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Enhancing the Quality of Components Washing Machine by Eliminating Heater Failure

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Abstract— *In automobile industries, manufacturing of engine parts undergoes various processes like Milling, Drilling, etc. Because of these processes aluminium burrs are generated on the component. Thus, washing of a component is important to ensure quality of the product before assembling in engine. Washing is done initially with the hot chemical solution in washing chamber and then hot air is blown to remove the coolant mist, aluminium burrs, dust, dirt, oil, etc and to dry the component. If the desired solution level is not maintained and the temperature of the solution exceeds the safe limit in the cleaning tank, the heater may get failed due to inherent internal heat radiation, and desired temperature cannot be achieved and components quality will also be affected. Hence this project aims at enhancing the quality of washing machine by providing an interlock mechanism for heater failure with the use of level sensor and temperature sensor. This interlock is done in MITSUBISHI PLC (Programmable Logic Controller) using GX-Works-2 software for programming.*

Keywords— heater failure, level sensor, temperature sensor, interlock, MITSUBISHI PLC.

I. INTRODUCTION

In automobile industries, every component before being assembled undergoes several machining operations like milling, drilling, boring, tapping, washing, etc. This project concentrates on one particular process, Washing.

Basically washing is done before the inspection stage. An oscillating type machine is used for washing and drying of component (crank case). The component to be washed remains stable throughout the washing process . Initially the component is focused and washed with a hot solution (temperature of 55-65° C) at a pressure of about 6 to 9 bar and it is sprayed to the component surfaces, blind holes, blind taps, bearing bores, slots, oil holes, grooves, machining edges by using vertical multistage centrifugal pump. Then the crank case is dried by blowing hot compressed air. This machine is configured in order to get cleaned component without having contaminants, dust, oil and loose burrs and thereby increasing the engine efficiency.

The washing machine contains several sections like cleaning chamber, dry chamber, clean tank, dirt tank, heaters, pneumatic valve, reservoir, pressure pumps, oil skimmer, control panel, operator panel, etc.

II. EXISTING METHOD

2.1. Need For Washing

Washing of a component is important in automobile industries for the following purposes;

- To reduce engine contamination in the vehicles.
- In order to increase the life time of engine.
- To ensure customer satisfaction.
- In order to provide proper placement of the engine parts during assembling.

2.2. Heater Failure

If the coolant level decreases in the tank, then heat produced from the heater cannot be dissipated to coolant. Because of this condition the heating coil gets damaged leading to heater failure due to internal inherent heat radiation. In addition to that if the solution gets heated above the critical temperature, there are chances of degradation of the component.

This failure leads to several inconveniences like, cost for replacement of the heater is high and also time consuming; quality of washing is not ensured; affects the production.

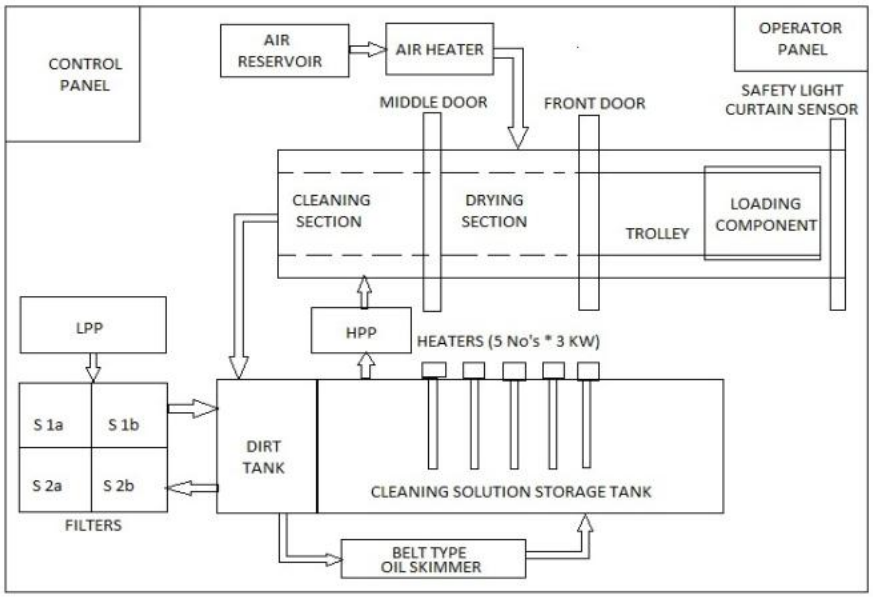

FIG. 1: BLOCK DIAGRAM OF WASHING MACHINE

2.3. Solution Heater

Washing is done with hot solution and compressed air. Hence a heater is provided within the solution tank to heat the coolant. The heater used here is of immersion type. An immersion heater has an electrical resistance heating element encased in a tube and directly placed in the water (or other fluid) to be heated. The immersion heater may be placed in an insulated hot water tank. Desired temperature of the solution is set by the operator manually.

