

An Application of Scada System for Industrial Control Laboratory

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Abstract—SCADA system applications have been become an indispensable necessity in today's automation industry. SCADA system performs different tasks with PLCs communication systems, and the well-known WinCC Scada software is produced by Siemens Company. In this study, communication of the S7-200 PLCs with the CP5611 PCI card, and using bus type connection topology for speed and efficiency, has been preferred. Because other network topologies are uneconomical and technically incompatible with PLCs, in this study only bus topology has been used. Control of PLC training sets and an educational industrial training lab is achieved via a SCADA system. In addition, under supervision of the teacher, a computer can be centrally monitored ensuring the ability to control and monitor applications simultaneously.

Index Terms—win CC flex, SCADA systems, industrial control

I. INTRODUCTION

It is possible to achieve comprehensive and integrated data-based control and surveillance systems, from control to production planning with all the equipment in a plant; and all automatic units from environmental control units up to utility services control and monitoring.

Automated systems eliminate human errors and may be operated by very small number of staff. Automated systems established with the latest technology, software and hardware can be highly open systems. They also allow for relatively easy extension and replacement. Furthermore, other systems can be integrated with the automated system.

II. SCADA SYSTEM DEFINITION

SCADA is the abbreviation of the "Supervisory Control and Data Acquisition". Business administrators use SCADA to control operations in their productive systems. SCADA systems are used in industrial processes (cement production, iron and steel industry, chemical industry, etc.), telecommunications,

transportation, power stations, and control of scientific applications such as fusion. [1].

III. WINCC FLEXES 2008 SCADA APPLICATION

A. Micro WINN

PLC addresses and setting of data transfer speeds are performed with this program. Micro Winn program is opened from the desktop by double-clicking and "Set PG/PC" screen is selected from the opening screen.

The option to use the PC to communicate with the PLC interface is selected. We select this for using PPI link with CP5611 card.

After marking cable PPI CP5611, the PC's communication speed with PLCs will be selected from "properties".

Usually, the communication speed reaches 9.6 kbps to the PLC. If a problem occurs in the first communication attempt, a retry can be attempted by changing connection speed. In our study, during application, the connection speed will be set as 19.2kbps [2].

After making the necessary arrangements, "Ok" button is clicked on and the set-up is concluded.

In order to ensure communication between the PLCs on the left side of the screen, the communication button is clicked. Communication between the PC and PLC is achieved by double-clicking on the opened window and consulting the addresses displayed.

If the operator desires to change the PLC addresses BAUD (communication) speeds, she must click the "SYSTEM BLOCK" button from a pop-up opening window.

The desired PLC address is written in the "PLC ADDRESS" section using the keyboard. PLC speed can be changed from the "Baud Rate" section. In general, they are adjusted to 9.6kbps. To make contact communication faster and establish OPC server with WINCC communication speed, a rate faster than 19.6kbps is beneficial. Indeed, for efficient operation of the cables in this system, it is better to allow them run at their fastest speeds.

Then in order to active changed settings in the "SYSTEM BLOCK", they must be loaded to the PLC.

For this, "DOWNLOAD" option, which is located in the upper menus, is clicked. A pop-up window opens. Here, if you have more than one PLC, the appropriate PLC is selected from the "Connection" option. By clicking on the "DOWNLOAD", this creates an empty place where the program installation is provided for the PLC.

If these operations need to be changed, or in case a conflict occurs in PLC addresses, procedures should be done separately for each PLC [3].

B. To Create ITEM in OPC Server

First, the installed OPC server on our computer is opened by double-clicking. A CP5611 card was already installed in the computer, so the program opens directly with MicroWIN CP5611 card. The arrow on the MICROWINN Word is clicked with the right button of the mouse. The NEW PLC option is clicked on the screen.

The "NAME" field on the screen should be filled appropriately to distinguish projects when there is more than one PLC. To avoid confusion, project should be named as PLC2 and PLC4, etc.

Addresses should be assigned to the PLC's from the "NETWORK ADDRESS" section. This address export process has been made before. Only former PLC addresses must be entered here. We have here entered PLC2 to name the section and 2nd address. Then we pressed the "ok" button.

