Acta Mechanica Slovaca **26 (4): 58 - 63,** September **2022**
https://doi.org/10.21496/ams.2023.012

Acta Mechanica Slovaca
ISSN 1335-2393
www.actamechanica.sk

Design of an Experimental Device for Remote Monitoring of Variables Through the Cloud Services

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Abstract: The article focuses on testing and verifying the proposed method for the real-time monitoring of remote experimental devices through the Cloud principle. This concept interconnects an individual Siemens product into one functional unit to prove the possibilities of control and monitoring such automated workplaces. In the next part, the article tests the connection, visualization, and accessibility of different devices.

Keywords: automation, predictive maintenance, PLC device, sensors, cloud

1. Introduction

Automation requirements in industrial, commercial, and even home applications constantly increase. Cost-effective solutions to minor automation problems increasingly require the use of low-level PLCs. To be able to monitor and control these solutions effectively (and, if possible, remotely), it is necessary to create a model experimental system (stand) through which the skills of programmers can be developed, as well as errors can be predicted directly during the running process at the selected automated workplace. Such compact solutions' advantages are high modularity and deployment in practical teaching-related automation subjects. This proposal is also based on available knowledge of similar facilities of other schools or companies. Also, during the design, the practice requirements were considered to bring the target group (working with this and similar devices) to a new way of thinking and solving practical problems [1-13].

2. Selection of individual modules to one functional unit

The experimental device (Fig. 1) represents a proposal that combines the knowledge of the study of automation subjects, similarly, solved projects and products training low-level PLC systems from practice, and the abilities of the target group in question. The typological selection of the PLC device is based on the design's complexity, complexity, and financial capability. The aim is to efficiently and compactly implement SIEMENS modules' installation, revival, and simple programming based on LOGO! Components.

The work was oriented more toward the theoretical level in the initial stages. When the individual components of the experimental system were gradually specified, information was collected about the possibility of their connection or the remote control's functionality.

Other activities focused on the experimental system's gradual 3D modeling (SolidWorks) in the corresponding software environment, while the ongoing work also emphasized its physical implementation over time. A prerequisite was the provision

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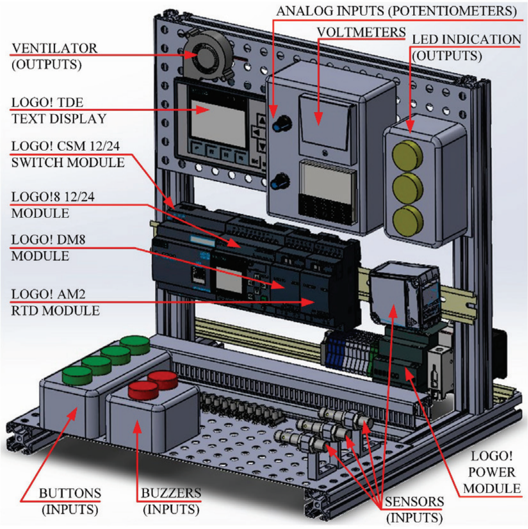

Figure 1: Concept of the experimental system (stand).

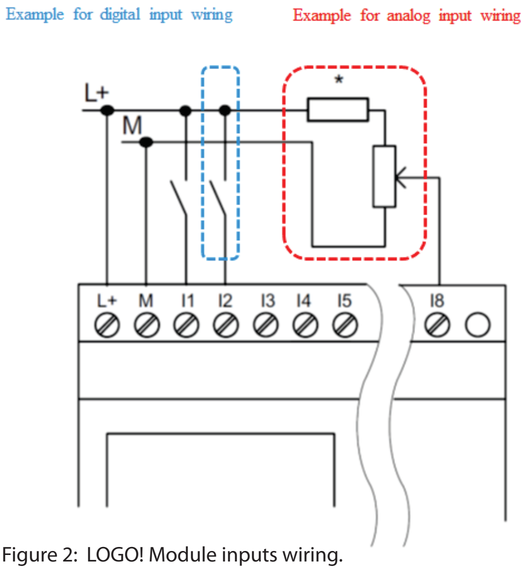

Figure 2: LOGO! Module inputs wiring.

of essential components for the power supply, selecting and purchasing sensors, buttons, or indicators. The basis is a 30x30mm aluminum profile and DIN rails, on which the individual modules were gradually mounted. The external dimensions are length = 390 mm, width = 350 mm, and height = 380 mm. They are connecting LOGO! Modules are realized by an Ethernet cable, while the critical node is a standard 4-port industrial SIEMENS switch that can be mounted on a DIN rail. A typical circuit breaker, safety switch, or the installation of terminal blocks for safe separation of the input source voltage from the constant 24V voltage is a matter of course.

