ISSN 1846-6168
UDK 67:316.776

KORIŠTENJE I PREDNOSTI PROFIBUS KOMUNIKACIJSKOG PROTOKOLA U INDUSTRIJI

USAGE AND ADVANTAGES OF PROFIBUS COMMUNICATION PROTOCOL FOR INDUSTRY

Igor Petrović, Mario Vinković

Stručni članak

Sažetak: *U komunikacijskim standardima visoke i srednje razine može se vrlo jednostavno definirati zahtjeve na takve mreže i kvalitetu protoka podataka. U prvom redu traže se komunikacije na visokim brzinama prijenosa podataka, a zatim i zahtjev na kvalitetu podataka prilikom stizanja na odredište. Zbog takvih zahtjeva industrijska komunikacija jednim svojim dijelom prati i razvoj komunikacijskih mreža koje se koriste u svakodnevnom životu, no uvijek mora garantirati bolju kvalitetu zbog lošijih uvjeta u kojima se odvija prijenos podataka. Profibus standard razvijen je kao rezultat velikog projekta upravo za industrijsku i procesnu okolinu. Njegova primjena je postala jedna od najprisutnijih u automatizacijskim sustavima veće složenosti, a prihvaćen je od strane gotovo svih značajnih proizvođača automatizacijskih sustava.*

Ključne riječi: *komunikacijski protokol, Profibus mreža, automatizacija, industrija*

Professional paper

Abstract: *In communication standards of high and middle level it can be easy to define demands on such networks and quality of data flow. Primarily high speed of data flow is demanded, and then also demands on quality of data at the end of transmission channel. Due to such demands industrial communication in one part always follows development of communication network systems for everyday usage, but must also produce better results in terms of bad environment conditions in which the data transfer is performed. The Profibus standard was developed as a result of great project for industry and process environment. The Profibus became one of most applicable communication standards for automation systems with high complexity, and is accepted by almost all significant vendors of automation system equipment.*

Key words: *communication protocol, Profibus, automation, industry*

1. INTRODUCTION

The new industry solutions are often very big and complex (part of big example for big system is presented in [1]), and therefore require automation system to be divided in more segments. If these parts of industry plant must work synchronously, some parameters must be accessed by multiple devices in that plant. Since communication must be mounted inside industry plant, it is necessary to ensure good quality of signal on receiving end of communication pair of devices. Standard communication network solutions are not provided for environment with so much external interference and influences.

The main growth of such industrial plants and machines is in automation segment where advanced options and preferences are needed to ensure better performance of production. When communication is provided through such environment, robust data transfer demands are highly outlined. One of such examples for robust machine is dual-axis tracking system for PV module like presented in [2], [3], [4], [5] and [6]. One of such automation communication standard is Profibus, which is very common in every form of industrial automation systems, regardless of used equipment vendor.

2. DEVICES AND MACINES IN INDUSTRY PLANT

In following sections two examples of industry plants are presented. Each example is provided with some form of industrial communication standard.

The example of brick drying automation system, presented in Figure 1., is provided by two automation parts, CPU (part 3) and SCADA interface (part 1). The CPU is placed very near energy supply paths, and must be resistant to external electromagnetic interferences made by electronic and mechanical drives and machines (part 2). The SCADA is also placed inside the same plant in order to allow operators to control the system from small distance. Since both of these parts are placed inside production section of industrial plant, communication standard used to provide data transfer between CPU and

SCADA (part 4) must be very resilient to electromagnetic interferences.

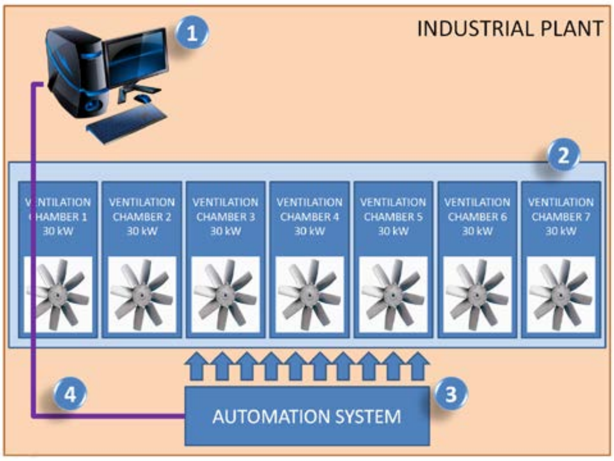

Figure 1. Brick drying automation system

The example of milk industry is regularly provided by complex mechanical solutions since food industry has very rigorous regulations for processing of raw materials. The CPU (API S7-300) for control of production part presented in Figure 2. works with distributed I/O devices (ET-200M) on large surface, and must be placed in three separate buildings to meet regulations for production process. The power supply is not of great importance for this solution since no linear, rotary or otherwise moving mechanical drives are used. This will allow free choice of solution to meet other significant process demands.