Here it is defined as the PLC2 of the set of PLC's. Then we create ITEM tags that provide descriptive information in WinCC program. To do this, all names and addresses should be introduced with the PLC's in the system.

After introducing the names and addresses, if you want to take information from inside of the PLC's to send with contact communication to the WINCC tags, then we should give names to those contacts. In order to avoid confusion, names should be given carefully and in order (For example, PLC2-I00).

Contacts are written (Here the names must be the same name as the MicroWINN. For example, like I0.0, M0.4, and Q0.5). For example the name field with a name like PLC2I00, which relates the PLC to a given ITEM, is accordingly completed to make necessary organizational sense.

Otherwise, later it is necessary to build 156 contacts and must define the 156 TAGs. To define output animation as seen in Fig. 1, it is reasonable to create an item order. [4].

The contact value should be written in the address area. For example the M0.0, Q0.0, I0.7, later the other ITEM (s) is created by clicking "ok" button.

In order to check defined ITEMS, whether communicated or not through the connection of the PLC contacts, the ITEMS are selected by holding down the left mouse button. ITEMS are transferred to the "TEST CLIENT" part by clicking red round "ADDS CURRENTS TO TEST ITEM CLIENT" button. The following test is applied to all items desired to be tested.

After transference into the test section, "Test Client Status" is executed on the desired items. At first, "QUALITY" option shows "BAD". When the test is

opened, OPC server will start communication with PLC contacts. Communication contacts which correspond to the speed of connection will be accepted into the "GOOD" position. Here the scan is executed in the right lower corner, as a display shows progression on a bar. In addition, a display must read "Status ON" position.

C. Making WINCC Flex 2008 Programming

Firstly, we install Wincc program to our computer. Then we run the Wincc flex program. When we run it, a splash screen appears. "Create an Empty Project" is selected from the menu on this opened screen. Here, opening of the main projects is achieved by utilizing the cursor arrow with the Mouse.

After opening the Program, the worksheet made to show the Visual design opens. On this worksheet of the program, we can design our pages with pictures that could be installed from outside the system. We can choose desired buttons from the program memory [5].

But before that, if you want to display the Windows screen or full screen, use the "DEVICE" option to select resolution settings while working in Runtime mode.

After double-clicking with the mouse, we see the screen resolution options in the pop-up window, and the desired resolution is selected. In addition, when the program is running, as we don't want to run it in full screen, we remove the check mark next to it. The program will then work with Windows. After making the necessary choices, save the project [6].

We see "Save Project As", and in the field we name our project to be saved as "LABORATORY".

After this step we must select a server in to get the contact information from the "connections" menu in WinCC server.

When this menu is double-clicked with the left mouse button, OPC server is selected from the pop-up window. The final project will be saved.

In the next steps, "TAG" (labels) are created to provide the information used to identify buttons and animations in the program. These labels are created by selecting the earlier created "ITEM" in OPC server. It is necessary to create these tags in such a way as provides a layout in which the PLC contacts (input contact, output contact, or virtual M contact) are written in detail. Otherwise if the names of contacts and TAG are not written correctly in the further parts of the project, confusion may occur while making connection process.

There is no need for each TAG to show the "SYMBOL" paths when it is created. It is sufficient to show TAG contacts only in the early part of the groups' contacts (Q0.0, I0.0 or Q0.0, I0.0 contacts paths). We can make other paths just by changing the contact numbers.

This is done by the following process sequence:

- 1) The shown symbol menu is double-clicked.
- 2) The relevant PLC number is double clicked from the contacts of the OPC server.
- 3) Select created TAGs to be communicated by contact.
- 4) After selection we notify the WINCC program by clicking on the CHECK mark.

After all TAG's are created, save again. Now design phase transition begins.

The home page of our automation program at the design stage (start screen) consists of total three pages: 1) PLC observation sheet, 2) and Laboratory lighting and 3) we can list as much as we want to study on the operating display using the "Add Screen" option (Fig. 1).

