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KORIŠTENJE I PREDNOSTI AS-I KOMUNIKACIJSKOG PROTOKOLA U INDUSTRIJI

USAGE AND ADVANTAGES OF AS-I COMMUNICATION PROTOCOL FOR INDUSTRY

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Stručni članak

Sažetak: *Porast složenosti tehnoloških procesa u industriji zahtijeva usporedno razvoj tehničkih rješenja koja će zadovoljiti visoke standarde u proizvodnji vezano uz kvalitetu, brzinu, pouzdanost i sigurnost u radu. Uz naprednіju hardversku opremu i sve razvijeniju programsku podršku izravno primjenjive za rješavanje standardnih problema i zadataka, razvijaju se aplikativna rješenja za industrijske komunikacijske protokole. Utjecaj elektromagnetskih smetnji, mehanička opterećenja, daljina prijenosa i sl. redom su rješavani povećanjem složenosti izvedbe novih komunikacijskih protokola i standarda. Jedan od takvih protokola je AS-I (eng. Actuator Sensor Interface), koji se ističe karakteristikom da se smanjenjem mehaničke složenosti povećava mogućnost upravljanja elementima za automatizaciju industrijskog pogona.*

Ključne riječi: *komunikacijski protokol, AS-I mreža, automatzacija, industrija*

Professional paper

Abstract: *The increase in complexity of technological processes for industry requires parallel development of technical solutions which will satisfy high standards in production regarding quality, speed, reliability and safety at work. The use of advanced hardware equipment and more sophisticated program solutions for application on standard problems and tasks provides better applicative solutions for the industrial communication technologies. The influence of electro-magnetic disturbance, mechanical loads, distance of transfer, and similar problems are usually solved by an increase of complexity of new communication protocols and standards. One of these protocols is AS-I (Actuator Sensor Interface), which stands out by its unique characteristic where the possibility of automation element management in industry plants is increased by reducing mechanical complexity.*

Key words: *communication protocol, AS-Interface, automation, industry*

1. INTRODUCTION

New technologies used in modern industry solutions very often are promoted trough usage of new and complex communication protocols, such as Profibus, Profinet or GSM/GPRS. In the lowest process level of automation system (as in [1]) some other criteria are applied. Usage of low complexity solutions is very common, both for electrical signal processing and communication with actuators and sensors.

Main issue for the lowest process level in automation system is direct contact of electrical energy transfer and signal acquisition with mechanical equipment used for technology or manufacturing process. Therefore, requirements for simple and robust solutions are very frequent. Heavy and powerful mechanical drives and machines often do not allow standard wiring and data transfer solutions to be implemented to the whole or a part of an industrial plant. Also, quantity of actuators and sensors can often add significant problems to mounting and wiring of a machine. On the other hand, some communication solutions are sensitive on noises due to low voltage and high speed of data transfer. The most common communication solution is presented in this paper with its application on two examples of machines in industry.

2. ROTARY MACINES IN INDUSTRY

The most complex application for sensor and actuator mounting and wiring are rotary machines in industry. Rotary machines can be derived with continuous or limited rotating of mechanical parts of machine. In such case wires and cables can be exposed to winding, which can lead to destruction of these wires and cables.

Example of simple rotary machine with limited rotation of mechanical parts is a dual-axis tracking system with PV modules. Dual-axis tracking is managed by two actuators, each providing rotation of mechanical construction for mounting the PV modules. The axes used for this machine are azimuth and slope. The azimuth is limited to 180° of mechanical twist from east to west, passing through south. The automation solution used in Figure 1 ([2], [3], [4]) is derived by two linear actuators, three light sensors with analogue signals and four limit switches, all placed on mechanical construction of dual-axis tracking system.

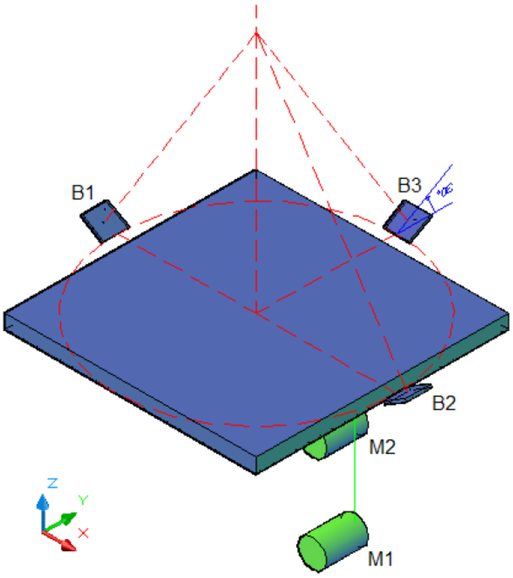

Figure 1. Dual-axis tracking system, solution 1, [2], [3], [4]

The example of complex mechanical construction for rotary machine is the system for packing bricks, as shown in Figure 2. The conveyor belts 1, 2 and 3 are fixed and only serve for transfer of brick blocks 6, as shown in Figure 2. Part 4 of the machine is used for application of plastic on brick blocks. In order to fulfill this task, continuous rotation must be applied to part 4 with all the equipment mounted on it, such as sensors (part 5) and plastic container actuators.

