



# Program Consideration of Washing Machine System (using SIEMENS PLC S7-1200)

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**Abstract:** This paper illustrates on the working of Automated washing machine by using programming logic controller. Hardware used in this projects is Programmable Logic Controller (PLC), solenoid valves, relays and functions such are timing, sequencing, controlling , relaying and alarming were implemented. A DC Motor is implemented because of its variation over a wide range of speed .Solenoid is used for the control of water as an input and output valves of the machine. All the devices are fully controlled on a few instructions once given by PLC.As a Programmable Logic Controller, SIEMENS PLC S7-1200 is used in this expermenatal research.

**Keywords:**Programmable Logic Controller), DC Motor, Ladder diagram, Solenoid valves, Relay.

## 1. INTRODUCTION

Now-a-days, people are living in such a tight schedule they don't have time to wash their clothes manually as well as it is much of a time consuming. In such cases plc based washing machine can be used which is easy, reliable and time saving. Such washing machine once given a instruction performs its task efficiently. In this automated washing machine DC Motor is used which is capable of working at variable speeds as per one's requirement. The main purpose of the project is to have automated washing device which washes clothes and sheets without any human intervention.

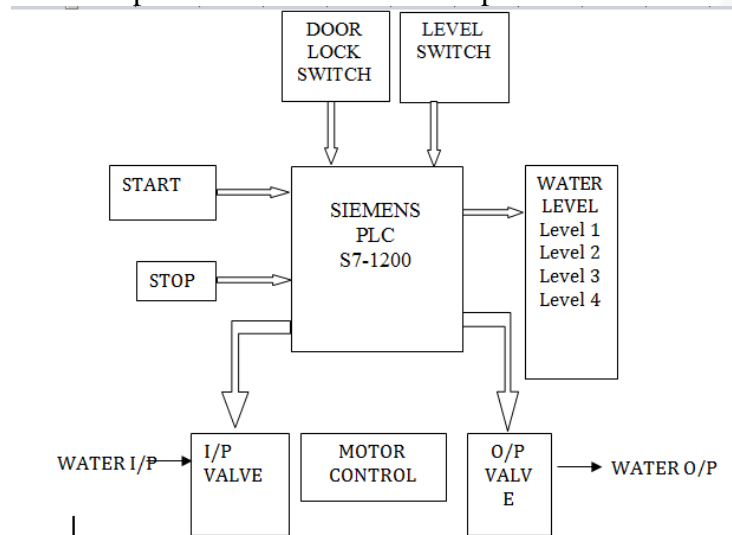
The term is applied to machines that use water as a primary cleaning solution, as opposed to dry cleaning. Washing includes immersing, dipping, rinsing, soaking in water or other liquids, usually accompanied by soap, detergent or bleach. The simplest machines may simply agitate clothes in water while switched on; automatic machine may fill, empty, wash and spin in an automated complex cycle. (W.Bolton, 2006).

## 2. HARDWARE SYSTEM CONSIDERATION

The three main components consists if inlet valve, motor control and the outlet valve which are controlled by the PLC [ programmable logic controller ]. P L C controls the different operations of the machine.[Soak, wash, rinse and spin].

According to the instructions provided by the user PLC controls the whole functioning. For example, based on the water level set by the user, input valve remains ON for that particular time which is set for that level. PLC reads the user's instructions and displays the status of the washing machine using different LED.

Door lock switch remains ON during machine operation and also ensures that the door of the washing machine is closed, if unexpectedly user opens the door, the door locks switch gets open and it sends signal to PLC and whole operation of the machine stops.



Picture 1. Block Diagram of Washing Machine

We had designed prototype of PLC based washing machine to get rough idea of various functioning and implementation process. For this we had used TIA software, two solenoid valve, DC motor, four relays and few patch cords. Relay circuit is connected on the PCB as per the relay logic to get desired output. Different motoring conditions are obtained through relay circuit. This relay's input are connected to PLC through various patch cords and relays output is given to motor, inlet valve, outlet valve and buzzer. Just for project purpose motor operations are being carried out in two different valve operation, so that we get a clear image of various motoring conditions.

### 2.1 TIA Software PLC



Picture 2. (a) TIA S7-1200 PLC (b) Solenoid Valve

The TIA software is implemented in this project. It combines the features that demand from TIA , such as Ethernet / IP, online editing, and a built-in LCD, plus provides an enhanced features, such

as: faster High Speed Counter / PTO, higher I / O count and enhanced network capabilities.(Shubham Chidrewar, 2018).

## 2.2 Solenoid Valve

A solenoid valve is an electromechanically operated valve .The valve of solenoid is controlled by the current flowing through a solenoid : In two-port valve the flow is switched either on or off whereas in three-port valve, the two outlet ports switch the outflow between them.

This valves are the most used control elements in fluidics. Their work is to shut off, release, dose, distribute or mix fluids. Solenoids provide high reliability, fast and safe switching, long service life, good medium compact design.

