 Hardware Configuration

Programming of X20CP1584 was carried out in a computer program Automation Studio. It also allows you to configure all the devices B&R connected to the controller. In this way, introduced among other things, information about the type of motor connected to the inverter or the address of the device having to exchange data with the controller via Modbus protocol. The frequency converter SEW EURODRIVE was configured using a computer program MOVITOOLS® MotionStudio. Description parameter aimed at properly communicated frequency converters and PLC are given in sections 3.3.

3.2 Configuring the connection of the controller with the drive ACOPOS 8V1016.50 2

Communication between the controller and devices connected to it shall be established by placing, connecting and editing components on the graphical diagram hardware that shown in Figure 3.

When entering drive to the hardware scheme in the Automation Studio must indicate in which additional modules are equipped. The presence of a network adapter allows you to create the schematic connection with the controller, which requires no additional configuration.

 DOI: 10.1051/matecconf/201711205004

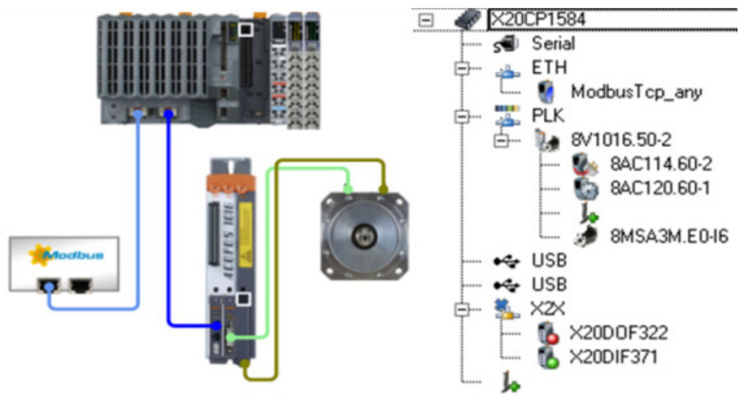

Fig. 3. Graphical representation of the hardware connections and the tree components created during the configuration of the PLC in the Automation Studio.

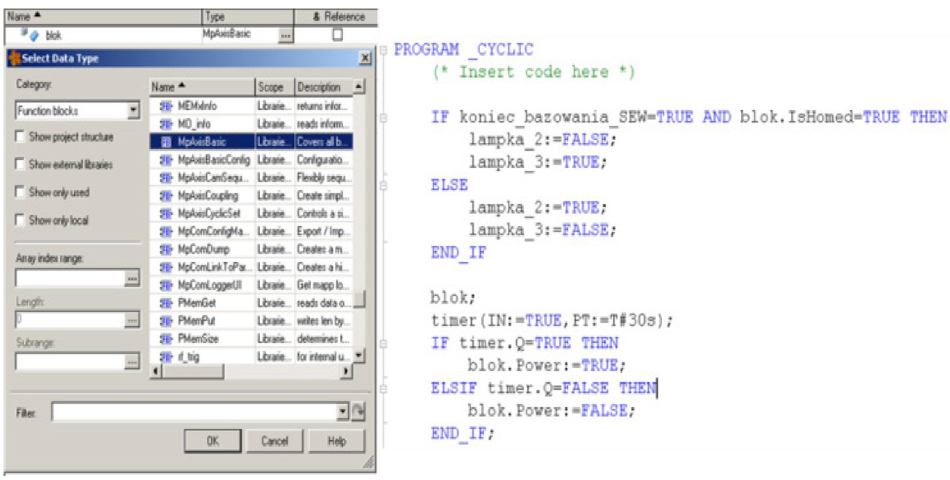

Fig. 4. The declaration of the function block MpAxisBasic and a part of the control program, which uses the unit for controlling the drive from B & R.

Send control information and parameter values to the drive system is done directly from the driver program. This is done by special function blocks to control the drive axle that is declared in the variables.

3.3 MOVIDRIVE® MDX61B Frequency Drive Driver Configuration

Controlling the frequency inverter from SEW-EURODRIVE can be done using the signals coming to it from the network [5-7, 8].

For this purpose it is necessary to set the parameters "Setpoint source" and "Control signal source" to "Fieldbus". The device will detect what network and what protocol is designed installed communication card. You must enter the data addressing device on the Ethernet network. MOVIDRIVE® MDX61B can receive from the controller three words process (marked in the parameter list as PO) and three process data words to the controller may send (marked in the parameter list as PI).

The data exchanged may include a selection from the list of commands, such as setpoint speed and control word to control the movement of the engine, and status data, eg. Current position read from the encoder (Figure 5, Figure 6).