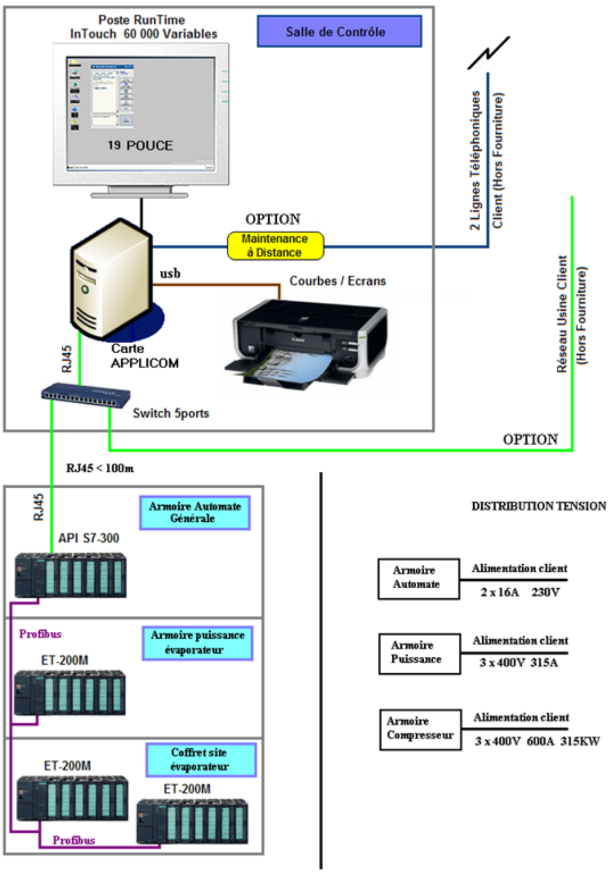

Figure 2. Milk industry automation system

In both of these automation systems it is obvious that communication network is needed to guaranty the good quality and high safety of production process. In next sections Profibus standard is applied on both of these examples.

3. PROFIBUS NETWORK FOR AUTOMATION SYSTEM

The Process Field Bus (Profibus) is middle process level standard for communication trough bit-serial fieldbus, with great respect to basic requirements of the field device interfaces. Development started in 1980's by a group of companies in Germany trough master project "Field bus" from 1986. Original specification was presented in 1989. The idea was to establish communication between field devices. It is most often used to communicate between multiple CPU's and distributed field I/O devices, Human Machine interfaces, etc. as presented in Figure 3. Profibus is not open technology, although it is accepted by almost all significant automation vendors.

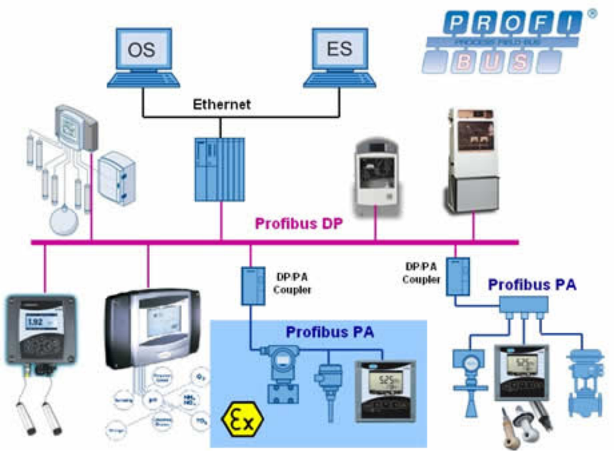

Figure 3. Example of automation system network [7]

First presented Profibus was Profibus FMS (Field bus Message Specification) which was complex, but latter was simplified trough new generations of Profibus protocol (Profibus DP and Profibus PA). Profibus network is easy to implement in automation system. The network is composed of few standard components: master (or masters), slaves (CPU's and I/O devices), power supplies (may or may not be same for whole network) and wiring with Profibus cable. Profibus cable is shielded twisted pair cable with characteristic impedance of 150 Ω. The cross-section of Profibus cable is presented in Figure 4.

