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A PNEUMATIC SYSTEM OF A PROCESS LINE FOR THE PERSONALISATION OF IDENTITY CARDS

Key words

Technical safety, RFID, actuators, control.

Summary

The article presents the construction details of the pneumatic system used in the process of personalising ID cards within a designed technological line. The systems actuators perform most functions (supplying, basing, transport) related with the technology in question. The line's control system, utilising a main PLC controller, allows direct communication between particular actuators or complex modules controlled via controllers of the local valve islands. The hardware and software solutions employed make it possible to perform research and development projects aimed at improving the security measures of the documents with RFID identifiers by implementing verification based on electronic data stored in the RFID unit and graphics printed on it (text, bitmap, barcode) correlated with the data.

Introduction

The security of using electronically protected documents, including ID cards, can be analysed in two consistent areas. The first concerns the resistance of the card's structure and graphics to mechanical factors connected with

everyday use. The second area encompasses the issue of the data security of the information stored in the card. Joint efforts, made in both areas, in an integrated technological system allow better security in using ID cards. Conducting research and development aimed at improving the security of ID cards utilising RFID technology is connected with having enough research material [1]. In order to obtain a product with reproducible attributes, it is necessary to use flexible technology lines performing processes connected with electronic and graphic personalisation, along with the product's surface's protection. The devices available on the market are designed to perform large-quantity manufacturing, usually following strict technological directives.

1. The concept of the process line

The Institute for Sustainable Technologies – National Research Institute in Radom conducts research concerning increasing security levels of manufacturing and using ID cards. As a result, a concept was created of a process line (Fig. 1) for electronic and graphic personalisation of electronically protected cards.

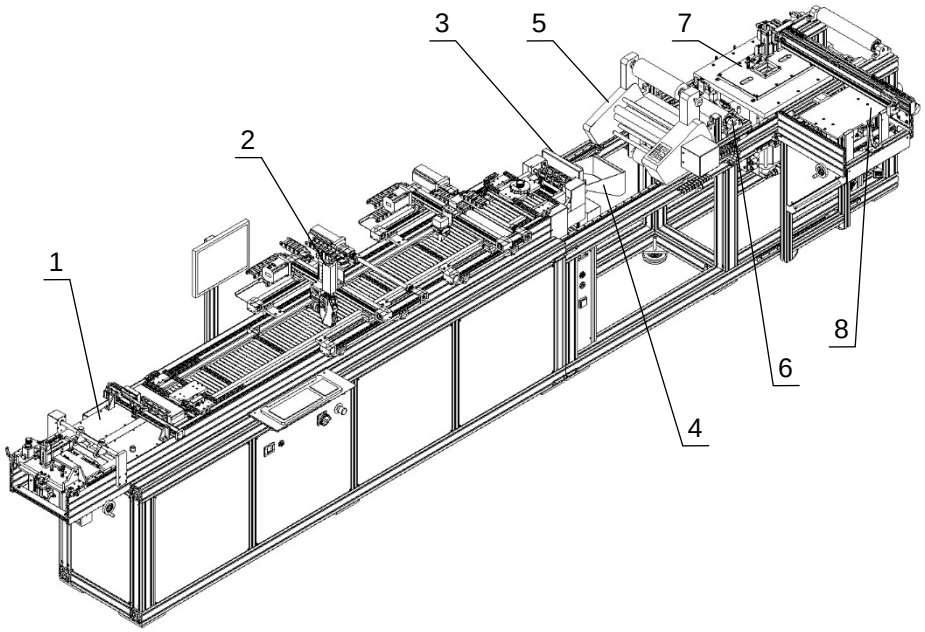

Fig. 1. The structure of the process line, pneumatic elements marked: 1 – feeder, 2 – printing, 3 – shredding, 4 – receiving, 5 – laminating, 6 – stopping, 7 – punching, 8 – receiving II

The assumed input materials are unpersonalised cards, sizes from ID1 to A4 with RFID units and plastic sheets up to 300mm wide. The process is implemented by 13 actuator modules. Mechanical, electric, and pneumatic

systems were used, according to the complexity level of the moves and their precision. The applied electric and pneumatic systems enable one to adjust the parameters of the moves performed (speed, coordinates, force) [2]. The parameters can be changed during the process line's integration and in the conditions of implemented flexible technology [3]. The final products are personalised and verified ID cards that are manufactured in variants characterised by different levels of surface protection (not laminated, one or two-sided lamination).

