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BLACK SEA SCIENCE 2020

Information Technology, Automation and Robotics

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Odessa National Academy of Food Technologies, 2020.

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LATCH AUTOMATIC CONTROL SYSTEM FOR MONITORING THE DOSING OF BULK SUBSTANCES

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Abstract. *The paper considers a theoretical mechanical model of a tank for dosing bulk solids using valves on pneumatic cylinders and a PLC (programmable logic controller) that controls pneumatic-electric valves, briefly discusses the issues of existing analogues, the advantages of pneumatic-electric valves over pneumatic. The main goal of the work is the automatic control of valves using PLCs to ensure a given dosage rate. Using a PLC simplifies the control of valves due to pre-recorded scenarios for a given amount of dosed substance, as a result of which the chance of pouring it into the carriage is reduced.*

***Keywords**: PLC (programmable logic controller), pneumatic cylinder, gate valve, pneumatic distributor, shipment carriage.*

Introduction

The automatic valve control system is based on an industrial controller, namely a programmable logic controller (hereinafter PLC).

PLCs are devices designed to collect, transform, process, store information and generate control commands. They are implemented on the basis of microprocessor technology and work in local and distributed control systems in accordance with a given program. From small to powerful and high-speed PLC systems provide the most demanding customers with comprehensive capabilities and flexibility in implementing modern network solutions in distributed control and monitoring systems. PLCs provide the most demanding customers with comprehensive capabilities and flexibility in implementing modern network solutions in distributed control and monitoring systems. According to the technical capabilities that determine the level of tasks to be solved, PLCs are divided into classes: nano, micro, small, medium and large. Initially, they were intended to replace relay-contact circuits assembled on discrete components - relays, counters, timers, hard logic elements.Programmable controllers find application in various industries. They are also used in the field of education and in the system of continuing professional training.

Ferrous and non-ferrous metallurgy. Of particular importance in these industries are safety requirements. Programmable controllers are used to control transport operations using coke oven batteries, loading blast furnaces, and to automate foundries. They are also used to solve problems associated with gas analysis and quality control.

Metalworking and automotive industry. These are precisely the industries where PLCs are widely used. They can be found on automatic lines and assembly lines, on stands for testing engines, as well as on presses, automatic lathes, grinding and modular machines, welding machines, automatic cutting machines.

Chemical industry. Currently, PLCs are used to control technological installations, devices for dosing and mixing products, treating chemical production waste, as well as in plastic processing plants and some units in rubber production.

Oil production. In addition to applications similar to the previous industry, PLCs are used at pumping and distribution stations to control operation and monitor trunk pipelines.

Transport and handling operations. Programmable controllers are used in sorting parcels, mail, mechanized management of warehouse operations, packaging, conveyor shipment, picking up products on pallets, in the elevator facilities, hoisting mechanisms, etc. (Types of PLCs in Fig. 1)

Fig. 1 - Types of programmable logic controllers

Analytical analysis of the literature

We have considered a large number of publications by various authors exploring this issue.

PLC is considered as a device for monitoring and controlling pneumatic cylinders of gate valves to achieve a predetermined dosing value.

Object, subject and research methods

Using an industrial PLC to control the dosing of bulk solids, it was decided to create a model of the tank with valves based on pneumatic cylinders and pneumatic distributors.

As a PLC, we use the PHOENIXCONTACT industrial controller of the AXC 1050 family.

AXC 1050 is a highly efficient controller with an Ethernet interface and Axioline F. The bus controller is Axioline, and it’s easy to switch the Axioline module to the second controller.

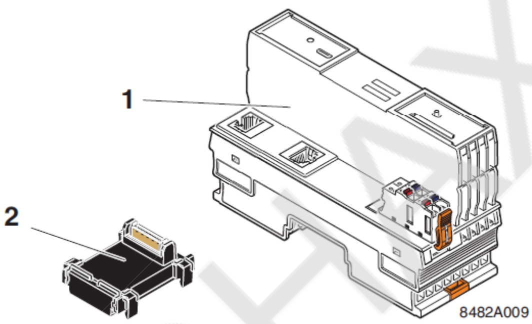
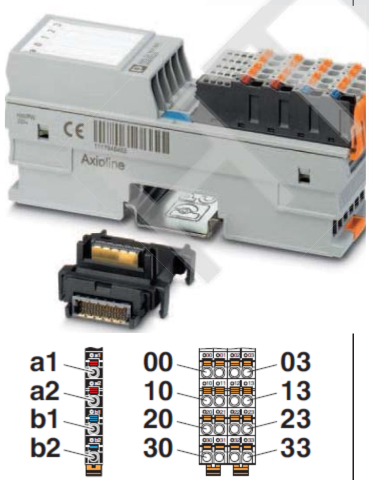