Solenoid valves are implemented in fluid power pneumatic and hydraulic systems, to control cylinders, fluid power motors or larger industrial valves. Domestic washing machines use this valves to control water entry into the machine. Solenoid valves are usually called as "solenoids."

We are using two solenoid valve one as an inlet valve and other for outlet valve. When an external signal of 24v is provided to solenoid valve both valve operate and allows flow of water. In this case 24v signal is provided by PLC. .(Shubham Chidrewar, 2018).

## 2.3 Relay

A relay is an electrically operated switch. To mechanically operate a switch many relays uses an electromagnet, but other operating principles are also used, such as solid-state relays. Relays controls the circuit by a separate low-power signal, or either several circuits must be controlled by one signal.

In our project we used four relays which operate at 24V. One relay is for obtaining forward motoring condition second is for reverse motoring condition and other two relays are used for controlling inlet valve and outlet valve. Voltage which is required to operate these relays is supplied through PLC output. .(Shubham Chidrewar, 2018).

## 2.4 DC Motor

A DC motor is machine that converts direct current [DC] electrical energy into mechanical energy [ME]. Almost all types of DC motors have some internal mechanism, either electromechanical, to change the direction of current flow in part of the motor.



Picture 3. DC Motor

DC motors were the firstly used, as they could be powered from existing DC lighting power distribution systems. A Direct –current motor's speed can be controlled over an extensive range, using either a variable supply voltage or by changing the strength of current in its field windings. Small range DC motors are implemented in toys, tools and appliances. Larger range DC motors are used in elevator and steel rolling mills propulsion of electric vehicles.

DC motor of 24v is used inside the washing drum for washing clothes. 24v supply is provided to the dc motor through relay using PLC. The reverse and the forward motoring condition is achieved using different conditions of relays. (Shubham Chidrewar, 2018).

### 3. PROGRAMMING CONCEPTS OF PLC BASED WASHING MACHINE SYSTEM

#### 3.1 Algorithm

Start the washing machine by pressing the 'START' switch. Set the timer for the water level by pressing the 'LEVEL SWITCH'. The inlet valve is on for that particular time set by the timer. Ensure that the 'DOOR LOCK SWITCH' is on.

Algorithm 1:

- (1) Motor running
  - Forward direction for 5 sec.
  - Reverse direction for 3 sec.
  - [This occurs for 2min.]
  - Forward direction for 60 sec.

- (2) Motors stops running
- (3) Outlet valve remains 'ON' for 60 sec.

Algorithm 2:

- (1) Again inlet valve remains ON for time set by level switch.
- (2) Motor starts running - Forward direction for 60 sec
- (3) Motor stops running
- (4) Outlet valve remains ON for 60 sec

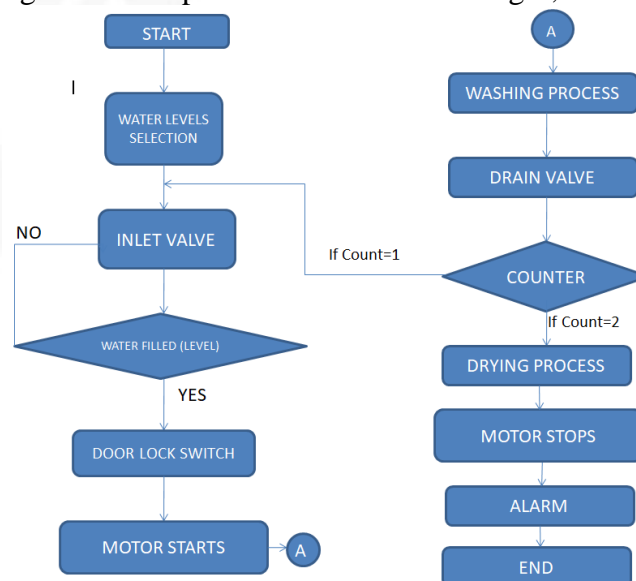
Algorithm 3:

- (1) Motor running -Forward direction for 120 sec
- (2) Motor stops running
- (3) Alarm starts ringing.

#### 3.2 Program Flowchart

When user press the START switch, one should select the water level depending upon the quantity of clothes which are being washed. Here we are using timer to limit the level of water, as output of timer is given to the inlet valve. For example for level 1, timer is set for 15 sec and for level 4, timer is set for 60sec, which means when user selects water level 4 then inlet valve remains ON for 60 sec. Further after water gets filled in the drum to the set level, PLC ensures that the door lock switch is ON i.e. door of washing machine is closed. After that motor starts rotating based on the algorithms set in stage 1 i.e. in forward and reverse direction. In this stage soaking and washing of clothes takes place.

After completion of stage 1 drain valve opens and removes all the water from the drum. In second stage again water is allowed through inlet valve up to the level set by the user, and motor starts to rotates as per the algorithms set in the program, and further water is drained out through outlet valve. In this stage rinsing of clothes takes place. In the third stage motor rotates in forward direction with no water in the drum. Thus remaining water from clothes get drain out due to centrifugal force, this process is known as spinning. After completion of all the three stages, motor stops and alarm goes ON.



