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Profibus DP

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***Abstract**: The article contains information related to the Profibus DP communication protocol. The article will discuss the basic protocols used in industrial networks and an example application of the Profibus protocol. It will then discuss the Profi-bus network, the principles of the protocol, and the description and configuration of a workstation configured according to the Profibus DP standard. The task uses a Siemens S7-1200 family controller operating in master mode, a VIPA DI/DO island operating in slave mode, and a light sensor as a measuring element.*

***Keywords**: Communication Protocol, PLC, Profibus DP, Siemens*

I. INTRODUCTION

Profibus is a protocol created by SIEMENS AG. It allows communication between ET 200 I/O devices and the exchange of information with display and operator panels, along with other field devices [1] [5]. The primary focus of this technology is to support the needs of the process industry; therefore, it is most commonly used in establishments that place high emphasis on product safety control.

Profibus is an industrial fieldbus that enables communication between automation devices, based on the IEC 61158 and IEC 61784 standards [6]. It is a complex communication protocol that operates on the three layers of the ISO/OSI model. The specific layers utilized by the Profibus network are as follows:

- Physical layer: determines the maximum network size and is responsible for data transmission speed.
- Data link layer: determines message size and location within the network.
- Application layer: an optional layer in the Profibus network that handles data delivery to the user and facilitates the handling of specific data.

The network's primary responsibility is to transmit large amounts of data efficiently in the shortest possible time. The communication protocol relies on profiles that define network properties. These profiles contain device and system-specific properties, parameters, and behaviors. Profibus DP is the most commonly used protocol variant, designed to be faster and simpler to use than its predecessor.

The Profibus DP system facilitates communication between PLC controllers and a variety of peripheral devices [2] [4].

Fig. 1. Official Profibus Protocol Logo

In Master-Slave mode, the primary transmitter cyclically exchanges data with subordinate receivers. The RS-485 interface is the most widely used transmission technology for communication in the Profibus DP standard. It offers transmission speeds ranging from 9.6 kbit/s to 12 Mbit/s.

The protocol functions by passing tokens between master devices, thus creating a logical token ring between master transmitters. Slave receivers cannot generate or send requests but only respond to signals received from the master.

The Profibus DP protocol is divided into three layers that define its functionality. These layers include:

- DP-V0 allows for cyclic data exchange and network diagnostics.
- DP-V1 enables both cyclic and acyclic data exchange between Master and Slave devices.
- DP-V2 supports communication in isochronous slave-to-slave mode, which facilitates communication with a synchronized clock and message transmission without requiring confirmation from stations on the network.

In the Profibus network, messages are composed of 11-bit characters comprising one start bit, 8 data bits, one parity bit, and one stop bit. These characters are transmitted sequentially without any intervening breaks. The Profibus network includes five types of network messages:

- SD1 - a command message encoded as an FC character.
- SD2 - a message containing variable-length data fields.
- SD3 - a message containing data fields of precisely 8 bytes.
- SD4 - a message responsible for transferring the token.
- SD5 - a confirmation message.

II. CONFIGURATION OF THE WORKSTATION ACCORDING TO THE PROFIBUS DP STANDARD

The workstation for simulating the operation of the alarm channel based on the Profibus DP communication protocol consisted of the following devices [3]:

i. Impulse power supply DR-4524 MEAN WELL – 84W/24VDC/2A,
ii. PLC driver Simatic S7-1200 CPU 1214C equipped in PN/E port and additional communication module CM 1241 RS485,

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iii. The VIPA/IM0/53DP station is equipped with: PM/DC/24V/10A power supply module with a module allowing connection of a larger number of devices to the power supply, DI 8/DO 8/x24VDC input/output modules, and AI 2x 12bit/0-10V analogue input module,
iv. Servodan light intensity sensor.

