ISSN 1846-6168 (Print), ISSN 1848-5588 (Online)
ID: TG-20160327225416

APPLICATION OF PLC DEVICE IN MODELING THE ELECTRICAL MACHINE DRIVE SEQUENCE

PRIMJENA PLC UREĐAJA ZA MODELIRANJE ELEKTROMOTORNOG POGONA

Igor Petrović, Denis Čamber, Zdravko Petrović

Professional paper

Abstract: *In complex industrial processes the simplification of work is ensured using complex automation solutions. In such systems it is crucial to provide as much automated tasks as possible in order to reduce possibility of human error and ensure high level of excellence for final product. Complex automation solutions require high level of excellence in design, production and commissioning. In this paper the use of PLC application for testing single part of automated system is presented. The results of testing are described in several specific steps recorded during the actual testing. This will ensure determination of errors without connection of actual electrical machine drive.*

Keywords: *model, automation, testing, PLC*

Stručni članak

Sažetak: *Olakšavanje rada u složenim industrijskim procesima osigurava se korištenjem složenih sustava automatizacije. U takvim sustavima cilj je što više poslova odraditi automatizirano da bi se smanjila mogućnost ljudske pogreške i da bi se osigurala visoka produktivnost. Složeni sustavi automatizacije zahtijevaju visok stupanj kvalitete u projektiranju, izradi i puštanju u rad. U ovom radu prikazana je primjena PLC uređaja u ispitivanju jednog dijela automatiziranog sustava. Rezultati ispitivanja opisani su u nekoliko specifičnih koraka snimljenih tijekom ispitivanja. Na takav način omogućeno je utvrđivanje pogrešaka bez spajanja konkretnog elektromotornog pogona.*

Ključne riječi: *model, automatizacija, ispitivanje, PLC*

1. INTRODUCTION

When new technology objects are designed, it is common to implement automation solutions. Most often designers are trying to cover as much process as possible for designed object, and therefore automation can become very complex, as presented in [1]. In order to guaranty easy use of such systems many parameters must be taken into consideration, as well as their interdependence. Once the system is balanced it is easy to use, reliable and safe, as presented in [2]. But in order to get these characteristics for the system, it is necessary to maintain high level of excellence throughout design and construction process.

In this paper a case study of single electrical machine drive automation testing using PLC is described, somewhat similar to examples in [3]. The electrical energy supply and relay systems are tested for its correctness and functionality. The model used in this case study is equipped with all input and output data for tested system, but not with supposed automation programming solution. The used PLC is programmed so that one can manually configure any possible scenario, while containing only physical correspondence between elements. Results are intended to be considered as functions in logical order. If any of these functions defer from expected it is obvious that some errors are present inside the system and further analytics must be applied to determine them exactly. The results of this kind of testing can suggest the part of the system where errors occur.

2. AUTOMATION SYSTEM AND ELECTRICAL MACHINE DRIVE

The sample case of automation system used in this case study is divided in several functional units, as presented in Figure 1., where single arrows represent direction of signal interchange and double arrows represent direction of energy flow.

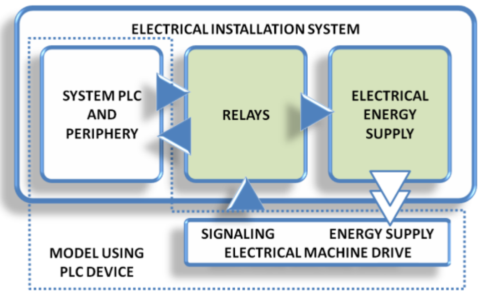

Figure 1. Block schematic for sample case of automation system

The sample case in this study is divided in Electrical installation system, mainly focused on electrical elements and wiring, and Electrical machine drive [4], concentrated on mechanical static and dynamical balance of process. The Electrical installation system is divided into functional subsystems:

1. System PLC and periphery
2. Relays
3. Electrical energy supply

All of these subsystems are hardware connected and they are exchanging information in order for the whole system to function properly. The Electrical machine drive is able to select if it is operated from System PLC and periphery (*Remote*) or directly from Electrical machine drive commands (*Local*), but in each case of operation the operation loop is gained through Relays and Electrical energy supply subsystems.

The information exchange is also presented in Figure 1, and it can be seen that information flow is designed as star configuration, with Relays subsystem as a center of grid. The Electrical machine drive is supplied with electrical energy from Electrical energy supply subsystem using standard Open/Close system and wiring presented in Figure 2.

