

# Process Automation Using PLC: A Web Server Approach

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**Abstract:** Industry Automation using PLC is a universally accepted approach due to its functionality and configurations from a small scale process having limited I/O to a large scale industry having thousands of I/O. For recent years with the advent of Industry 4.0 Concept devices are configured with the in-built network connectivity which makes device itself as a Server for Remote Access of its parameters. The same concept is also utilized at the Programmable Logic Controllers (PLCs) for the recent years. Web Server – a technology being used by different PLC vendors nowadays allows the users to facilitate their automation projects with remote internet based access. The same concept is implemented here to showcase how economically, a small process can also have the same high-end remote access with minimal configuration. Batch Mixing Process is taken as the application, where user freedom to select the mixing components based on different demand. Siemens PLC CPU Simatic S7-1212C Controller, which is having inbuilt Web Server feature is used for automation here. While designing the project it is kept in mind that the one with less technical knowledge can also operate it.

**Keywords:** PLC, Automation, Batch Process, Web Server

## I. INTRODUCTION

Automation is the use of control systems such as computers, controllers to control industrial machinery and processes, to optimize productivity in the production of goods and delivery of services. Automation is a step beyond mechanization.

## II. AUTOMATION USING PLC

PLC (Programmable Logic Controller) a digitally operating apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic sequencing, timing, counting, and arithmetic to control, through digital or analog input/output modules. It is a distinctive form of computer device designed for use in industrial control systems. Once programmed, the PLC will perform a sequence of events triggered by stimuli referred to as inputs. It receives these stimuli through delayed actions such as counted occurrences or time delays.

PLC programming is increasing rapidly because of greater programming flexibility and ease, scalability, more memory, smaller sizes, very high-speed (gigabit) Ethernet, and built-in wireless features. PLCs are getting benefits from USB technology and thus make it easier than ever before to get online, program, and monitor your control systems. PLC programming will evolve, and with the availability of smaller micro and mini USB connectors, you can expect to see this option on more of the smaller PLCs. In the future, PLCs will continuously evolve while adapting technology enhancements in communications, hardware, and software. A research<sup>[1]</sup> conducted shows PLCs use in industry is rapidly increasing.

Fig.1 Shows Basic Architecture of PLC, where I/O Modules for Modular PLC, have inbuilt limited I/O available. Usually these type of standalone PLCs are used for simple and small process automation. Nowadays, these standalone PLCs are available with wide variety of features, one of them is Web Server as Protocol. For large I/O systems, I/O Modules apart from PLC CPU can be connected in a rack, based on the requirement, such I/O Modules are also available in wide range like Digital Input, Digital Output, Analog Input, Analog Output, Transducer Specific, Relay Specific etc.