2. Pneumatic system of the line

During designing phase, the aim was to maximise the usage of pneumatic actuators to perform necessary movements required by the process. The designed pneumatic system (Fig. 2), with a structure corresponding to its functions, consists of 8 modules.

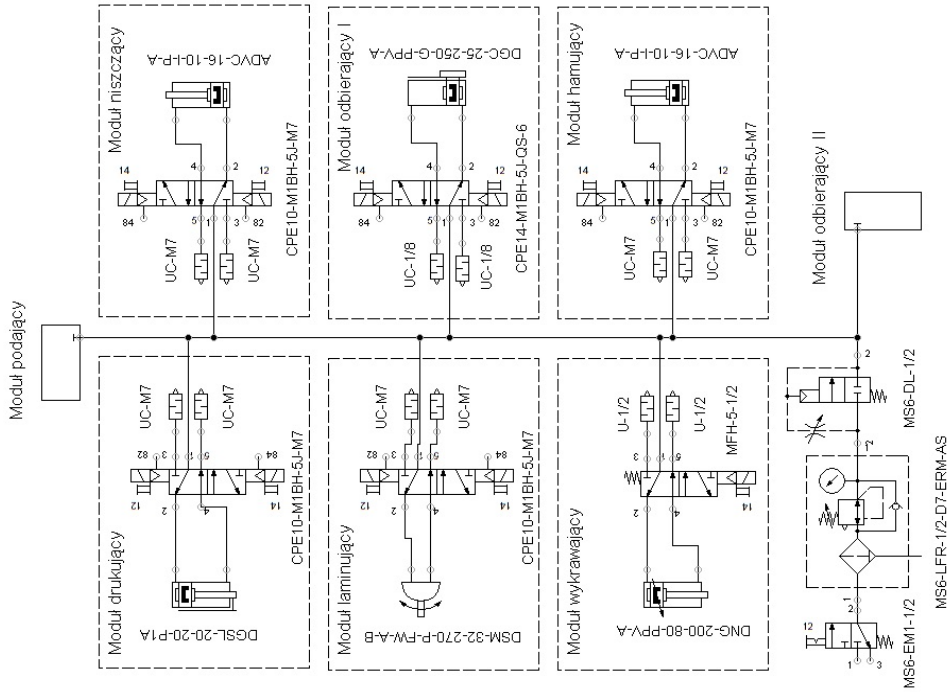

Fig. 2. The schematic of the line's pneumatic system

The cards intended for personalisation are supplied by the feeder mechanism [4], which is an autonomous device controlled by a local PLC controller which is an integral component of the valve island (Fig. 3).