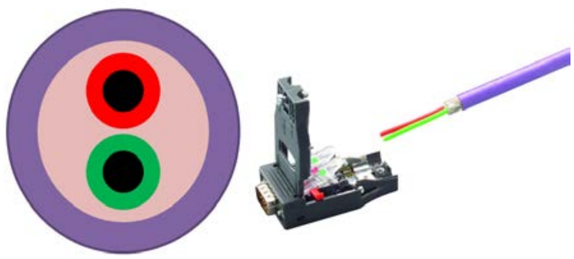

Figure 4. Profibus shielded cable

Profibus DP (Decentralized Peripherals) works in a bit rate range from 9.6 kbit/s till 12 Mbit/s. The communication speed is determined by complexity of the network. Single cable length can be from 100 m till 1200 m which depends on the used bit rate, before using repetitors. Profibus DP uses transmission method for communication with other devices. The optical transmission allows 15 km before using repetitors. Since the RS-485 balanced transmission is used, 32 devices is maximum number of stations on the network.

Profibus PA (Process Automation) is based on MBP (Manchester Bus Powered) transmission technology and allows data and power feed trough the same cable. This technology can be used in explosive-hazardous environment if power is reduced. Bus topology of network will allow 1900 m length and 60 m of branching for devices. For Profibus PA the bit-rate is fixed on speed of 31.25 kbit/s.

Profibus DP and Profibus PA are compatible in the same network if DP/PA Coupler modules are used. All of this information are available in [8], [9], [10] and [11]. Figure 5. presents Profibus DP slave module for Siemens Simatic S7-1200 automation systems.

Figure 5. Profibus DP slave module for Siemens Simatic S7-1200 [12]

4. IMPLEMENTATION OF PROFIBUS NETWORK FOR FIELD DEVICES

The automation for brick drying system that consists of one field device provided by S7-300 rack (Figure 6.) and SCADA application (Figure 7.) is basic model when Profibus standard should be used for communication.

Since both of these devices are inside same building, along with mechanical equipment and power supply installation, whole space is very susceptible to noise in communication media. Therefore, Profibus was selected due to its resilient isolation and good speed of data transfer. The S7-300 rack is configured to provide 96 digital outputs and accept 64 digital and 16 analogue inputs. All digital outputs are used to start separate motors in production system. The analogue readings are for temperature and moisture inside every of 7 chambers. Digital inputs are mostly used for terminal switches, positions and protection of machines in production system. Therefore, the Profibus DP is sufficient to provide insight in process status for seven chambers of brick drying system, in signal transmission quality and speed of data interchange as well.

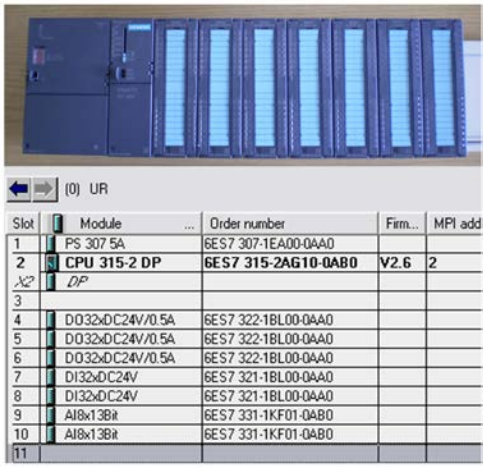

Figure 6. S7-300 rack with Profibus DP for Brick drying automation system

Figure 7. Sample of SCADA screens for Brick drying automation system

The example of milk industry can be presented with solutions for milk processing system (Figure 8.). The CPU for milk processing management will need some information about system output. Therefore, the CPU acquires some I/O devices in distributed parts of system, since milk processing system is distributed in three separate buildings. The Profibus DP is selected in order to enable good regulation properties. Multiple lines of material flow from input to output of system have direct influence on automation system. If single part of system works at high production speed, than all other parts of system will either increase processing speed (if possible), or will influence on that part of system to reduce its production speed. Communication can be provided by simple Profibus standard Point-to-Point communication between the CPU for processing system and the I/O modules for packing system. The main issue in such communication is in fact how to recognize when such event is present. It can be provided by displaced I/O devices, in this case sensors and actuators throughout the system controlled by the CPU. In order to provide such solution, the Siemens Simatic ET 200 remote I/O device modules are used. The usage of Profibus DP network for field device level solution can provide, if necessary, connection of SCADA to the whole system. The PC station with Profibus DP port and WinCC Runtime application can be used to monitor whole industry system from one center. In this application the CPU is used with PROFINET network for central monitoring of the system.