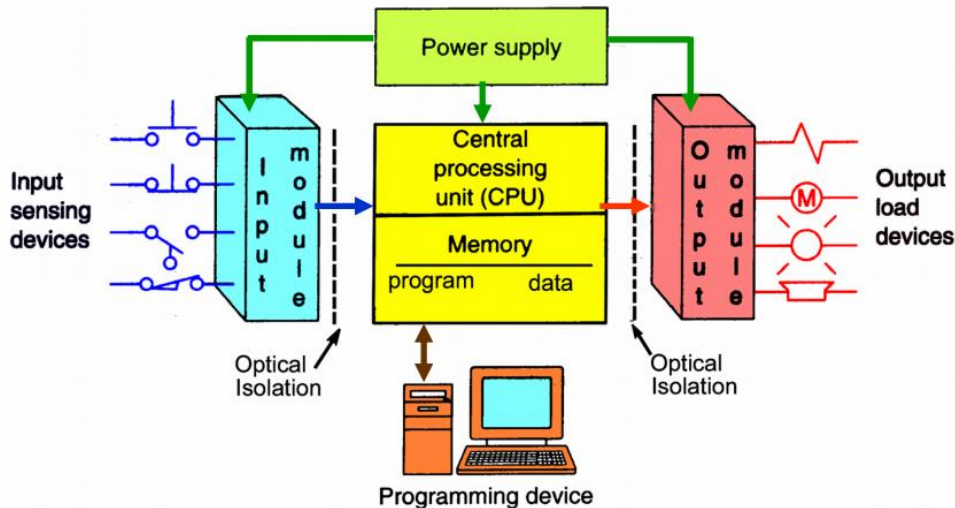


Fig.1. Basic PLC Architecture<sup>[2]</sup>

**Simatic PLC CPU as Web Server:**

SIMATIC CPUs with PROFINET interfaces provide the opportunity to access CPU variables with the help of web pages provided by the system. Access the integrated web server of the CPU via a web browser. The web server contains standard web pages, such as the Start Page, identification, diagnostic buffer, module status, messages, communication, topology, and file browser. In addition to the standard web pages, you can also design and call the web pages individually for your application case.

To create your user-defined web page, you can use tools such as Microsoft Expression Web, Notepad++, etc. For designing your web page, you can use all options provided to you by HTML, CSS (Cascading Style Sheets), and JavaScript. In addition, there are Automation Web Programming (AWP) commands for directed communication with the CPU. The following Figure gives an overview of the implemented solution.

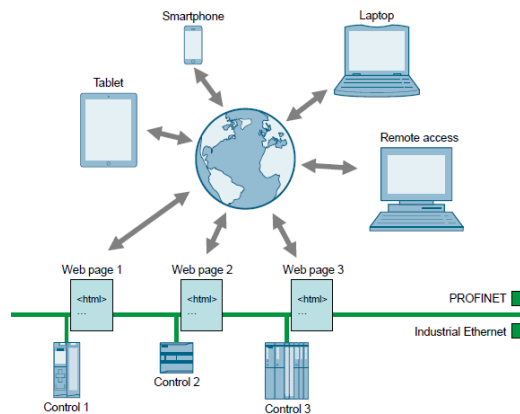


Fig.2. Simatic PLC as Web Server<sup>[3]</sup>

**Process Description:**

The main idea of this project is to mix various fluids and distribute the mixture as per requirement.

- The user can decide which one to select amongst various fluids.
- The quantity of various fluids each can be controlled.
- Two or more fluids can be customized to prepare a mixture.
- The mixture can be distributed out in specific number of sets.

In this batch process three tanks are used. Two tanks are filled with different colors and in third tank performs the mixing. Tanks are connected with the valves for perfect liquid mixing ratio. In one container liquid mixing process will be developed by turn the rotor ON. We will be able to customize it that way using PLC. If we need a 1000ml of mixture for different grades. We take 400ml from A and 600ml from B or we can take equal of A and B etc. grades we'll be able to

customize it with the help of PLC. Here amount of the liquid to be mixed are determined by time setting of valve, which reduces the use of level sensor for the same. Ex. For 1000 ml liquid, valve opens for 30 sec. for 500 ml, 15 sec. etc. These values are dynamic, so, by applying formula, the valve opening timer is changed. This expression can be used to control the amount of the liquid and its result and can directly be given to timer to generate a delay of that much time so that the valve remains open for that particular interval of time. The same method can be used to distribute the mixture out of the container.

**Process Automation Components:****1. Siemens SIMATIC S7 CPU 1212C as PLC:**

For the batch process here, Siemens Make PLC SIMATIC S7 CPU 1212C Used. Following are key features of the same:

- AC/DC Relay
- On Board 8 Digital Inputs: 24 V DC
- On Board 6 Digital Outputs: Relay
- Analog Inputs : 2 Nos. 0-10 V DC
- Power Supply : AC 230V 50 Hz
- Program Data Memory: 75 KB
- Integrated Memory: 2 MB
- Protocols: Web Server, PROFINET I/O Controller, PROFINET I/O Device, SIMATIC Communication, Open IE Communication.
- For Web Server Protocols: Used Defined Web Sites Supported

**2. Toggle Switches:** A lever used as an actuator is an electromechanical switch known as a toggle switch. It moves between two states (positions) using a single lever. Widely used in the medical field, aerospace, home appliances. Here in PLC, a toggle logic is used to create a flip flop.