Fig. 2 Checked view of the controller and that’s one-way tire

Axioline Digital Station Modules

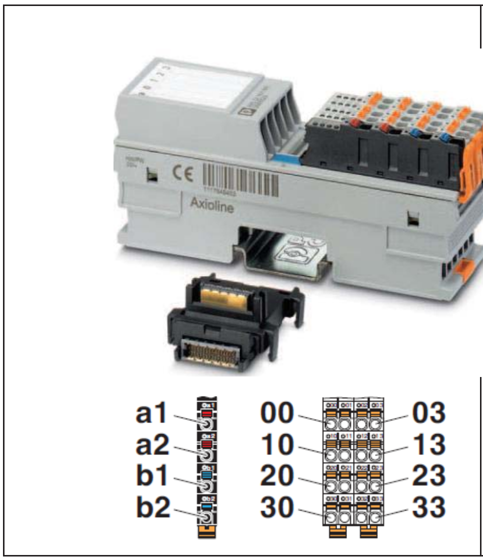
AXLFDI16 / 1 1Nm - a digital input module, digital inputs: 16, 24 V constant line (in Fig. 3).



Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_I)	Supply for digital input modules (bridged internally)
b1, b2	Blue	GND	Reference potential of the supply voltage (bridged internally)
Digital inputs			
00 ... 03	Orange	IN01 ... IN04	Digital inputs 1 ... 4
10 ... 13	Orange	IN05 ... IN08	Digital inputs 5 ... 8
20 ... 23	Orange	IN09 ... IN12	Digital inputs 9 ... 12
30 ... 33	Orange	IN13 ... IN16	Digital inputs 13 ... 16

Fig. 3 digital input module

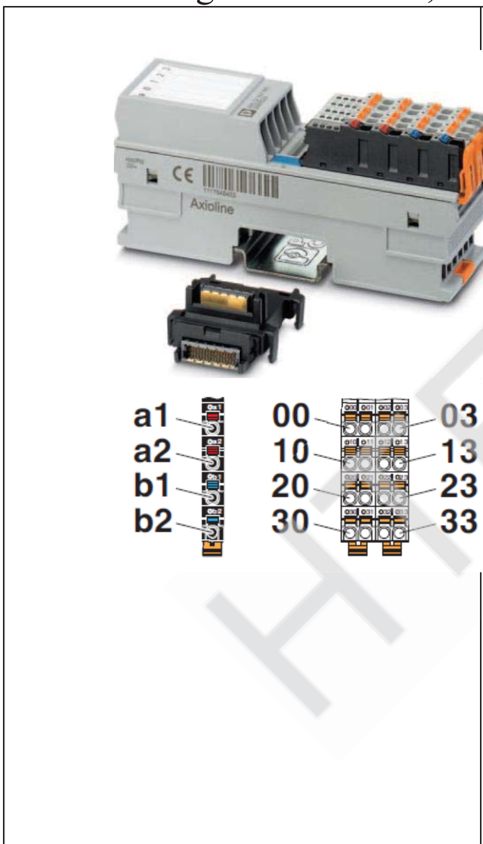
AXL F DO16 / 1 1H - digital drive module, digital output: 16, 24 V, constant current, 500 mA (Fig. 4).



Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_O)	Digital output module feed-in (bridged inter-nally)
b1, b2	Blue	GND	Reference potential o supply voltage (bridg internally)
Digital outputs			
00 ... 03	Orange	OUT01 ... OUT04	Digital outputs 1 ... 4
10 ... 13	Orange	OUT05 ... OUT08	Digital outputs 5 ... 8
20 ... 23	Orange	OUT09 ... OUT12	Digital outputs 9 ... 12
30 ... 33	Orange	OUT13 ... OUT16	Digital outputs 13 ... 1

Fig. 4 Digital Drive Module

AXL F AI2 AO2 1H - analog module input to input, 2 inputs, 2 outputs (in Fig. 5)
- Arrow ranges: 0 mA ... 20 mA, 4 mA ... 20 mA, ± 20 mA
- Range: 0 V ... 10 V, ± 10 V, 0 V ... 5 V, ± 5 V



Termi-nal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_A)	Analog module feed-i (bridged internally)
b1, b2	Blue	GND	Reference potential o the supply voltage (bridged internally)
Analog inputs			IN01, IN02
00, 01	Orange	U1+, U2+	Positive voltage conn tion for channel 1 and
10, 11	Orange	U1-, U2-	Negative voltage con-nection for channel 1 and 2
20, 21	Orange	I1+, I2+	Positive current conn tion for channel 1 and
30, 31	Orange	I1-, I2-	Negative current con-nection for channel 1 and 2
Analog outputs			OUT01, OUT02
02, 03	Orange	U1, U2	Voltage connection fc channel 1 and 2
12, 13	Orange	I1, I2	Current connection fc channel 1 and 2
22, 23	Orange	GND	Reference potential fc all AO channels
32, 33	Orange	GND	

Fig. 5 Analog I / O module

The layout of the tank with valves based on pneumatic cylinders and pneumatic distributors is shown in Fig. 6

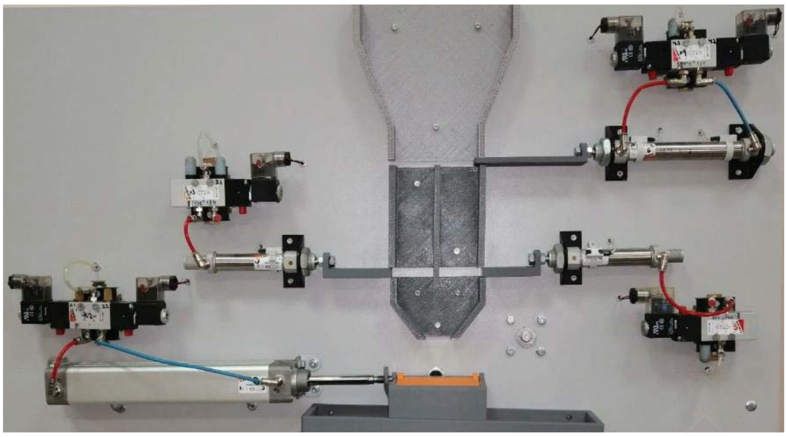


Fig. 6 Layout of a tank for dosing bulk solids

The layout consists of:

- Three gate valves: one long (Z 1.1) and two short (Z 2.1 and Z 2.2, respectively).
- Two pneumatic bistable cylinders, one of which (ПЦ 1.1) controls the gate valve (З 1.1) and the second (ПЦГК) cargo carriage (ГК) for further cargo transportation and two monostable cylinders (ПЦ 2.1, ПЦ 2.2, respectively).
- Two bistable electro-pneumatic valves (EPR PC 1.1) and (EPR CC), respectively, and two monostable electro-pneumatic valves (EPR PC 2.1) and (EPR CPU 2.2), respectively.
- Cargo carriage (GK) for further transportation of goods.

The principle of the model in the simulation:

Bulk substances (in this example, grain) fall into the zone in front of the gate valve (Z 1.1), which is initially in the closed state (as well as Z 2.1 and Z 2.2). After the valve is opened (З 1.1), the grain enters the substance separation section and, when the desired value is reached, the valve (З 1.1) closes. Further, under a given dosing condition (specified by the program in the PLC), either both valves (Z 2.1 and Z 2.2) or only one are opened. After that, they close and the load carriage replaces the filled tank with a new one. Then the cycle repeats.

Conclusions

The paper considers the task of creating a tank for dispensing bulk solids using valves based on the PHOENIXCONTACT PLC of the AXC 1050 family. Investigation of maintaining the stability of the operation of metering valves.

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