The central component (module) of the experimental device is the LOGO! PLC system. It is a type in the following specification (12/24 RCE). This type has eight digital inputs (four configurable analog inputs) and four (relay type) outputs. For the correct functioning of the analog inputs, it is necessary to connect a resistor (6K6 ohm), while the connection can be seen in Fig. 2.

As mentioned above, the PLC is equipped with four relay-type outputs. In addition, it is possible to have a PLC with a transistor output type, but the disadvantage is their load capacity. The relay outputs can be loaded up to values of approx. 10A, while the transistor type can be loaded up to 300mA. We should not forget the fact that each output of this PLC is galvanically isolated, so it cannot happen that you will lose all outputs of the PLC device in case of overload (or incorrect connection). The link between the output of both types can be seen in Fig. 3.

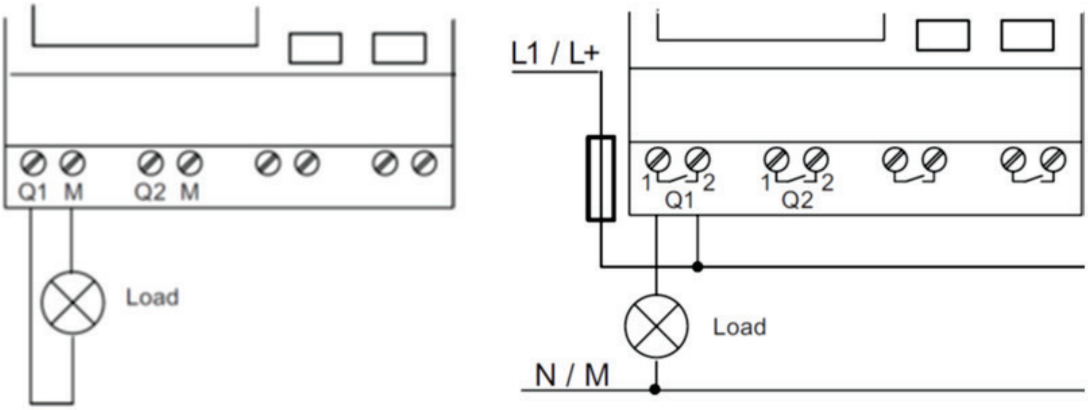

Figure 3: LOGO! Module outputs wiring (semiconductor type on the left side, relay type on the right side).

The nature and focus of this solution assume the future expansion of functions, either from the point of view of inputs and outputs, communication via GSM or LTE, or home automation control. With that in mind, this experimental device is supplemented with an expanding input/output module (additional four inputs and four outputs available). Overall, this PLC LOGO! 8 can handle 24 digital inputs, eight analog inputs, 20 digital outputs, and eight analog outputs. In addition, if eight more PLC modules are connected (on a Master-Slave basis) in one network, the numbers will increase to 88DI, 40AI, 80DO, and 24AO.

For optimal operation and fast communication between LOGO! Module and various expansion modules are recommended to connect the digital modules first and then the analog ones. The exception is the PI controller when using AI directly on LOGO is recommended! Module, or join the additional analog module immediately after the primary LOGO! Module. The final realized experimental device can be seen in Fig. 4.

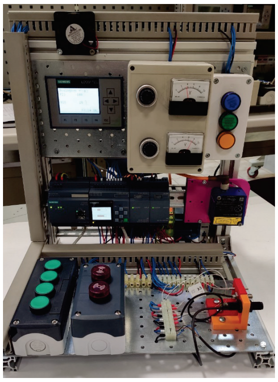

Figure 4: Experimental device (stand).

3. Steps to monitoring and control via Cloud

SIEMENS has access to the Cloud through AWS (Amazon Web Services). It is a subsidiary of Amazon.com that provides a "Cloud computing" platform for rent to individuals, companies, and governments on a paid subscription basis. There is also a free subscription available for the first 12 months. The approach simultaneously collects data from several sources (machines, automated systems, sensors, etc.). Data transfer to the Cloud, monitoring and optimization of data, and status of automated devices, Fig. 5.

The necessary and first step for us to remotely control or monitor the selected experimental device is to register and set up an account on the AWS portal. The intuitive process guides us through essential items such as name, company, country, or email address. In the following steps, we will choose a new user, and I will select access to individual AWS packages. The initialization process ends with assigning an access password and a unique key, which will be used precisely when setting up Cloud access on the side of the PLC device.