**3. IR Sensors:** Infrared Sensor is electronic devices measuring and detecting infrared radiation from the surrounding. Active IR works as a proximity sensor and is commonly used in obstacle detection systems such as robots. They are mostly used as an emitter. These sensors can measure the heat of an object and its motion. It is used more because of its low power requirements make them suitable for most electronic devices like laptops, telephone etc.

**4. SMPS:** SMPS is a switched-mode power supply, an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. It transfers power from AC and DC sources, to convert a level of voltage to the voltage or current required by the client through different forms of architecture. It has the ability to regulate the output voltage. It can increase and decrease output voltage to maintain.

**5. Level Sensor:** Detects the level of liquid and other fluids, even detects the level of fluidized solids, including slurries, granular material powder etc. It monitor, maintain and measure liquid level. The device is used to determine the level of liquid that flows in an open or closed system.

**6. DC Motors:** A class of rotary electrical motors that converts DC electrical energy into mechanical energy. It is available in different sizes and power, varying from small motors in toys to the large mechanism that power vehicles, cranes, air compressors etc.

**7. Solenoid Valve:** They are electromechanically operated valves. They are mostly used to control elements in fluidics. It is a type of valve which uses solenoid, an electronic coil with a movable ferromagnetic core, generating a magnetic field.

**III. PLC PROGRAMMING**

For a given Batch Process of Mixing, A Ladder Logic Diagram is written with using Basic Building Blocks available in Programming Software for Siemens PLCs, TIA Portal V15. TIA Portal allows in a single platform to configure Device, Its I/O Modules, and Its Different Programming features, Networking, HMI Development and Web Server Integration. This Software is a Proprietary Software of Siemens PLC. It offers a universal approach towards PLC Automation.

For the process of use, Ladder Diagram with 28 Rungs configured, comprising logic to apply user choices for different amount of liquids for mixing, resulting in different products.