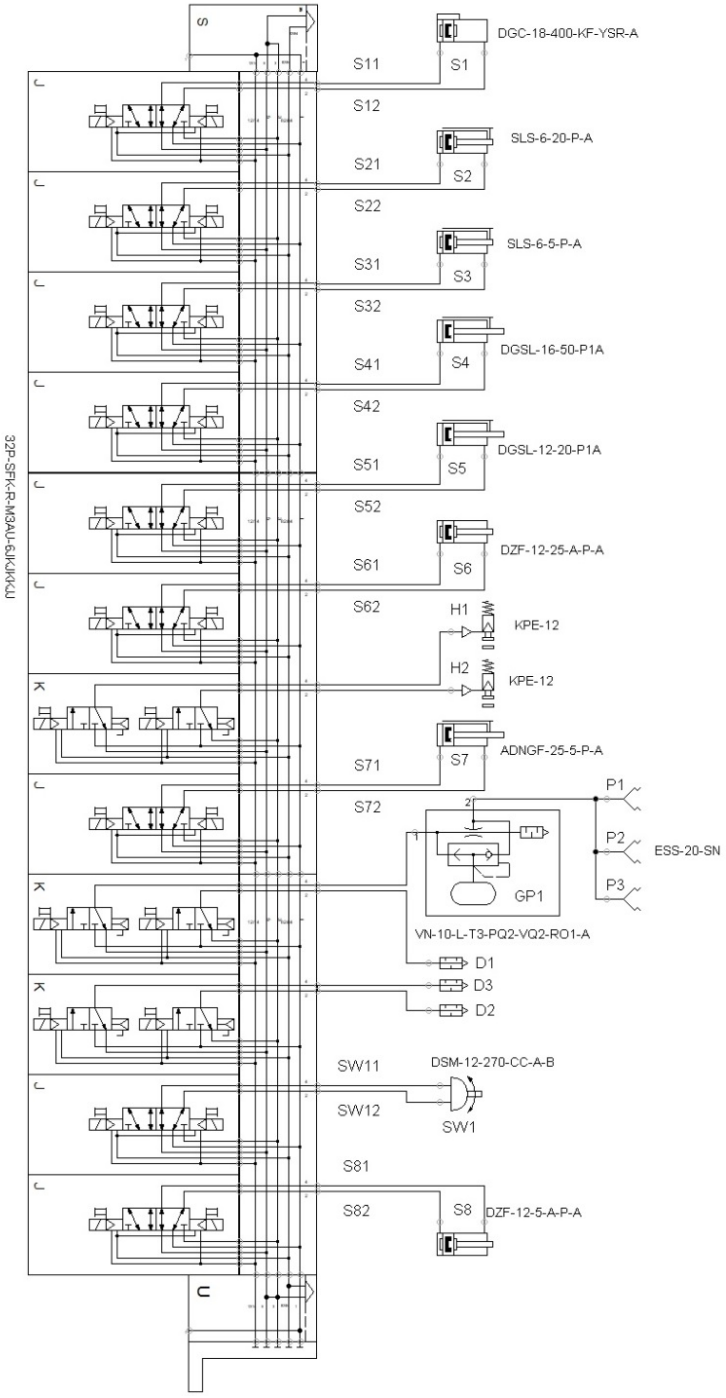

Fig. 3. The schematic of the pneumatic feeder mechanism

The assumed concept resulted from the structure of pneumatic and electric connections placed in close proximity to the applied actuating systems. The feeder module, which is the most structurally complex module (12 actuators), was equipped with two alternative systems (under pressure and Bernoulli) of taking the cards from the cartridge. These systems can be used according to the parameters of the cards: size, thickness, transparency.

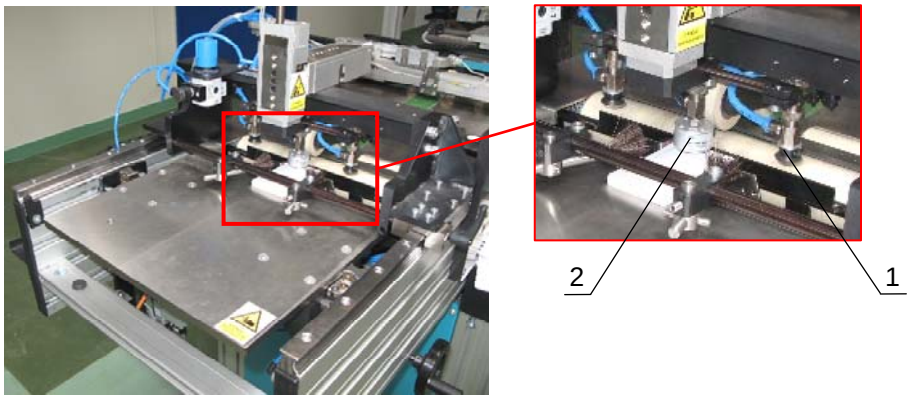

Fig. 4. Feeder module: 1 – under-pressure suction cups, Bernoulli nozzle

The unambiguously positioned product is moved onto a segment belt conveyor equipped with elastic clamps ensuring that the product remains in its position.