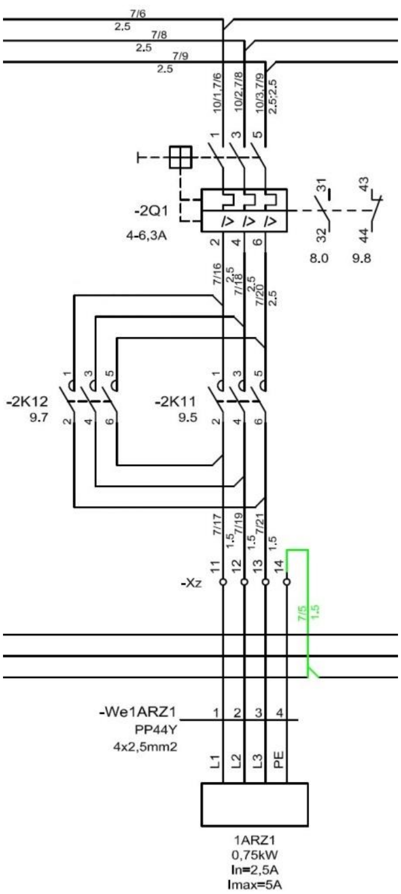

Figure 2. Standard Open/Close system and wiring

Considering the motion status of Electrical machine drive it responds to system through some information regarding open/close limit switches, open/close torque gained and thermistor switch. The Relay subsystem is using this information to operate and protect Electrical machine drive from over current or similar threats due to Electrical energy supply. The information is also forwarded to System PLC and periphery subsystem, where if Remote operation is selected, the program returns control signals for Relays to forward to Electrical energy supply.

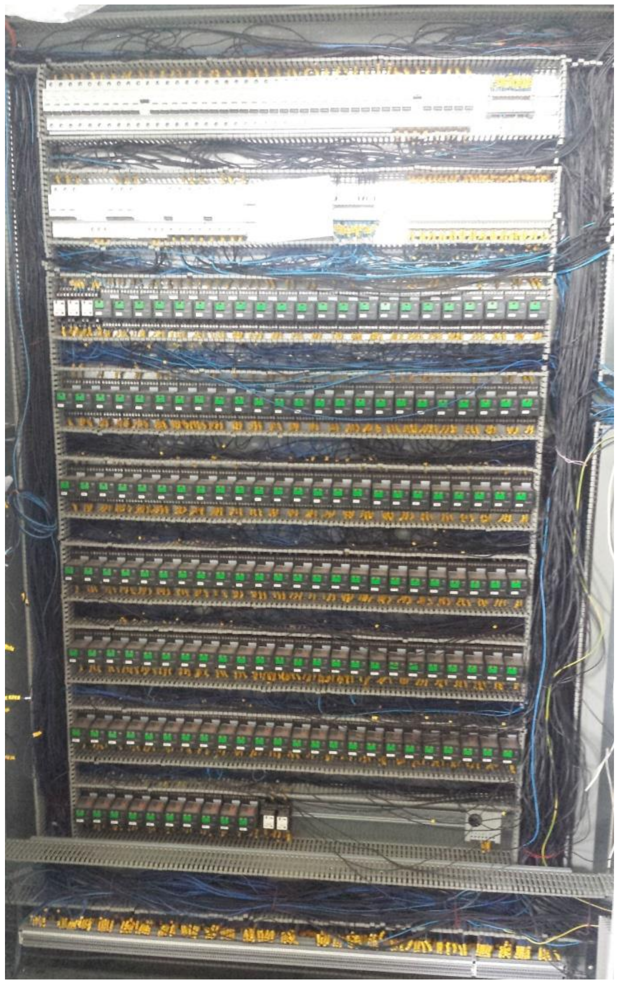

Figure 3. Example of Relays installation in sample case of automation system

Figure 4. Example of Energy supply installation in sample case of automation system

3. CONFIGURATION OF SIMULATION STATION

In order to gain high level of excellence for this product one must ensure as good testing as possible before delivery. Therefore, the testing is done using PLC device described in [5] (not the one in System PLC and periphery), named Simulation station, which is equipped with model of Electrical machine drive and System PLC and periphery. The model is actually provided through program integrated in Simulation station.

The Simulation station is planned in one part to match electrical connection of Electrical machine drive and System PLC and periphery in other part. The connection links are made exactly to match connection terminals of Electrical machine drive and System PLC and periphery, and model ensures functionality match. The logic of System PLC and periphery is not the topic of this case study and is not implemented in model. Also, the model is equipped with SCADA application for monitor, measurement and operation control, using software solution described in [6]. The testing operator is fully able to monitor all incoming signals from Relays, monitor state of incoming energy flow from Electrical energy supply, and also operate all outgoing signals to Relays. Outgoing signals allow simulation of any scenario available and is not dependent on most of input signals. The measurement is not supported in this Electrical machine drive and therefore is not implemented in subject SCADA.