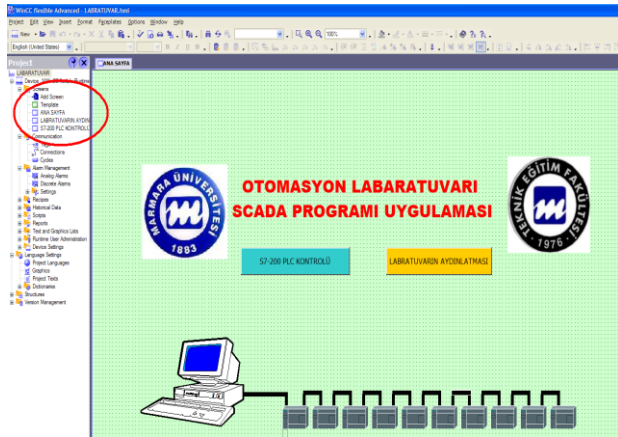


Figure 1. The project start page.

In our implementation the start screen has been prepared as a main page. Here, in order to connect tasks of buttons that are shown with blue and yellow, a lower screen is called by double-clicking the relevant button. Here, related tasks are selected from the "EVENTS" menu using the button icon. When left mouse button is clicked, the operator selects the necessary menus. An image linked to the relevant page is represented by the icon [7].



Figure 2. Identification of the buttons' task.

Likewise the same operations are repeated for the yellow button. When clicked, it must route the user to the intended page.

After creation, the contact numbers and PLC shapes are present on S7-200 PLC's control observation screen (Fig. 2). The buttons and animations must be connected to the related individual TAGs.

For example PLC1's output representing Q0.0 contact must be connected to PLC2-Q00 TAGs.

1. Here when we double-click on the button we will see a necessary pop-up window for us to make adjustments for the relevant created shape.

2. From the following menu "appearance" is selected.

3. "ANIMATIONS" related TAG connection is made.
4. The TAG will be prompted to create the animation according to the value of BIT.
5. Which bit value, which color should be selected? In this program, for 0 bit information: red; for 1-bit information, green option is preferred. These transactions should be applied to all created PLCs I (input contacts), Q (output contacts) and M (virtual contacts) (Fig. 3).

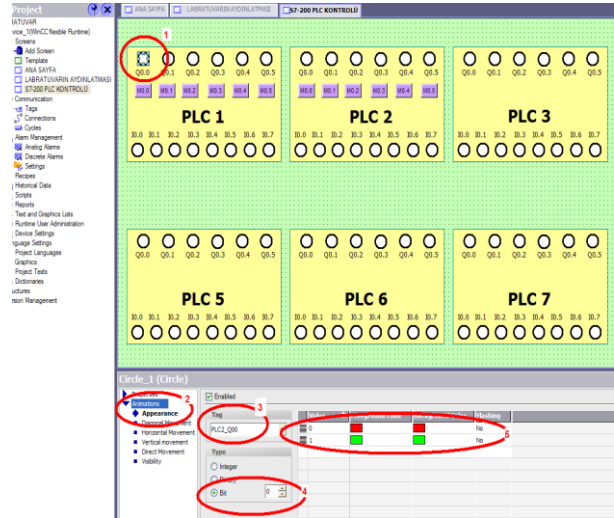


Figure 3. Animation definition of the buttons.

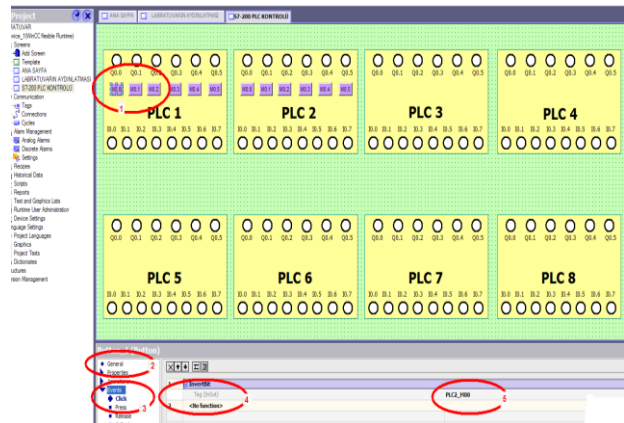


Figure 4. Task definition of the PLC buttons.

