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Paper
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# MODERN SCADA SYSTEMS IN PRODUCTION OF SOY FLOUR AND GRITS AND TEXTURED SOY PROTEINS

# MODERNI NADZORNO-UPRAVLJAČKI SISTEMI U PROCESU PROIZVODNJE SOJINOG BRAŠNA I GRIZA I TEKSTURIRANIH SOJINIH PROTEINA

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## *ABSTRACT*

*This paper describes the SCADA (Supervisory Control And Data Acquisition) software in the plant for production of soy flour and grits and textured soy proteins (TSP), which relies on PLC (Programmable Logic Controller). Six touch panels in the field are networked with two PC's in control room and together make a system that on one side communicates with the PLC and on the other side allows operators access to all parts of the plant.*

*The additional features of software are: the alertness to the possible excesses of the system via alarm messages, the graphical representation of tags in form of a tables or trends, archiving information in a database, creating reports, etc...*

*The software is designed with the suggestions of operators who have extensive experience in the management of these plants.The software was tested and put into operation in the factory "Soyaprotein" in Becej, Serbia.*

***Key words**: SCADA, PLC, flour, grits, TSP.*

## *REZIME*

*Za rad mašina i uređaja u proizvodnoj industriji neophodni su upravljački elementi koji omogućavaju pouzdano pokretanje, nadzor, upravljanje i zaustavljanje bilo koje mašine ili procesa. U prošlosti se upravljačka programska logika ostvarivala kroz relejnu tehniku ožičenjem električnih kontakata releja. Glavni nedostatak ovakvog pristupa je što svaka promena logike upravljanja zahteva značajne zahvate na samom ožičenju. U ovom radu je prikazan softver za nadzor i upravljanje u postrojenju za proizvodnju brašna, griza i teksturiranih sojinih proteina (TSP-a), koji se oslanja na programabilne logičke kontrolere (PLC-e). U pojedinim pogonima je omogućeno upravljanje sa lica mesta pomoću „touch“ panela, dok su celokupan nadzor i upravljanje implementirani u komandnoj sobi. Šest „touch“ panela su umreženi sa dva PC računara i čine sistem koji sa jedne strane komunicira sa četiri PLC-a koji vrše neposredno upravljanje, a sa druge strane omogućava operaterima uvid u sve delove postrojenja.Upravljačka logika je u ovom slučaju memorisana u programsku memoriju sistema za upravljanje i praktično je nezavisna od opreme i ožičenja, te se može menjati i dopunjavati bilo kada uz pomoć uređaja za programiranje i odgovarajućih programskih alata. Prelaskom na predloženi pristup upravljanju dobijene su i mogućnosti upozorenja na moguće ispade sistema putem alarmnih poruka, grafički prikaz veličina u vidu tabela ili trendova, arhiviranje bitnih informacija u bazi podataka, kreiranje izveštaja, itd.Softver je kreiran uz sugestije operatera koji imaju višegodišnje iskustvo u upravljanju ovim pogonima. Koncipiran je tako da korisnicima (operaterima) omogući jednostavan nadzor i upravljanje. Softver je testiran i pušten u rad u fabrici „Soyaprotein“ u Bečeju.*

***Ključne reči:** nadzor, upravljanje, PLC, brašno, griz, TSP.*

## INTRODUCTION

For the work of machines and equipment in the production of soybean for human nutrition it is necessary to have control elements that allow reliable running, supervision, control and stopping of any given machine or process. In the past, software control logic was achieved through the relay technique, with electrical wiring of relay contacts. The main disadvantage of this approach is that any change in the control logic requires significant actions on the wiring.

Nowadays, the control algorithm is realized by the software. The control logic in this case is stored in internal memory of controller and it is practically independent of the equipment and wiring, and can be changed and updated at any time using the device for programming and appropriate software tools.

This paper presents SCADA (Supervisory Control And Data Acquisition) software which is placed at the top of the control hierarchy (Bailey and Wright, 2003). Basic purpose of this SCADA system is to collect all important data from the process (Stuart, 2004). This is managed with the help of the PLC. In fact, the PLC communicates with machines, drives and instruments in the field and then supplies the SCADA system with the necessary data. SCADA on the basis of these data shows the state of the plant to the operators. On the other hand, operators have the opportunity to control the drive, with using SCADA again, and set the reference values in the PLC.