 DOI: 10.1051/matecconf/201711205004

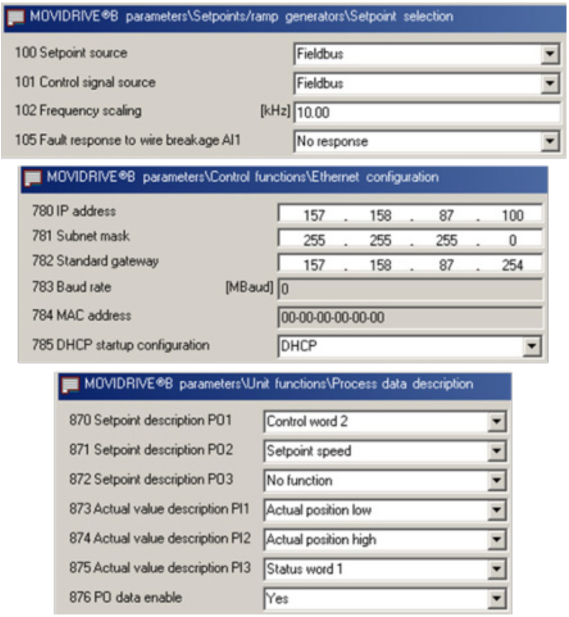

Fig. 5. Group of the frequency inverter in MOVITOOLS® MotionStudio.

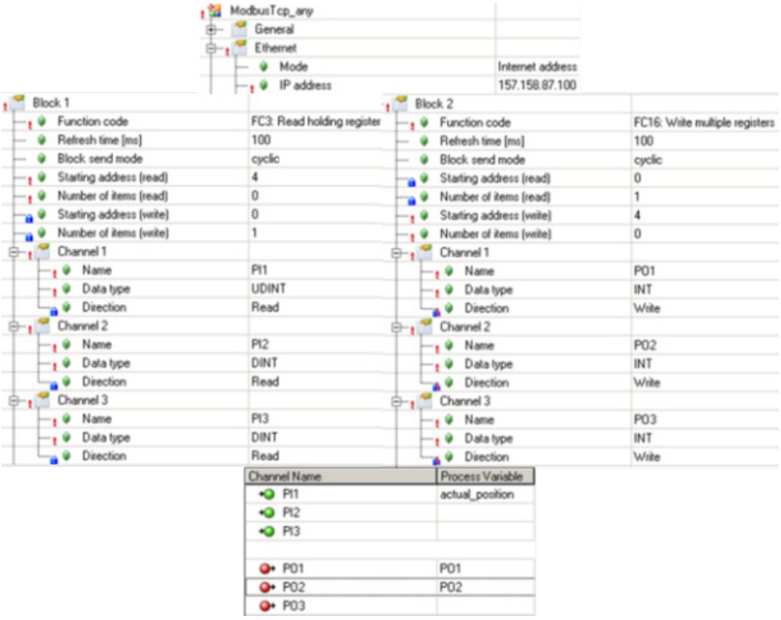

Fig. 6. Example of the window parameters of Modbus device in the Automation Studio.

The diagram hardware in the Automation Studio is a Modbus device, which in this case is a frequency converter SEW EURODRIVE.

In the configuration, enter the IP address, create blocks with the respective functions of Modbus (to read and write registers), indicate the initial address registers words process (in MOVIDRIVE® MDX61B they have value 4) and define the three channels of the appropriate data type in both blocks. These channels are then assigns a variable in the controller, which is used when programming the sequence of the drive.

4 Summary

Automation of a high-bay warehouse with electric drives with frequency inverters and industrial communication networks was developed and implemented.

The laboratory stand is working in a prescriptive manner, so it can be stated that the developed control system is working correctly. The use of the POWERLINK and Modbus networks has provided a fast, stable and easy to establish process information exchange within the automation system in question.

The study also shows the advantages of electric drives with frequency inverters. In addition to high accuracy and wide range of speed control, it is possible to exchange control and status data with other devices.

In addition, compared to pneumatic or hydraulic applications, the electric motor together with the whole transmission ratio is quite simple to operate, taking into account, for example, the supply of the supply medium. The frequency inverter can be equipped with a number of expansion modules, which allows you to connect the devices to the industrial network via the appropriate communication protocol.

References

1. A. Wróbel, W. Surma, *IOP Conf. Series: Mat. Sci. & Eng.* **145**, 052004 (2016)
2. B&R, *ACOPOS User's Manual* (2014)
3. B&R, *X20 system User's Manual* (2016)
4. B&R, *Automation Studio - Files of documentation*
5. D. Reclik, G. Kost, J. Świder, SPG - Fast Tracked Vehicles (in Polish) **2**(22), (2007)
6. Operating Instructions – MOVIDRIVE® MDX60B/61B, SEW-EURODRIVE (2010)
7. MOVIDRIVE® MDX61B Fieldbus Interface DFE11B Ethernet, SEW-EURODRIVE (2004)
8. A. Wróbel, *IOP Conf. Series: Mat. Sci. & Eng.* **95**, 1, 012090 (2015)