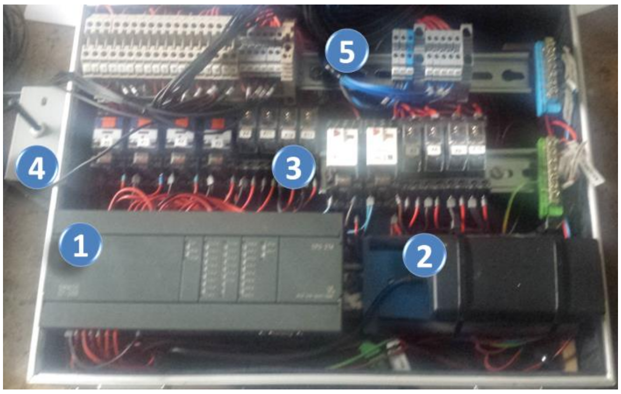

Figure 5. Simulation station

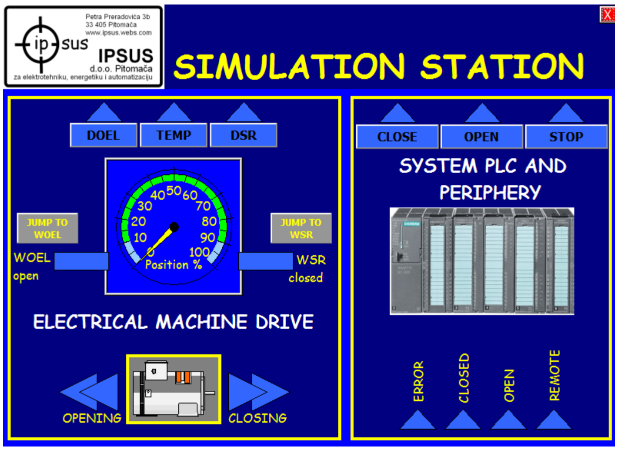

Figure 6. Offline screenshot of SCADA application

The Simulation station is presented in Figure 5 and consists of:

1. Power supply
2. PLC device with model program
3. Periphery for PLC device
4. Thermistor output model
5. Connection terminals

The offline SCADA screenshot is presented in Figure 6. Electrical machine drive part of model can be seen on the left side of the screen. It is equipped with five output signals from modeled drive, and two input power flows into modeled drive. Output signals are fully independent and can be activated at any time. Input signals are activated from Electrical energy supply and cannot be operated manually. System PLC and periphery part of model can be seen on the right side of the screen. It is equipped with three output signals from modeled PLC, and four input signals into modeled PLC. Output signals are partially dependent to inputs, and cannot be activated if Local operation or Error inputs are active. Input signals are activated from Relays and cannot be operated manually. Application is communicating with PLC device using PC/PPI interface through RS-232 port of computer.

4. TESTING RESULTS USING SIMULATION STATION

Testing results are made online during the actual testing in the Ipsus electrical workshop on 3rd March 2016. Testing is s sequentially conducted on 8 separate devices, using same procedure for simulation scenarios.

Figure 7 is a screenshot in moment (sample 1) when system is operated Locally to open, already hit open limit switch and just gained limit torque. In this moment the system should stop opening operation in Relays and Electrical energy supply. If opening stops, system works properly for this scenario. If the action does not stop it means that system has a fault.

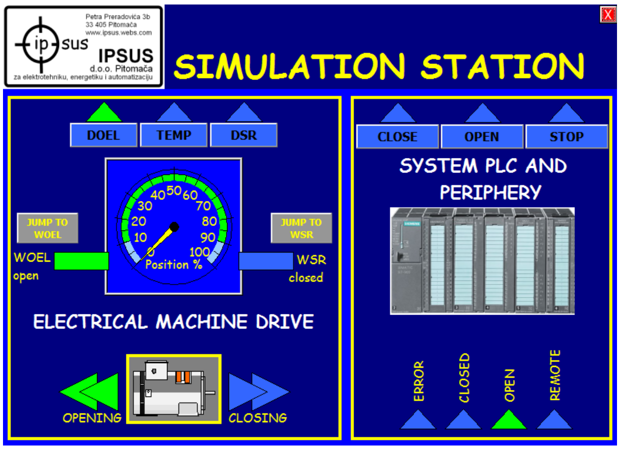

Figure 7. Testing – sample 1

Figure 8 is a screenshot in moment (sample 2) when system is operated locally and starts to close, and still hitting open limit switch. Limit torque is not active on either direction. In this moment system should be in normal closing operation in Relays and Electrical energy supply. If closing is operational system works properly for this scenario. If the action does not stop it means that system has a fault.