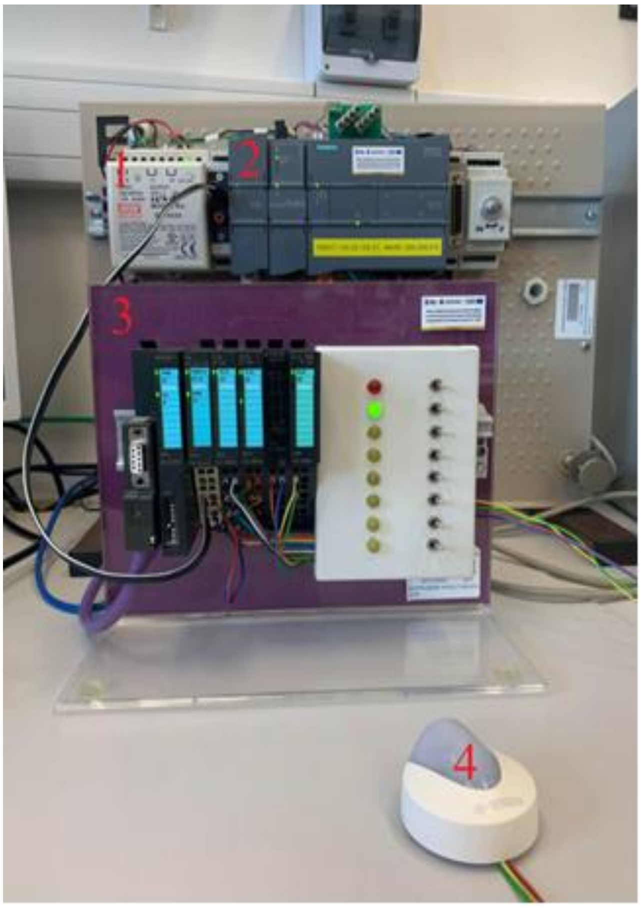

Fig. 2. Workstation Set up According to Profibus DP. Standard

The devices were connected using an RS-485 cable. The network of the implemented system consists of two nodes: a superior node, which acts as the master of the S7-1200 PLC controller, and a subordinate node, which acts as the slave of the VIPA/IM0/53DP island.

In the network configuration, the following DP addresses were assigned to the devices:

- PLC controller (master) DP - 2
- IO island (slave) DP - 8

The control program for the entire system was written in ladder logic. The master device is waiting for information from the slave regarding any malfunctions that may have occurred. Malfunction signals were generated in two ways: through a digital signal produced by a bistable switch integrated into the IO module, or through an analogue signal generated by a light intensity sensor when it reached a specific value. Once a malfunction occurred, an LED on the master device would start flashing at a frequency of 1 Hz until the malfunction was confirmed and resolved.

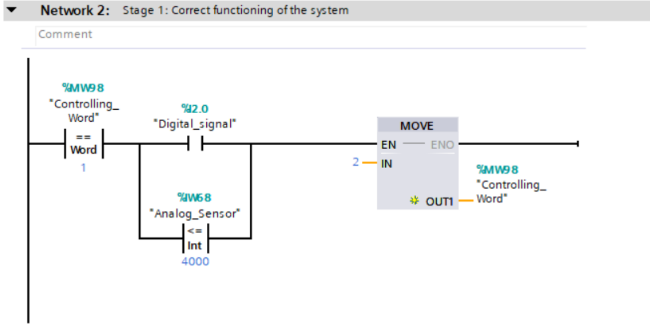

Fig. 3. Screenshot of Part of the Ladder Logic Program

III. DESCRIPTION OF ALARM SYSTEM PROJECT

The project's primary objective was to develop a distributed alarm system capable of receiving both digital and analogue signals, indicating equipment failure on a small scale. The sensor, which is connected to the input/output island, is situated a certain distance from the controller. If an issue occurs, it sends a signal to the controller, triggering the alarm. Three of these systems were constructed using communication protocols.

One such protocol is the Profibus DP, which utilises a bistable switch located on the input/output island to generate a digital signal indicating failure. Alternatively, an analogue signal can be triggered using a light intensity sensor connected directly to the island. The alarm signal is sent to the Programmable Logic Controller, which then confirms the alert.

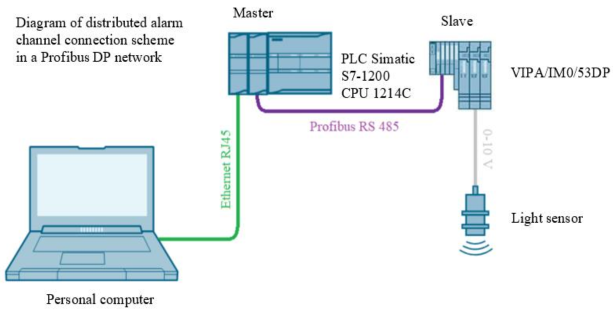

Fig. 4. Diagram of Distributed Alarm Channel Connection Scheme in a Profibus DP Network

IV. CONCLUSION

Setting up a connection via the Profibus DP network is relatively straightforward and requires minimal time and effort. This is because the Profibus bus, like the S7-1214 DC/DC/DC controller equipped with the CM 1241 communication module, was developed by Siemens. The input/output island from Vipa is also compatible with the S7-1200 controller. All configuration is done in a dedicated tab, making the entire configuration process very user-friendly. Additionally, the communication utilises a serial medium with a D-SUB port, which allows for verification of the signal between individual pins.

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It is worth noting that the proposal of the completed test configuration can be expanded with additional measuring and actuating elements capable of exchanging data in the Profibus DP standard.

This type of solution is used, among other applications, in the maritime industry, which aligns perfectly with the subject matter of Gdynia Maritime University.

DECLARATION STATEMENT

I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/Competing Interests:** Based on my understanding, this article does not have any conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
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- **Author's Contributions:** The authorship of this article is contributed solely.

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Kacper Falkiewicz. He is a dedicated student of Electrical Engineering, specializing in Computer Control Systems, at the Faculty of Electrical Engineering at the Maritime University in Gdynia. His primary area of study is automation, and he is currently working on his engineering thesis, focusing on Industry 4.0. This project explores PLC programming, industrial networks, Excel-based databases, process visualisation, and the Factory I/O program. His work aims to integrate advanced technologies to enhance manufacturing and industrial processes, reflecting his commitment to contributing to the evolution of modern industry through innovative engineering solutions.