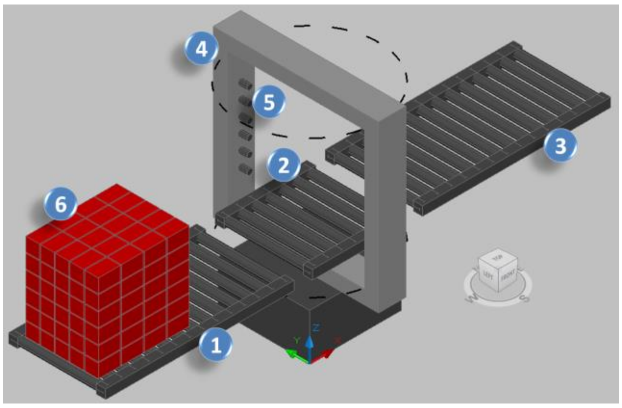

Figure 2. Brick packing machine

Since rather high number of actuators and sensors are mounted on rotating mechanical constructions, one must consider the simplest solution for automation of this machine. For example, there are four limit switches and three analog sensors on dual-axis tracking system. Limit switches must be provided with one wire for power supply and four wires for switch signals, and six wires for analogue sensors. Also, there are six sensors on brick packing system that are mounted on rotating part of the machine. Therefore, minimum of wiring will be provided by two wires of power supply and six wires for digital signals. The solution obtained should somewhat reduce the number of wires for implementation of these actuators and sensors in the automation system.

3. AS-I NETWORK FOR AUTOMATION SYSTEM

The Actuator/Sensor Interface (AS-Interface, AS-I) is only low process level standard with bit-oriented fieldbus. The development started in late 1980s and early 1990s by a group of companies. The original specification was published in 1994 as version 2.04. and its enhancements in 1998 as version 2.11. Later, additional capabilities were provided in 2005/2007 as version 3.0. The idea is to provide multiple simple field devices with power supply and data acquisition only by using two wires [5]. It is often an alternative for high level fieldbus networks (such as Profibus, Profinet, etc.) when low cost and robust solutions are required, as shown in Figure 3. AS-I is open technology accepted by most of automation equipment providers.

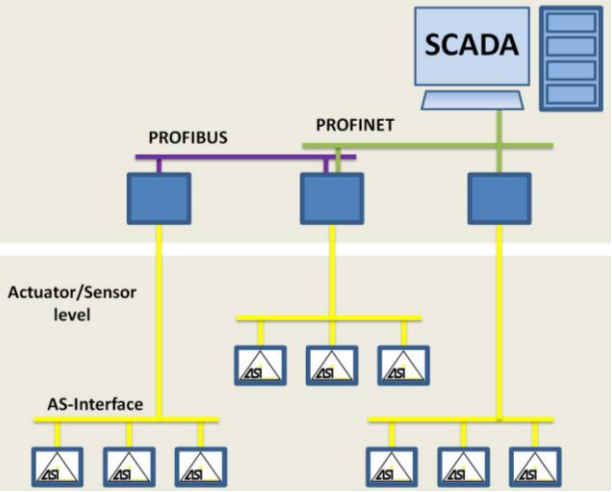

Figure 3. Example of automation system network [6]

AS-I network is easy to implement in automation system. The network is composed of only four components. Only one network master and multiple slave modules for input/output devices can be applied. A single power supply is used to supply whole network components with power and communication. The main characteristic of AS-I is wiring infrastructure, which is provided by only two-wire cable (*flat cable)* as presented in Figure 4.

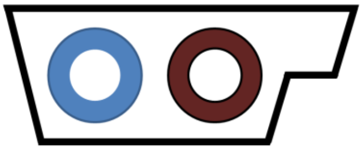

Figure 4. AS-I flat cable

In AS-I network only one network master is placed to manage the network. Both, network master and all slave modules, are powered by the same supply in voltage range of 29.5 V to 31.6 V, and data is transferred by current modulation. Slave modules are each provided with unique network address, which cannot be used again in that network. Adding a new slave module to network has no effect on other members of network since it is done by “penetration” technique, where new module penetrates cable isolation which can be online. Reaction time of AS-I network is maximum of 5 ms for data exchange with 31 modules, and 10 ms for 62 modules. Single bit time is 6 μs. Maximum cable length is 100 m for single line, and must be derived from single cable segment. After 100 m repetition module must be applied, and length can grow even to 300 m. Maximum length of network can grow up to 500 m if master module is placed in the middle of cable segment. End of single segment must be locked with terminator resistor to reduce reflectance. For star-shape network total length is practically not limited. When using standard AS-I modules only 124 actuators/sensors can be operated, but if extended master and extended addressing mode are used it can grow to 248 actuators and 248 sensors. If, for example, Siemens Simatic S-7.A.A profile with 8I/8Q is used, than number can grow up to 496 actuators and 496 sensors. Analogue signals are also supported in AS-I network. Modules are divided as only digital (2DI/2DQ, 4DI/4DQ or 8DI/8DQ), only analogue (2A), super-fast analogue, or combined (1A/1DQ). AS-I standard data exchange is provided by master call, and is 14-bit long message which contains data of device address in 5 bits, 4 bits for digital output information and framing bits. Slave module responds by 7-bit message which contains 4 bits of slave inputs. All of this information can be found in [7], [8] and [9]. Figure 5 presents AS-I slave modules.