This needs to be done for buttons to define the EVENTS (Fig. 4).

- 1) Left Mouse button is double-clicked on the button for the desired connection.
- 2) A Button name is given from "GENERAL" menu.
- 3) If we want to change the position of the button, CLICK option is selected by mouse from the "EVENTS" menu.
- 4) As a result of the mouse click, M contact which is connected to bit, and the movement to be desired in that option is selected. Our program INVERTER (to reverse the current 0 value to do 1 value or 1 value to do 0 value) has been requested.

The display is provided of the PLC contacts created on the entire screen by doing these processes. Also, the Q outputs can interfere with defined virtual M contacts. The outputs to do INVERT property are gained.

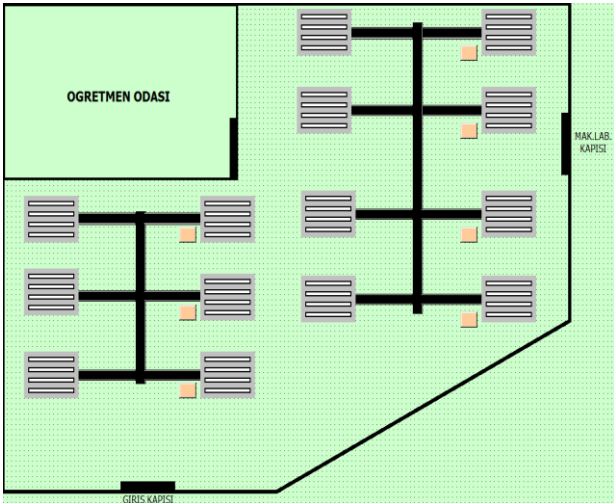


Figure 5. Lighting display.

The second page is named “laboratory control” as it controls lighting in the laboratory (Fig. 5). An architectural bird's eye view layout of fluorescent lamps has been drawn. Providing control of these lamps has been considered by the number 5 PLC. M contacts of the lamps are controlled artificially with cream colored buttons displayed below the lamps. Thus, interventions will be to the Q outputs of the related PLC. Lighting control of the laboratory will be provided with the relays connected to the Q outputs. Also the buttons provide a transition between main page and observation page.

The fluorescent lamps shown below in this page demonstrate the representation of animated lights and connection of the buttons. But here, in order to fulfill the functions of the buttons, TAG connections should be made to the virtual contacts. It is absolutely necessary not to neglect the most important detail: When the program is inverted, virtual M contact bit to the related PLC, the user must remember the previous job subsetting. In the first part, how to do installation process by means of Micro Winn program has been explained.

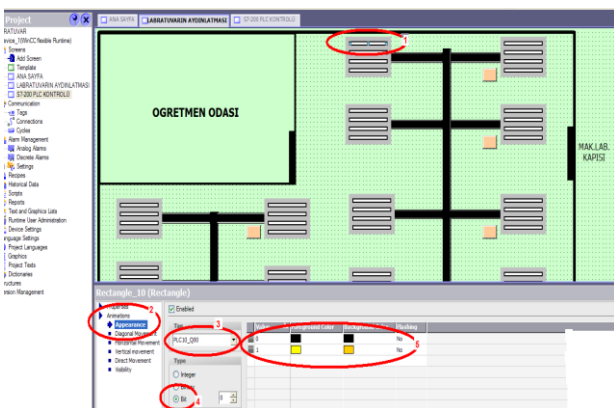


Figure 6. Animation description of the buttons.

An output of the Q symbol in Fig. 6 representing the fluorescence in the laboratory is inverted by the button. While Q0 output is 0 the black is on; while Q output is 1 yellow is on; and how the animation gains a TAG connection will be explained in sequence:

- 1) The left mouse button is double clicked over the first selected symbol.
- 2) “Appreance” is selected from an “Animation” menu” that drops down.
- 3) What TAG we want to move with symbol is selected and the connection is made.
- 4) Changes occurring in the TAG should detect as BIT. That is defined with selection.
- 5) According to the information that comes from the selected tag, which bit values and what color are desired, the proper animation is provided.