After the digital information is stored in the RFID chip, the card is conveyed to the printing – personalising module (Fig. 5).

Fig. 5. Printing module: 1 – printing head, 2 – pneumatic actuator, 3 – clamps

The pneumatic actuator of the module is responsible for the vertical movement of the printing head from the operational position to the position where it skips the clamps.

Electronically and graphically personalised (alphanumeric characters, graphics, barcode) product is conveyed to the graphic verification module. In that module, the correctness of the graphics printed and the alphanumeric part's compatibility with the data stored in the electronic chip's memory are verified. In case of a negative verification, the card is – after leaving the transporter – perforated in the shredding module located directly in front of the receiving module I.

In case of a technology including surface protection, the product is conveyed to the laminating module (Fig. 6) which allows one-sided or two-sided lamination.

Fig. 6. Laminating module

The module's working parameters are controlled with the use of the local controller that enables to set the speed and temperature of the lamination. A pneumatic system is applied to ensure the constant contact force of the silicon laminating rollers

Laminated cards, in the form of a strip, are then conveyed, via the stopping module, to the punching module (Fig. 7). The role of the stopping module is to stop the product strip while punching. The stopping position is determined by optical reflection sensor located over the puncher's matrix. The punching of final cards from the strip is performed on a timer puncher in which relative movement of the stamp and the matrix is performed via a high-diameter 2500 mm actuator that enables to obtain necessary cutting force.

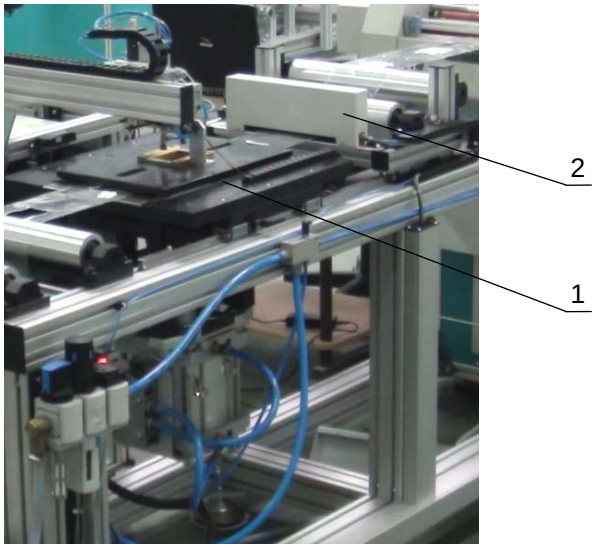

Fig. 7. Modules: 1 – punching, 2 – stopping

The punched ID card is picked up by a set of suction cups of the receiving module with a pneumatic structure (Fig. 8) resembling the feeder module.