This paper describes the practical solution to the supervisory control software for the efficient control of the plants for the production of soy flour and grits and TSP. The system configuration is based on specialized SCADA software WinCC (Windows Control Center) and WinCC Flexible which are both produced by Siemens. The system was implemented and put into operation in the soybean processing factory "Soyaprotein" in Becej, Serbia.

Some other practical solutions of SCADA systems readers can find in (Bugarski et.al., 2007), (Bugarski et.al., 2008a), (Bugarski et.al., 2008b), (Bugarski et.al., 2009) and (Bugarski and Nikolić, 2009)

The main purpose of this paper is to provide experience and practical application of SCADA systems and solutions for the improvement of professional practice.

## MATERIAL

### Hardware Configuration

Supervision and higher level control is realized by using two PCs, under Windows XP operating system located in the control room. These computers are connected to the process computers (PLCs) via the Ethernet communication using a standard TCP/IP protocol (Clarke and Reynders, 2004).

The real control of the process (directly from the field) is enabled by using six touch panels, which are placed close to certain parts of the plant.

The SCADA software is used for distributed control and data acquisition in a process. The data processing apparatus, which presents the processed data to the operator and through which the operator controls the process, is HMI (Human Machine Interface). The main operator interface is a set of graphic screens.

Although the SCADA software packages are developed via different manufacturers, one can see similarities in their architecture. The basic components of any SCADA system are: Tag Management, Graphics Designer, Alarm Logging, Tag Logging, Report Designer, etc.

### Equipment

For data acquisition and direct control Siemens PLC S7-300 is used. The SCADA software is installed on two standard PCs and three Siemens 12' touch panels and three 15' Allen Bradley touch panels. For the communication with SCADA (PCs and touch panels) PLCs use Ethernet communication with TCP/IP protocol, while for communication with the frequency converters Profibus network is used.

The system consists of about 100 motor drives of various powers of which 13 are controlled with the frequency converters (Vasić et.al., 2009). The motors are used to run the fan, mill, classifier, rotary feeds, pumps, aspirators, feeder, extruder, knife, slide gate, live bin, cutter head, dryer exhaust fans, recirculation fans, dosing conveyers, elevators and other conveyers.

From the other equipment in the system there are 22 pneumatic valves to divert the material into the cells, then 23 level switches, 2 pressure switches, 2 differential pressure sensors, 6 analog current sensors, 9 solenoid valves, 19 temperature sensors, 7 flow meters and 1 weight sensor.

## RESULTS AND DISCUSSION

The SCADA software follows the functional organization of the plant. There are four main screens (Figures 1, 2, 3 and 4) from which operator can monitor the whole plant and two of them are start pictures on two PCs when the applications are started. The whole plant is shown in these four pictures. This requires higher-resolution monitors. These screens are used only for monitoring of plant (main parameters of the process) and not for controlling the drives (turn on/off engines, open/close valves).

Left-clicking on any machine opens a small window, which enables control of that machine. This window contains a number of position to which the window applies, the state of motor protective switches and visual and textual state of machine itself.