The process continues on the side of the PLC device by enabling remote communication based on the Cloud connection and registering a new thing (new access). The next step is the possibility of verifying the remote connection through a test (Connection - Succeed). Finally, a suitable additional step is to enable the WEB server to the PLC, which usually works in the local network (Allowing Web server access). However, it should be remembered that communication via the Cloud cannot be simultaneously enabled with the Web server (it is valid that either one or the other is allowed).

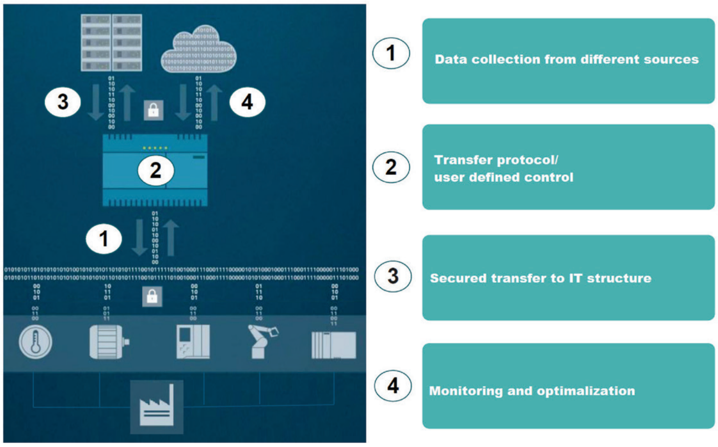

Figure 5: Cloud computing architecture by SIEMENS and AWS corporations.

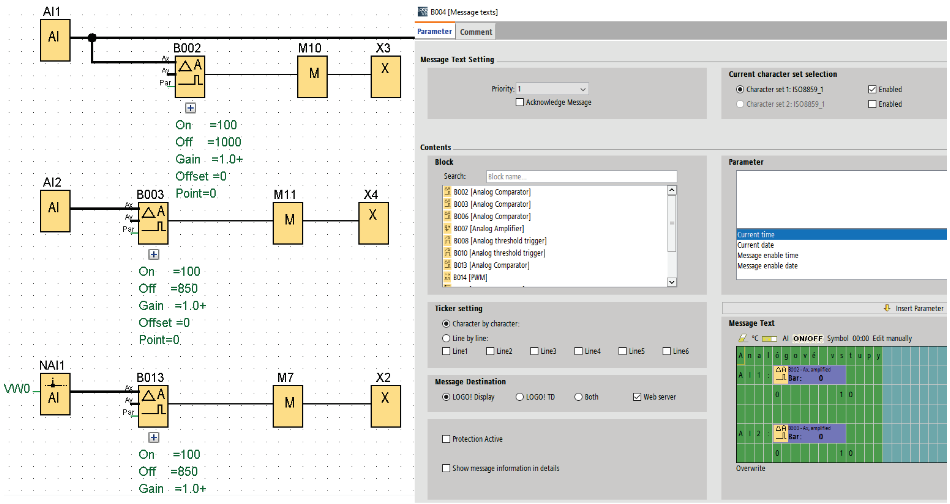

Figure 6: Part of the sample program and HMI setting on the PLC display.

Figure 7: Actual information visualized by embedded LOGO display and external TDE display.

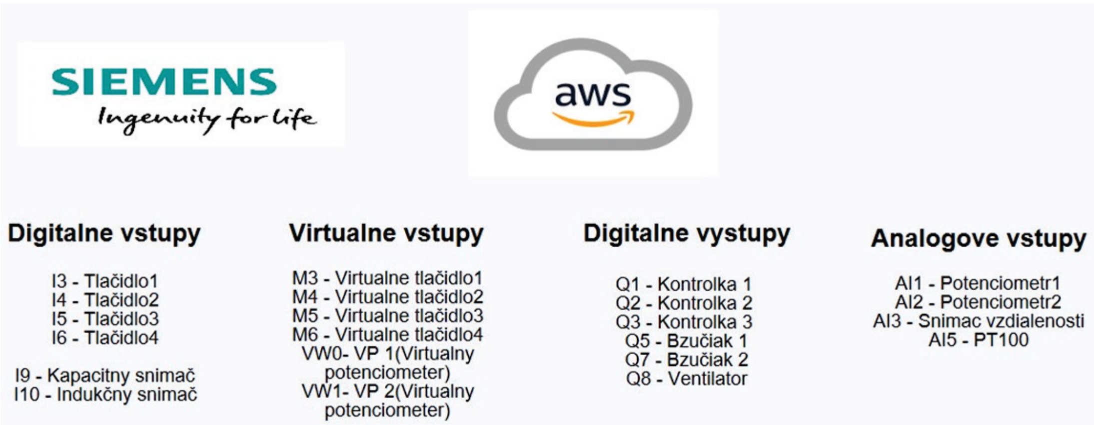

Figure 8: The allocation of the different variable types.