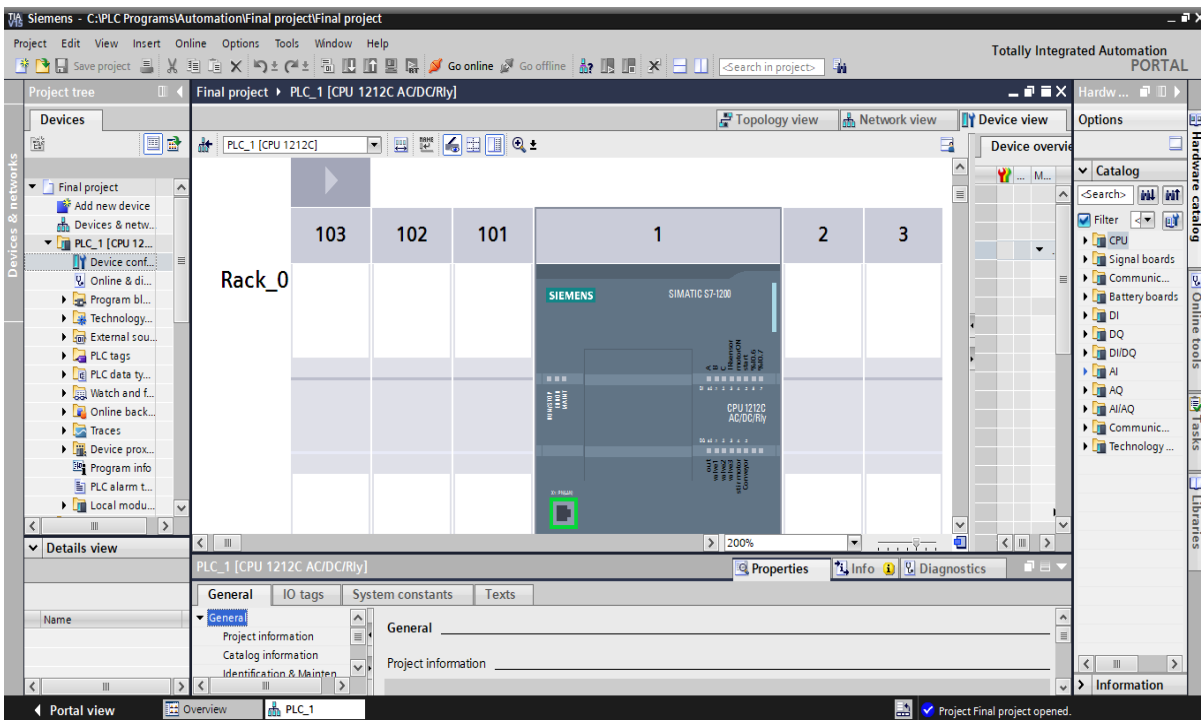


Fig. 3. TIA Portal Software Screen for Programming

Here are ladder diagram blocks of the program.

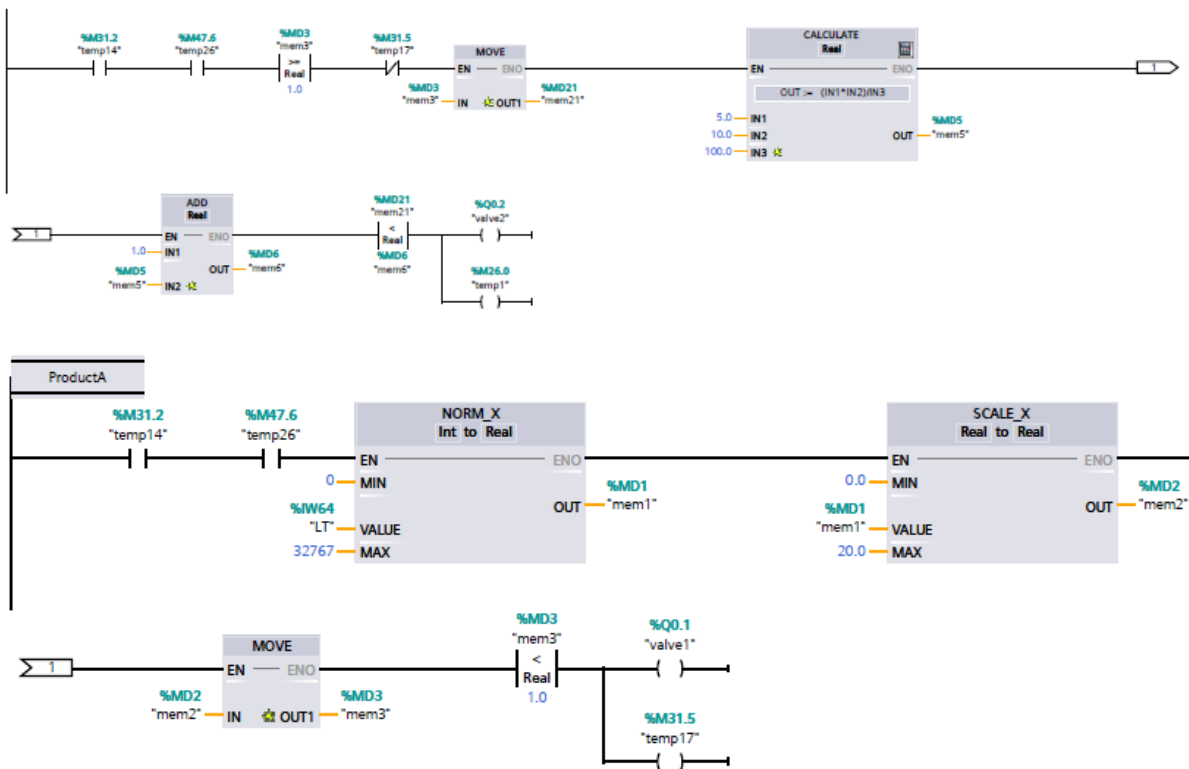
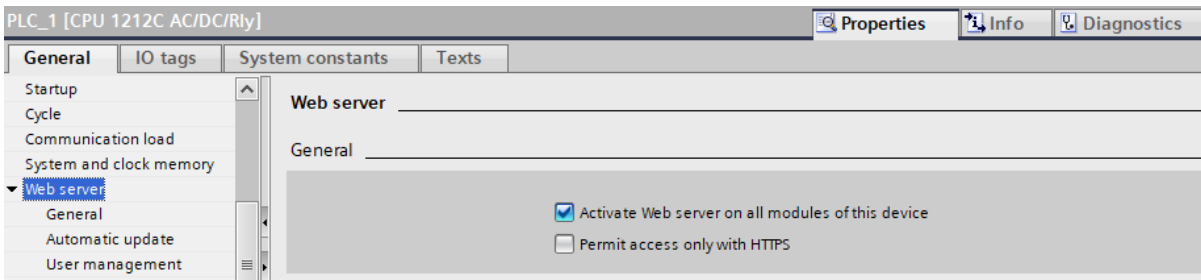