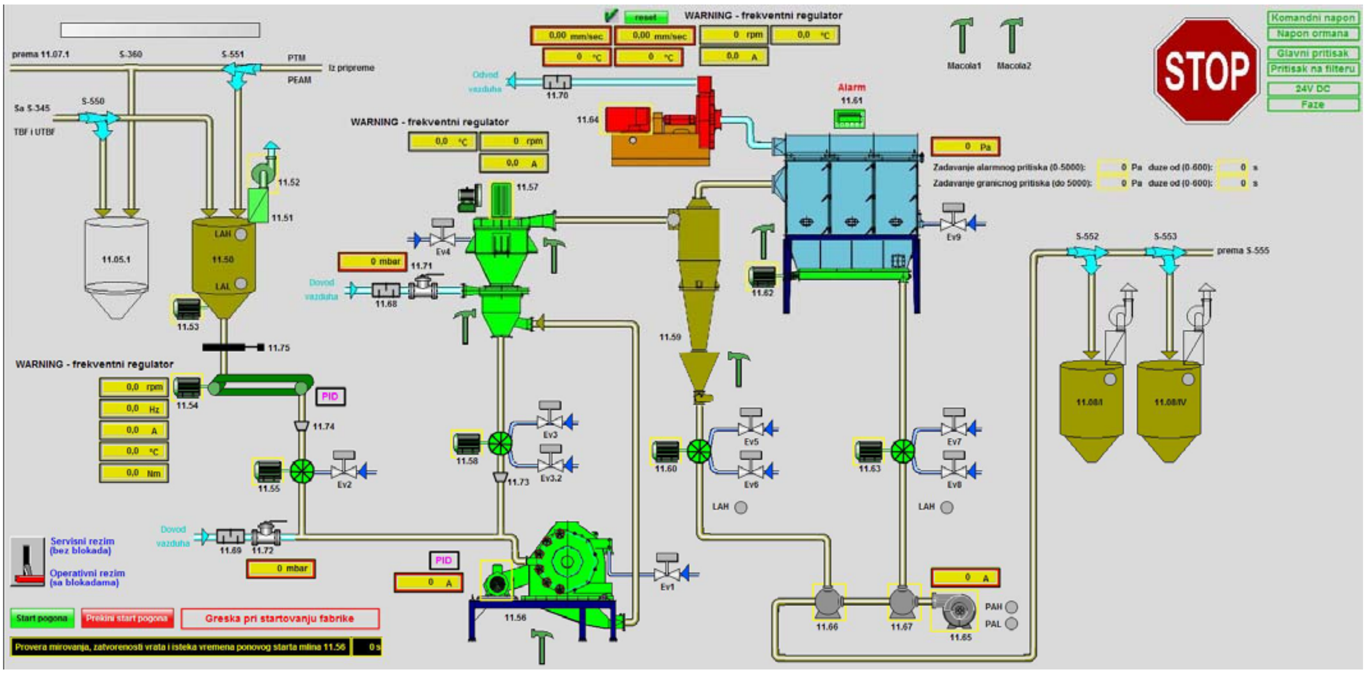


*Fig. 1. Flour and grits plant*

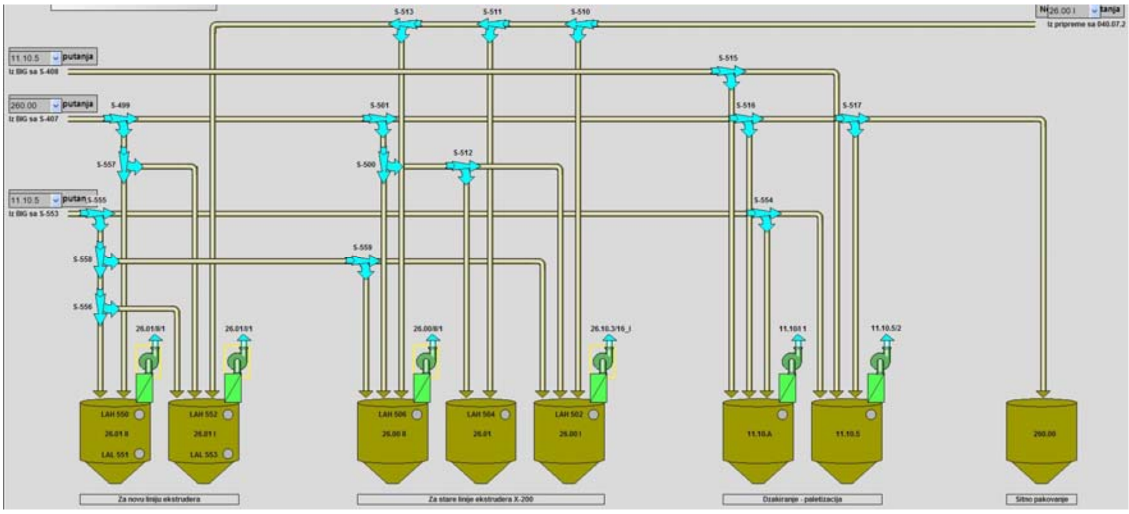


Fig. 2. Suplly for TSP

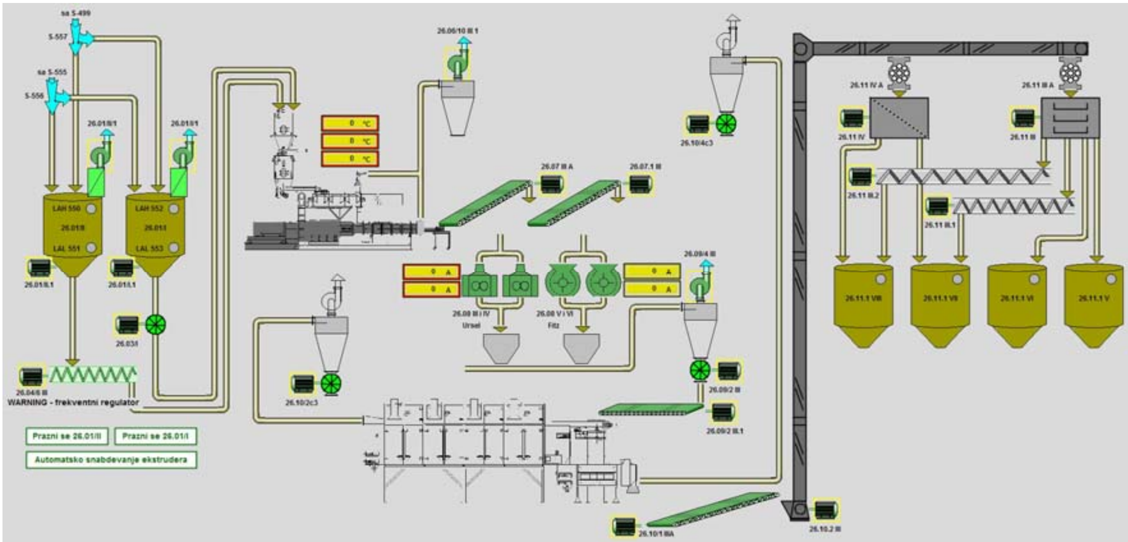


Fig. 3. Textured soy proteins plant

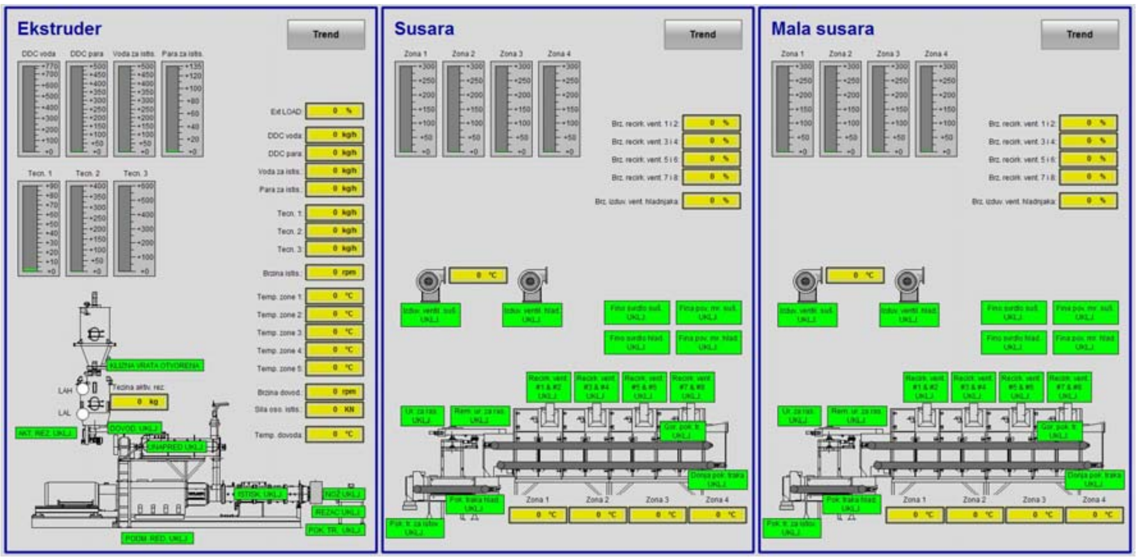


Fig. 4. Extruder and two dryers

For machines that are powered by frequency converter there is a field for the reading of actual speed and below there is a box for setting the desired speed. There is also a switch which selects whether the engine starts with the SCADA or from the field and of course the buttons for starting and stopping the engine.

Usual colour animations of machines are: green when the machine is working, grey when it's stopped and flashing red when something is wrong.