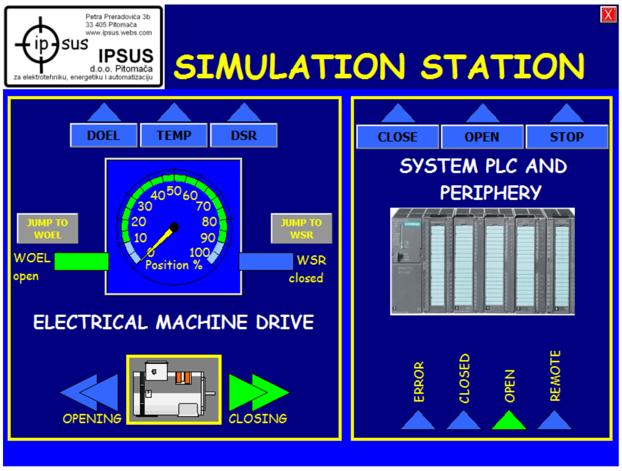

Figure 8. Testing – sample 2

Figure 9 is a screenshot in moment (sample 3) when the system is operated exactly like in sample 2, only in Remote operation. It starts to close, and still hitting open limit switch. Limit torque is not active on either direction. In this moment system should be in normal closing operation in Relays and Electrical energy supply. If closing is operational, the system works properly for this scenario. If the action does not stop, it means that the system has a fault.

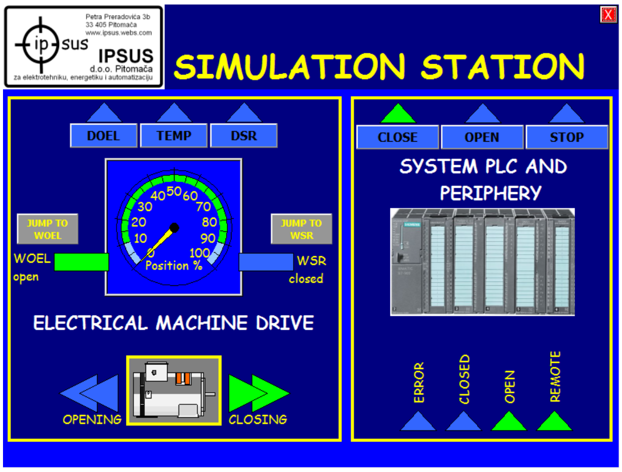

Figure 9. Testing – sample 3

Testing results indicated few errors. The exact errors were detected and changes were applied to gain full functionality of the tested system.

5. CONCLUSION

This case study presented simple testing improvement on the example of electrical machine drive with automation. Once the simulation station is configured and tested it is easy to use it for testing the electrical installation. Errors are usually present due to human factor, but in this way can easily be discovered and annulated. The upside of this kind of testing is that it reduces problems during, or even improves, commissioning.

6. REFERENCES

[1] Bolton, W: Programmable Logic Controllers, Fifth Edition, USA, Elsevier, 2009.
[2] Bailey, D.: Practical SCADA for Industry, USA, Elsevier, 2003.
[3] Cetinkunt, S.: Mechatronics with Experiments, Wiley, 2015
[4] http://www.tri-state-tech.com/auma/sar1_iom.pdf (available on 02. 02. 2016.)
[5] Siemens Simatic: S7-200 Programmable Controller System Manual 08/2005, Siemens AG Nurnberg, 2005
[6] Siemens Simatic HMI: WinCC flexible 2008 Compact/Standard/Advanced User's Manual 07/2008, Siemens AG Nurnberg, 2008

Authors` contacts:

Igor Petrović, PhD
Technical College in Bjelovar
Trg Eugena Kvaternika 4, 43 000 Bjelovar
043 / 241 – 201; ipetrovic@vtsbj.hr

Denis Čamber, mag.ing.el.techn.inf.
Končar – Inženjering za energetiku i transport d.d.
Poslovna jedinica: Infrastruktura i gradovi
Fallerovo šetalište 22, 10 000 Zagreb
01 / 3655 – 611; denis.camber@koncar-ket.hr

Zdravko Petrović, MEE
Ipsus d.o.o. Pitomača
Petra Preradovića 3b, 33 405 Pitomača
033 / 715 – 093; ipsus.doo@gmail.com