Fig. 4. Ladder Diagram View of PLC for Batch Process Automation

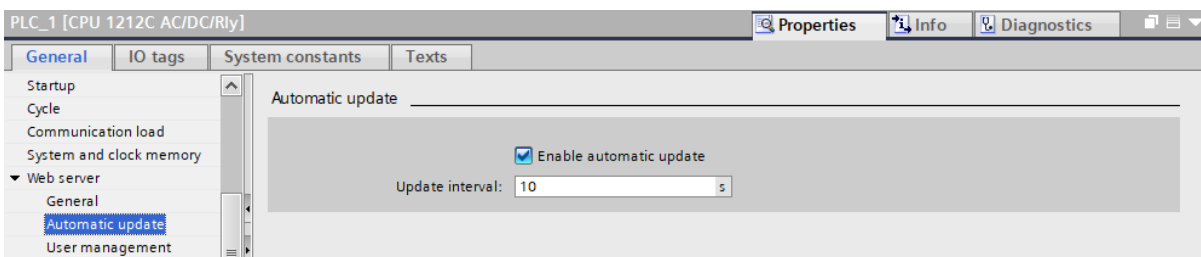
**Using Web Server of PLC:**

To configure and use the Web Server of PLC (Here S7 CPU 1212C) in TIA Portal, Device Configuration of PLC, Enable

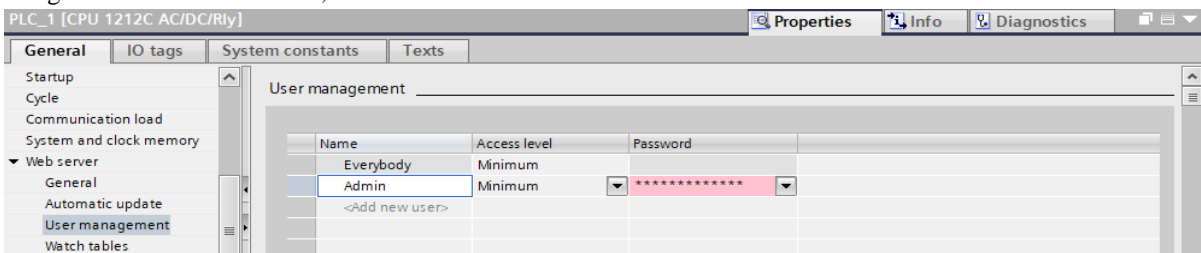
the Web Server as shown below:



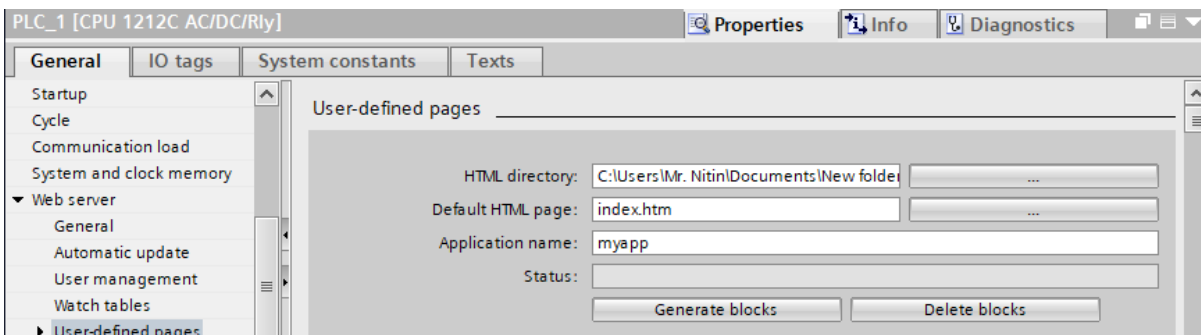
Then, Provide Automatic Update of the Web Server Time Duration as below:

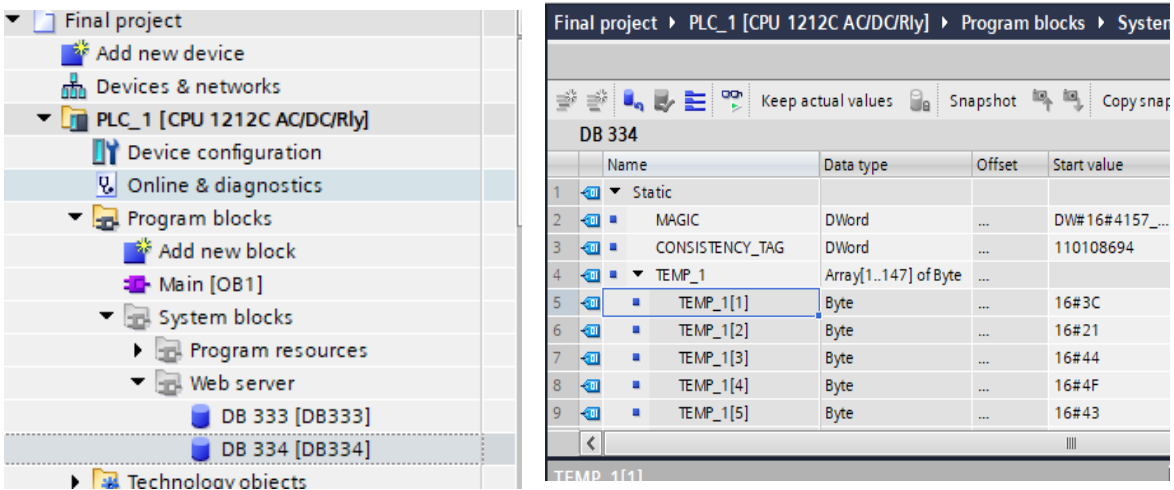


Once the configuration is done, in TIA Portal, Default Web Server User is taken as Everybody, to which, a developer can add new user, for example Admin, and encrypt the user access with password. The User will be prompted once designed with this credentials, to enter the Password from remote internet access.



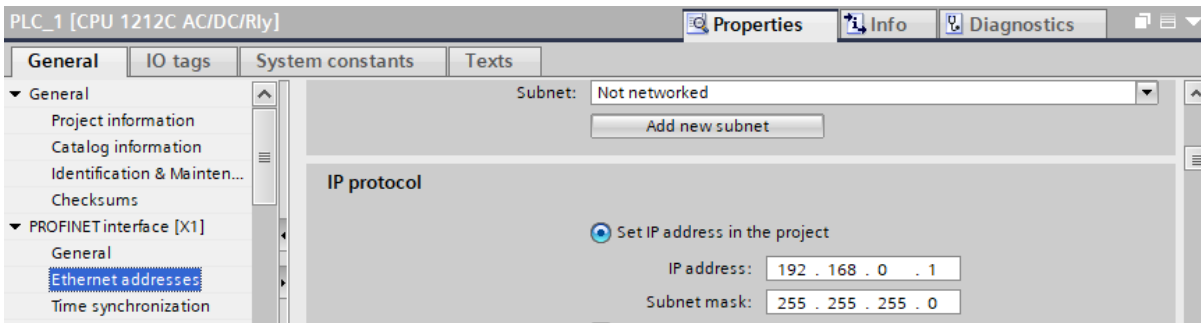
Now User can add its own HTML Web Pages as User Defined Pages in the TIA Portal, via browsing to the folder where the HTML developed pages saved. It will convert the HTML Pages via generating its blocks DB333 and DB334 Blocks in TIA Portal.