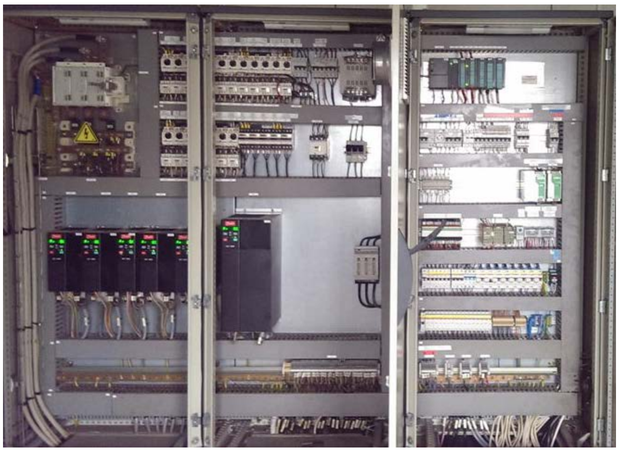

Figure 8. Profibus DP network master (S7-300) for milk industry automation system

5. CONCLUSION

In automated production systems very often quick interchange between automation units is of great importance. If such communication is transferred inside production process objects, it is important to ensure good signal quality resilient to external electrostatic interference and influences. With Profibus DP speed of data transfer can go up to 12 Mbit/s. Also, power supply can be provided for field devices if Profibus PA is used. Therefore, Profibus standard became one of most popular solution for automation systems with high demands of field data interchange between multiple CPU units and/or field I/O devices.

6. REFERENCES

[1] Jurčević, D.; Petrović, I.: Automation of sewage pumping station shaft, Technical Journal, Vol. 7, No. 1 (2013) 8-12

[2] Gašparac, I.; Vražić, M.; Petrović, I.: Sensor distribution strategy for dual-axes photovoltaic positioning system, EDPE 2009 - 15th international conference on electrical drives and power electronics, Zagreb, 2009., 1-6

[3] Petrović, I.; Gašparac, I.; Vražić, M.: Comparison of expected and measured values of luminance sensors in dual-axis photovoltaic positioning system, The XIX International Conference on Electrical Machines (ICEM 2010), Rome, 2010, 7-10

[4] Gašparac, I; Vražić, M.; Petrović, I.: Expected and measured values of luminance sensors in dual-axis photovoltaic positioning system, Procedings of Joint IMEKO TC 11 – TC 19 – TC 20 International Symposium Metrological Infrastructure, Environmental and Energy Measurement, Zagreb, 2011, 52-56

[5] Petrović, I.; Šimić, Z.; Vražić, M.: Comparison of fixed and dual-axis tracking PV systems, 14th International Scientific Conference on Production Engineering CIM 2013 June 19 - 22, 2013 Biograd, Croatia, 213-216

[6] Petrović, I.; Purković, D.; Vrhovski, Z.: Comparison of PV systems in different modes of operation, Technical Journal, Vol. 7, Nr. 3, 2013, 225-228

[7] http://www.aprotedi.com/ima/fotosb/profibus1.jpg (Available on 04. 11. 2013.)

[8] Siemens Simatic NET: PROFIBUS Networks Manual, Release 2 05/2000

[9] Siemens Simatic NET: PROFIBUS Network Manual, Edition 04/2009

[10] http://en.wikipedia.org/wiki/Profibus, (Available on 29.10.2013.)

[11] Siemens Simatic: S7-1200 Programmable controller system manual, Isue A5E02486680-06, 04/2012

[12] http://intenso.name/images/stories/CM_1242-5_Slave_vR_SW_sRGB.jpg, (Available on 08. 11. 2013.)

Kontakt autora:

Technical college in Bjelovar
Trg Eugena Kvaternika 4
43 000 Bjelovar
043/241–201

Igor Petrović, PhD
ipetrovic@vtsbj.hr

Mario Vinković, student
mariovinkovic@gmail.com