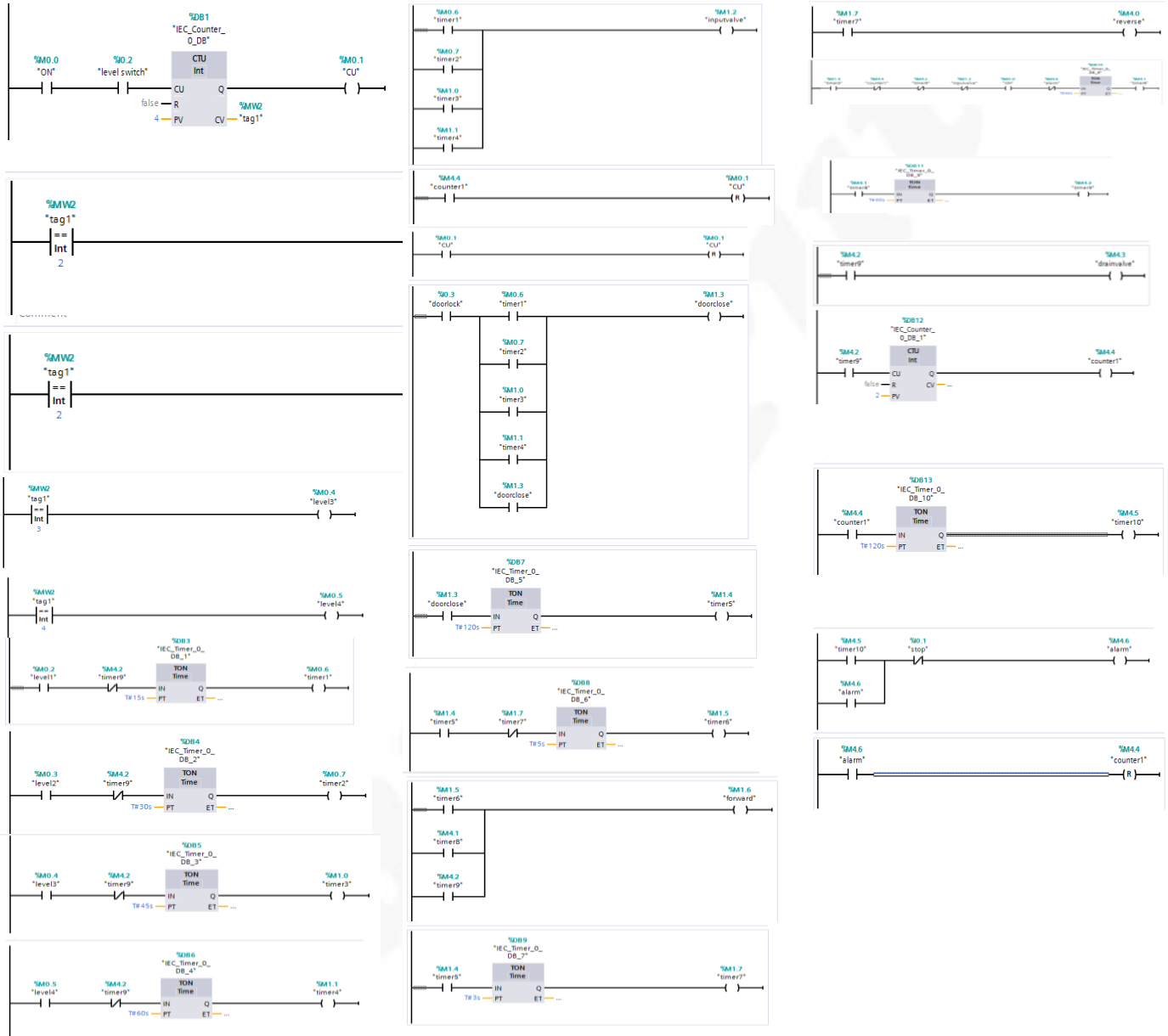
Picture 4. Proposed Flowchart of a System

#### 4. RESULTS

TAI software is used for the following testing purpose.

- Drag-and-drop editing
- Diagnostics
- Database editing
- Reporting

The result ladder diagram for our program consideration of a model PLC based Washing Machine is shown in Picture 5.



Picture 5. Ladder Diagram

#### 5. CONCLUSION

PLC is being extensively used for various applications for atomization. So use of this technology to carry out different washing operations in washing machine [soaking, rinsing, spinning, etc. with precise control has been achieved. This experimental based research paper can be carried out the experience of using SIEMENS PLC S7-1200 and improve the used of Industrial Automation Processes.

## 6. RECOMMENDATION

The first author of this paper serve as a supervisor to do this experimental research paper. This research paper carried out mainly case study of PLC which was teaching in Fifth Year Electronic Engineering Course. By this paper, both the teachers and students are successfully practice the system considerations, software approach and Ladder Diagram Programming for a PLC based project.

## 7. REFERENCES

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