The aforementioned operations must be done separately for each fluorescent lamp animation.

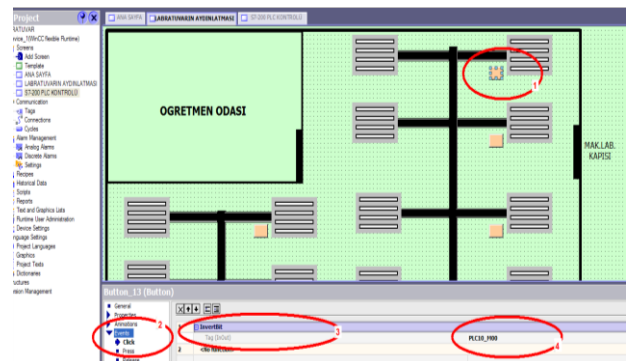


Figure 7. Task definitions of the Lamp buttons.

The numbered events in the above picture identify functions of the shapes of the created buttons (Fig. 7).

1. Firstly EVENTS will be selected according to the corresponding button. The left mouse button is double-clicked.
2. Click is selected from the EVENTS menu.
3. INVERT BIT is selected as a sub-option of the EDIT BITS option. Invert bit option isconnected. Q output values are made as it is 0 becomes 1 and 1 becomes 0. With the help of this option, Q outputs connected to the button are electrically able to switch it from off to the on, or on to the off position.
4. In this option, button TAG connection is made. Movements of the button to move a desired TAG are established that TAG is marked by selecting.

The buttons function when identification process is carried out separately for all. Here, generally while the first three options remain the same, we should note that if the fourth option is misconnected to the wrong TAG, the button will not performs its function.

Our WINCC programming part is over. Before programming PLCs were physically connected to each other with PROFIBUS cables, their communications supported with the help of a CP5611 card connected to our computer. If there is a SCRIPT application it should be brought to RUNTIME mode by doing COMPILER.

After this point, the screen will also work in RUNTIME mode. Information comes from the PLCs with the help of the OPC server will be displayed on the screen with the help of TAGs.

The main page (Start Screen) will display as below. The second page, which is the S7-200 PLC control page, will appears as follows (Fig. 8 and Fig. 9).

Thirdly the image in RUNTIME mode on the laboratory lighting screen will be as follows (Fig. 10).



Figure 8. Runtime main control screen.



Figure 9. PLC runtime control screen.

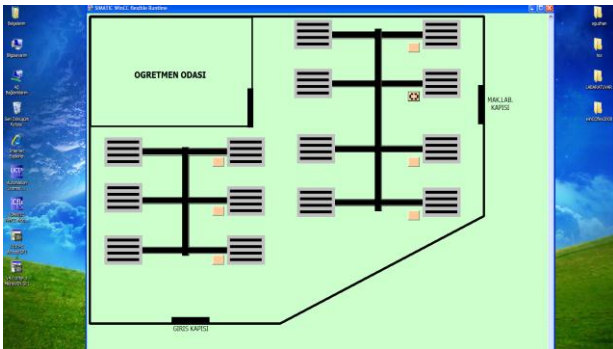


Figure 10. Run time lamp control screen.

IV. CONCLUSIONS AND DISCUSSION

Industrial Automation Laboratories are studied in the schools of our country. However, there are significant deficits in the resources necessary to properly qualify students in the knowledge of automated systems. If we consider today's industrial developments, earlier SCADA systems are commonly found in such laboratories, despite the fact these systems are known to be indispensable for industry.

For these reasons, as carried out in this study for pedagogical purposes a lot of PLC sets are available in an industrial control laboratory to be controlled through a SCADA system under the name of "the teacher's desk"

and supervised from a central location. Applications have been carried out to be followed simultaneously. Through the application of this system, industrial automation education will not be limited to be taught by just PLC systems materials. In addition, in future working life, the students will often draw on this training as they advance professionally in the use of SCADA systems [8].

In order to exit from the "Runtime" screen as Windows applications, it will be sufficient to close the window with the close button at the top-right corner of the window.

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