Figure 5. AS-I slave modules

4. IMPLEMENTATION OF AS-I NETWORK TO ROTARY MACHINES

Simplicity of applying the AS-I communication to rotary machines lies in the possibility of using slip rings. If slip ring was used for standard wiring solutions, the number of slip rings would be too high. Therefore, application of AS-I in combination with slip rings will always introduce only two slip rings, regardless the complexity of mechanical solutions for machine functionality.

When observing possibility of implementation of AS-I in the example of dual-axis tracking system (solution 1), the simplest AS-I solution can be applied. Considering sensors readings acquisition solution, three analogue sensors (B1, B2 and B3) and four limit switches (M1 high and low, and M2 high and low) can be collected by 3 AS-I modules (1 x 4DI/4DQ and 2 x 2AI), as presented in Figure 6. Actuators do not require special attention since they are in the proposed solution mounted on the fixed part of dual-axis tracking system.

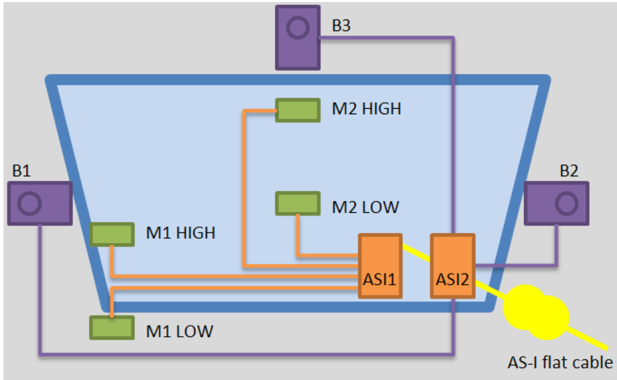

Figure 6. AS-I for dual-axis system, solution 1

Solution is more complex if applied on a real dual-axis tracking system presented in Figure 7. The rotating base (1) of dual-axis tracking system will cause the slope actuator (2) to rotate along with it. Since this solution is not equipped for regulation as described in [2], [3] and [4], there is no need for analog sensors on rotating base of dual-axis tracking system. Therefore, this problem can be solved by single AS-I module 4DI/4DQ. For solution presented in Figure 7 a stepper motor is used for slope regulation, since it is just a model for testing automation equipment.

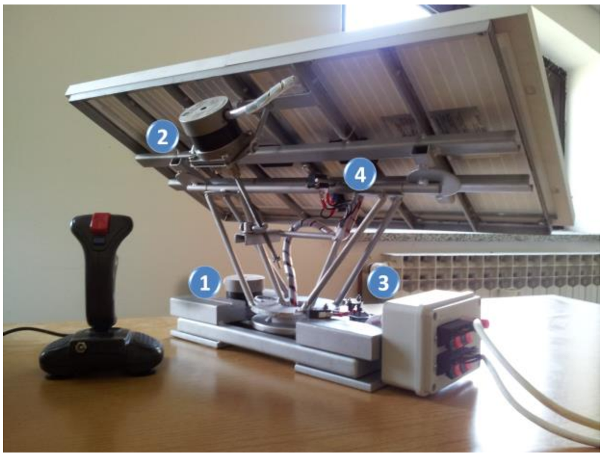

Figure 7. Real dual-axis tracking system

Figure 8. Industrial plant for brick production and packing [10]

Solution for brick packing machine is more complex since six IC sensors and the subsystem for applying plastic on brick blocks are used. The subsystem consists of one actuator for adhesion of plastic role to brick blocks and one actuator for cutting the plastic when rotary movement of machine is finished. Therefore, the whole subsystem can be performed by one AS-I module 8DI/8DQ.

5. CONCLUSION

If complex mechanical solutions are applied in industry very often there are high limitations on mounting and wiring of automation equipment. Mechanical loads and rotary movements usually require simple and quality solutions of automation systems. The two-wire communication is the best solution in terms of functionality and simplicity. Even when used for rotary machines, AS-I can easily be applied trough slip rings with very low interfering in mechanical construction of a machine. Although AS-I network is rather limited in terms of number of nodes (31), simplicity in usage makes this protocol highly desirable when planning and designing automation system for an industrial plant.

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