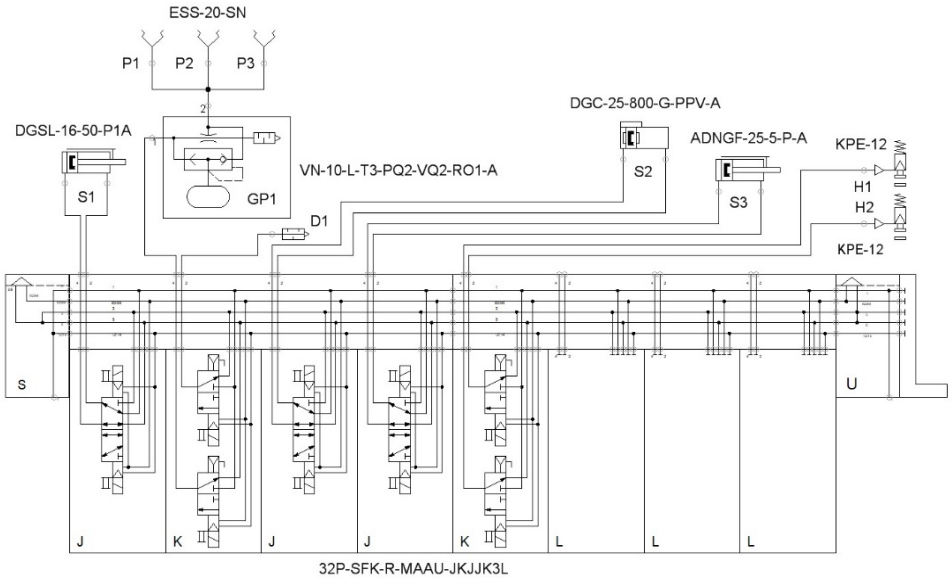

Fig. 8. The schematics of the pneumatic receiving module II

Receiving laminated ID cards from the punching module's socket is performed with an under-pressure grab equipped with two or three suction cups (Fig. 9). The cards are put aside in a stack onto a rotating table whose position changes with the amount of cards manufactured.

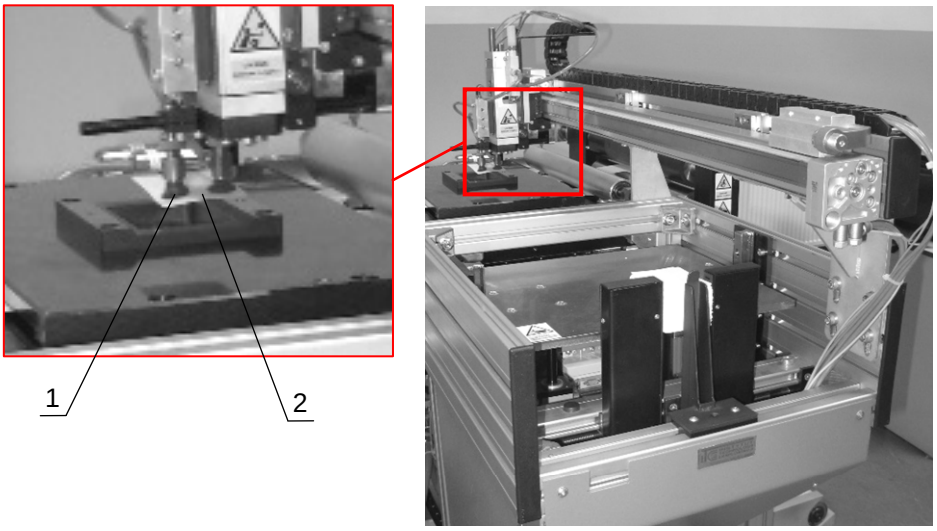

Fig. 9. Receiving module: 1 – suction cup, 2 – personalised ID card

All modules equipped with valve islands can operate in two basic modes. The first is the maintenance mode, which enables one to control the module's operation via an external PLC controller. In this mode, an Ethernet communication bus is employed to enable and check the states of particular subsystems of the module connected to the inlets and valves of the valve island. The second mode is the automatic mode in which the CPX controller of the valve island autonomously performs the operation of the entire module.

3. The process line for making multi-layer cards

A prototype line (Fig. 10) for graphic and electronic personalisation of RFID cards [5] was implemented in the Polish Security Printing Works in Warsaw.

The pneumatic system performing planned technological operations allows flexible adjustment of the process's parameters in the area of personalisation (database structure, graphic design) as well as the actuators' functionality.

Fig. 10. Process line

Changes in the program, concerning the timing of particular actuators' movement [6], can be performed at the PLC's software level by adjusting the process via switching on/off particular actuator modules, or at the level of particular valve islands (Fig. 11).