4. Programs and HMI visualization

Verification of communication, monitoring, and subsequent remote intervention directly into the experimental device via the Cloud connection requires the creation of a sample test program, which includes the writing of current data (states) of selected variables both on the display of the PLC system itself and the remote Cloud, Fig. 6.

Demonstration functions of the sample program use the PLC device's available inputs and outputs. At the same time, the monitored sensor parameters (inductive, capacitive, and distance sensor) are additionally visualized through the built-in and external display. In addition, exceeding the analog values from the potentiometers is signaled by the warning buzzing of the indicator light on the corresponding output. At the same time, this information is also visualized through an external display, Fig. 7.

5. Verification of control and monitoring via Cloud

The verification of the proposed remote access is based on creating an HMI screen through HTML code and "flipping" it to a remote AWS storage. For this purpose, it was necessary to use knowledge of programming and the creation of visualization using a freely available software product of SIEMENS (LWE- Logo Web Editor). This software enables effective communication with the Cloud remotely thanks to the appropriate settings. Local memory, network, and flag variables were used as inputs to demonstrate control. It allowed us to control, virtually manage and intervene in the running program directly on the experimental device while we were informed about each change thanks to the visualization, Fig. 8.

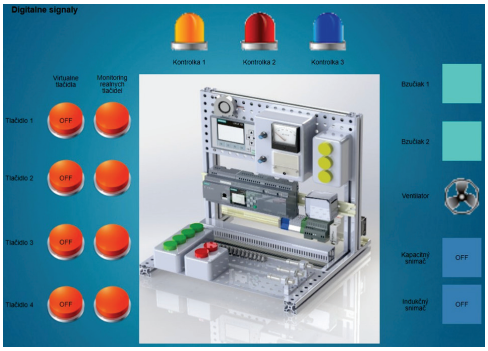

Figure 9: The remote monitoring, control, and visualization of digital signals.

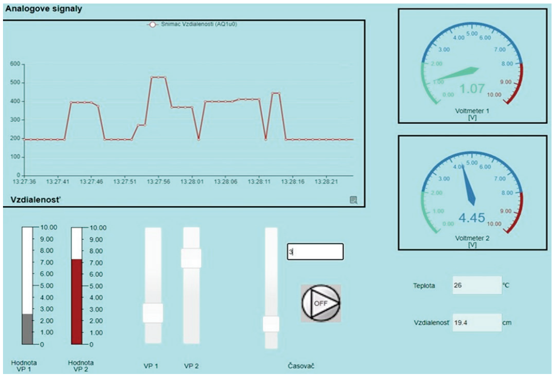

Figure 10: The remote monitoring, control, and visualization of analog signals.

Digital signals represent virtual buttons, online remote monitoring of their states, the indication of their changes, and possibly also values from sensors (inductive, capacitive, distance sensor), Fig. 9.

Analog signals simulated through potentiometers and a resistance temperature sensor (PT100) draw a graphical representation and display the actual numerical course of the measured values, Fig. 10.

6. Conclusions

Testing and its results and experimental trials (in the form of remote intervention into the running process) demonstrated several conclusions. The most important is a too-slow response (reaction) to the requested change. It is a delay in the order of seconds (approx. 2-3 seconds), which is almost unusable in actual practice, so further work needs to be done to improve this factor. The starting point seems to be applications based on intelligent condition monitoring, which offers complex solutions consisting of preset alarms, status indications, fault diagnoses, intuitive control, and simple integration. Secondly, and positively, the possibility of governance, management, and access from different devices (smartphone, tablet, laptop) through a single account was affected. Overall, remote control, power, and monitoring in this way can be considered a particular (suitable) method when the customer does not require an immediate response to his reaction. Finally, of course, the possibilities of remote control with the aim of predictive maintenance continue to improve. Other solutions on the market eliminate our shortcomings but at a different price. In conclusion, it can be concluded that concerning the assigned research task, the assignment of the target group (preferably students and researchers), as well as the implementation of a sample test example to verify the functionality of the solution, this compact and inexpensive solution can provide a suitable alternative to small application examples from practice.

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