Along with the main pictures, the operator can monitor the picture with trends of analog values, the picture that displays all alarm massages, the separate image for monitoring the engine work hours and the picture which presents the consumption of the drives (current, voltage, active and reactive power, active power factor, frequency, etc.) (Fig. 5)

Smaller and simpler versions of these screens are designed separately for each touch panel. Touch panels are located in the field where operators can see the machines they are starting. The most of the control is placed in the field on touch panels but most of the supervision is placed in control room on PC's. Figure 6 shows start screen of extruder touch panel. Figure 7 shows start screen of dryer touch panel.

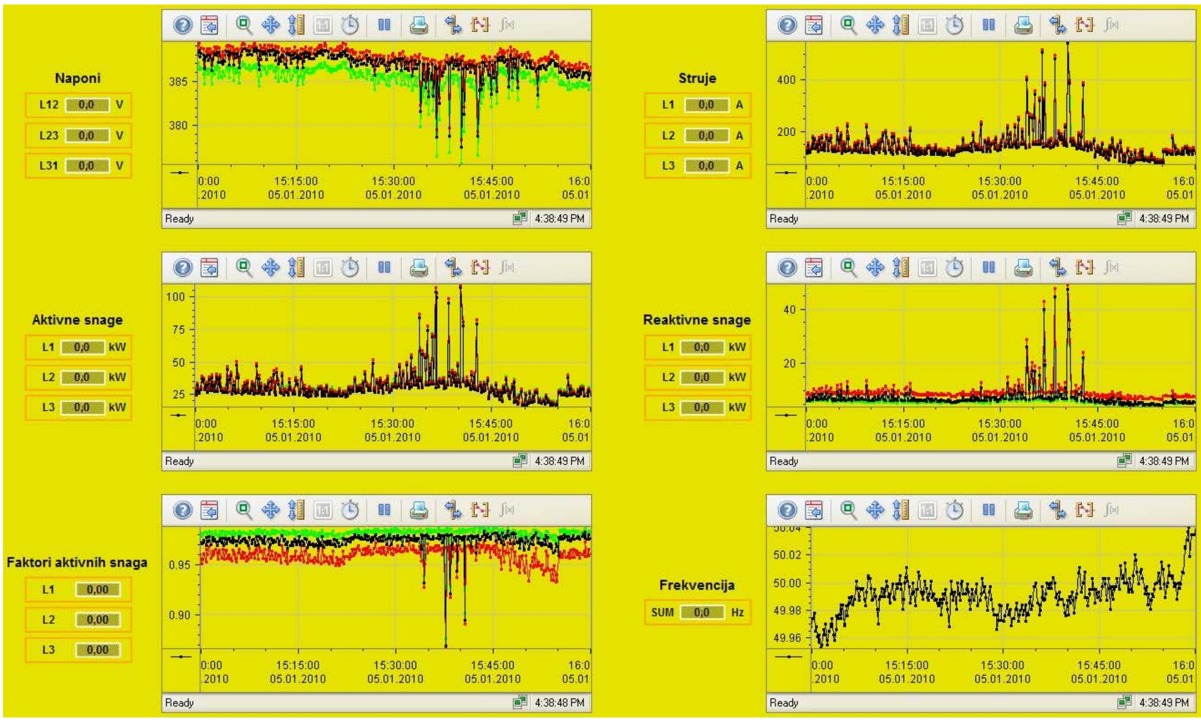


*Fig. 5. Power consumption trends*

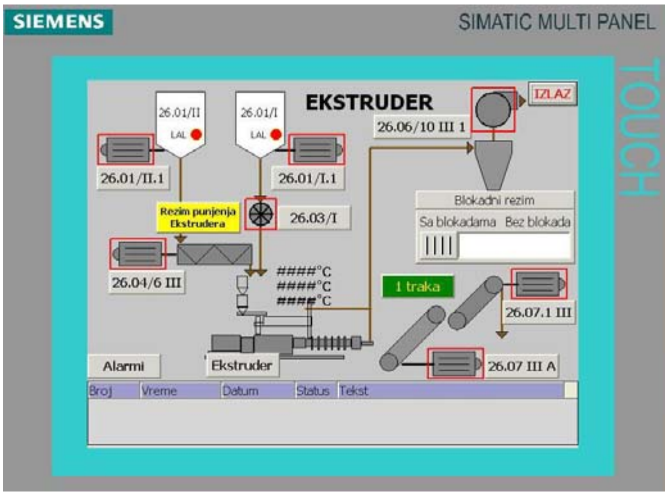


*Fig. 6. Extruder touch panel*

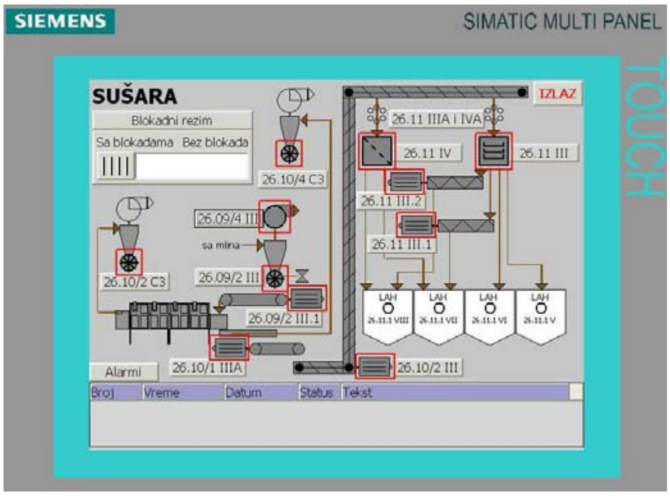


*Fig. 7. Dryer touch panel*

Set of a 152 alarm messages is defined and these messages are displayed at the bottom of the screen and there is also a sound warning related to them. The total number of signals included in this SCADA system is 833. Their classification is shown in Table 1.

*Table 1. Signal types*

| Signal type | Digital inputs | Digital outputs | Analog inputs | Analog outputs |
|---|---|---|---|---|
| Total number | 430 | 157 | 231 | 15 |

## CONCLUSION

This paper describes the realization of the SCADA system in the plant for the production of soy flour and grits and TSP, based on the software written in the Siemens WinCC software package.

The software was tested and put into operation in the plant for the soybean production "Soyaprotein" in Becej, Serbia.

This software provides a reliable system for supervision and control of soybean factory. Although soybean plant has so many machines and signals, this SCADA software allows operators to easily manage the whole production process. All relevant information is stored in a database and can be easily accessed from the software via the graphics and tables. Also, all the critical situations in the manufacturing process are covered with a wide range of alarm messages.