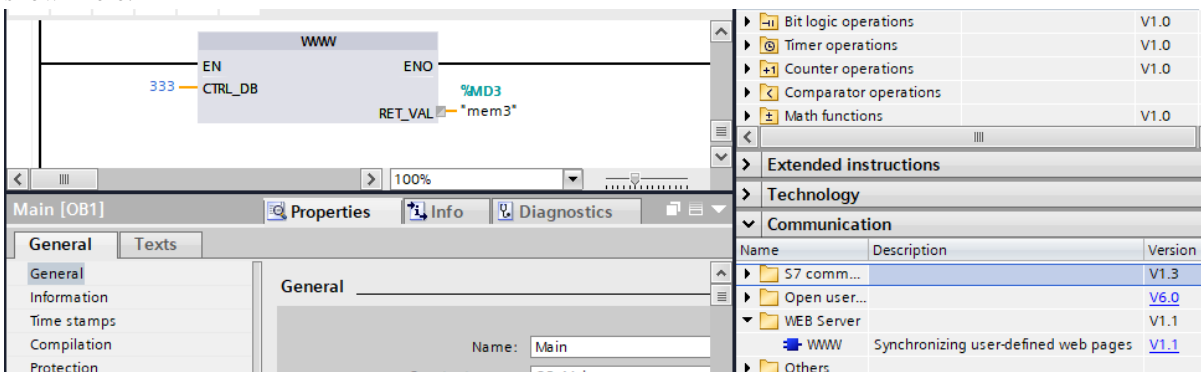


Here the Web Pages developed contain the syntax variables as the different Variables of the process under control. Different Parameters as defined in the ladder logic, For Example COUNTER, can be called for its dynamic value, by writing syntax COUNTER in the HTML page, along with necessary instructions, results in display of the COUNTER from PLC on an IP Address entered from any remote computer.

To view the PLC as Web Page at remote computer via internet, the PLC device is to be defined its IP address and Subnet Mask in TIA Portal. For example, here the PLC IP Address defined is 192.168.0.1 and Subnet Mask Defined is 255.255.255.0. With this IP Address assigned to device, a User can access Its PLC on Remote Computer. Web Server Allows to Create User Defined Web Pages using HTML Developer Platform as simple as Notepad or Notepad++. Notepad++ is a little advanced version of Notepad and offers more features than conventional Notepad application.



To enable Web Server for PLC, User has to add a Basic Building Block of Communication in the Ladder Diagram as shown here:





**Summary:**

Here a Batch Process Automation with the help of PLC is selected to showcase the PLC as the cost effective and user friendly device for small scale automation also. As the standalone PLC, one like SIMATIC S7 CPU 1212C used here, offers a Web Server as the facility, Small Process Automation also gets the advanced feature of Remote Monitoring and Control of its Process with no additional software and hardware required at the remote end. Web Server is totally free to use, as it offers User Defined Page Development in the conventional and as simple as Notepad Application for creating Process related pages. Thus it does not require any complex language also for the configuration. Along with quite simple and cost effective approach, it also provides security over the remote end, by only allowing https:// based access to its device and also with encryption. Web Page Access can be simply done by a less skilled operator also with limited knowledge of the high end softwares.

**IV. CONCLUSION**

Thus, Web Server based PLC Selection at the small scale automation is a better approach that users should utilize. Further scope remains on user side, to add more user defined pages, allowing HMI and Graphic Representation of the Logs in terms of Texts created at PLC and so on.

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