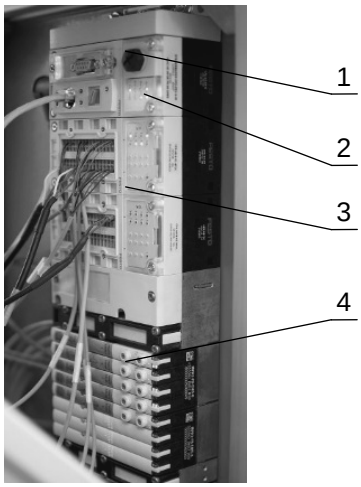

Fig. 11. Valve island of the receiving module: 1 – CPX controller, 2 – communication module, 3 – input/output modules, 4 – pneumatic valves

Changing physical parameters can be done through manual adjustment of the parameters of the pneumatic drives – the pressure and position of the restricting parts that determine the repeatability of the performed functions.

The communication of particular components with the PLC controller required the implementation of input/output modules supporting over 40 digital binary signals (Fig. 12) apart from a Modbus TCP/IP protocol.

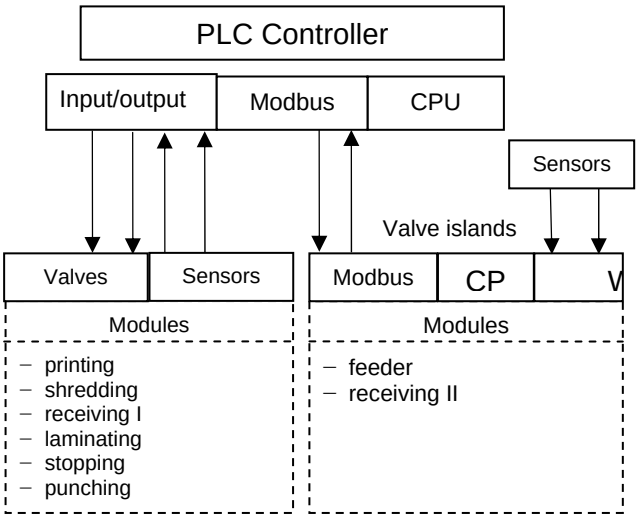

Fig. 12. Control system's structure

The amount of data transmitted resulted directly from the number of pneumatic actuators equipped with position sensors.

Summary

The designed pneumatic process line enables manufacturing small batches of personalised and verified ID cards. Pneumatic actuators make it possible to adjust the parameters of the performed functions (transport, clamp) within the flexible manufacturing technology. The devised solution is dedicated to low- and medium-quantity production in a semi-automatic cycle. The configurable structure facilitates the adaptation of the device to perform various tasks determined by a changing variety of intermediates used and final products. The control system, using a PLC controller, allows direct communication with particular actuators or complex modules controlled by valve islands' CPX controllers. The software and hardware solutions implemented enable one to conduct research and development aimed at improving the security level of RFID ID cards.

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System pneumatyczny linii technologicznej do personalizacji kart identyfikacyjnych

Słowa kluczowe

Bezpieczeństwo techniczne, RFID, układy wykonawcze, sterowanie.

Streszczenie

W artykule przedstawiono budowę systemu pneumatycznego wykorzystanego w procesie personalizacji kart identyfikacyjnych w ramach opracowanej linii technologicznej. Elementy wykonawcze sytemu realizują większość funkcji (podawanie, bazowanie, transport) związane z opracowaną technologią. System sterowania linii, wykorzystujący nadrzędny sterownik PLC, umożliwia bezpośrednią komunikację z poszczególnymi elementami wykonawczymi lub złożonymi modułami sterowanymi z poziomu sterowników lokalnych wysp zaworowych. Zastosowane rozwiązania sprzętowe i programowe pozwalają na realizację prac badawczo-rozwojowych zmierzających do poprawy poziomu zabezpieczeń dokumentów zawierających identyfikatory RFID poprzez prowadzenie weryfikacji na podstawie danych elektronicznych zapisanych w układzie RFID oraz nanoszonej grafiki (tekst, bitmapa, kod kreskowy) skorelowanych z przechowywanymi danymi.