With simple modifications this software can be efficiently used in similar industrial processes.

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## REFERENCES

Bailey, D., Wright, E. (2003). Practical SCADA for Industry. Elsevier.

Bugarski, V., Kulić, F., Jeličić, Z., Vasić, V., Oros, Đ. (2007). Conception and realization of system for remote supervision and control of mineral frtilizer production. Journal on Processing and Energy in Agriculture (former PTEP), 11 (4), 187-190.

Bugarski, V., Kulić, F., Francuski, Lj., Vasić, V. (2008a). The implementation of a distributed system for supervision and control of cold storages. Journal on Processing and Energy in Agriculture (former PTEP), 12 (3), 168-170.

Bugarski, V., Francuski, Lj., Kulić, F. (2008b). Realizacija nadzorno upravljačkog sistema hladnjače. Prva regionalna konferencija: Industrijska energetika i zaštita životne sredine u zemljama jugoistočne evrope - IEEP, Zlatibor, Serbia, 24 – 28. June.

Bugarski, V., Nikolić, P., Francuski, Lj., Kulić, F., Jeličić, Z. (2009). Supervisory and Control Systems of Cooling Plants. Journal of Thermal Engineers of Serbia - TERMOTEHNIKA, XXXV (1), 9-19.

Bugarski V., Nikolić, P. (2009). Conception and realization of system for remote supervision and control of soy flour and grits production, Proc. 53rd ETRAN Conference, Vrnjačka Banja, Serbia, 15 - 18. June.

Clarke, G., Reynders, D. (2004). Practical Modern SCADA Protocols. Elsevier.

Stuart, A. B. (2004). SCADA: Supervisory Control and Data Acquisition. ISA.

Vasić, V., Marčetić, D., Kulić, F. (2009). Prediction of Local Instabilities caused by Inverter Dead Time in AC drive. 13$^{th}$ European Conference on Power Electronics and Applications, Barcelona, Spain.

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