FIG. 2: IMMERSION HEATER

The immersion heater used here consists of heat zone and non heat zone. The section which is immersed in the solution is the heat zone, above which the non heat zone is located. The function of the non heat zone is to prevent the coil from damage.

The heater consists of a cylindrical rod within which a conducting coil is placed. This coil is surrounded by an insulating material such as special sand, porcelain. When electric current is passed through the coil, the rod gets heated up and this energy is dissipated to the solution. Advantages of electric heating methods over other forms include precision control of

temperature and distribution of heat energy, combustion not used to develop heat, and the ability to attain temperatures not readily achievable with chemical combustion.

2.4. Need for Sensors

- The heater failure can be avoided by monitoring the temperature and level of solution by using sensors.
- The level of solution in the tank is checked by using float type level sensor (solution level indicator).
- The temperature of solution is measured by placing two wire system thermocouple inside the solution which senses the temperature and displays it in temperature controller placed in the operator panel.

III. PROPOSED WORK

In the existing work, the heater failure was a drawback and hence to overcome this problem level sensor and temperature sensor are proposed in this project

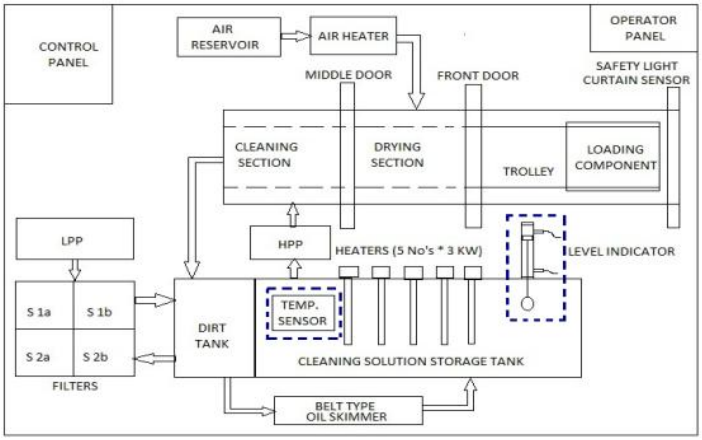

FIG. 3: BLOCK DIAGRAM OF PROPOSED WORK

3.1. Hardware Connections

The hardware components like PLC (Programmable Logic Controller), MCB (Miniature Circuit Breaker), Relays, SMPS (Switching Mode Power Supply), Control transformer, Contactors are connected as per the circuit diagram.

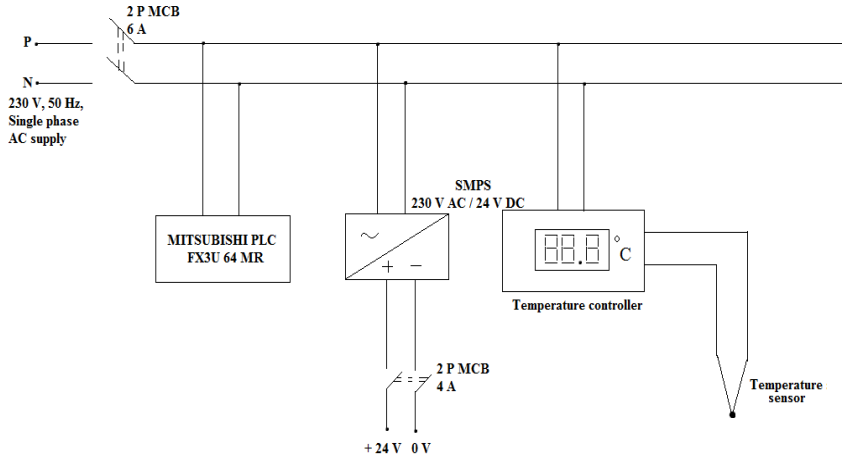

FIG. 4: POWER CIRCUIT

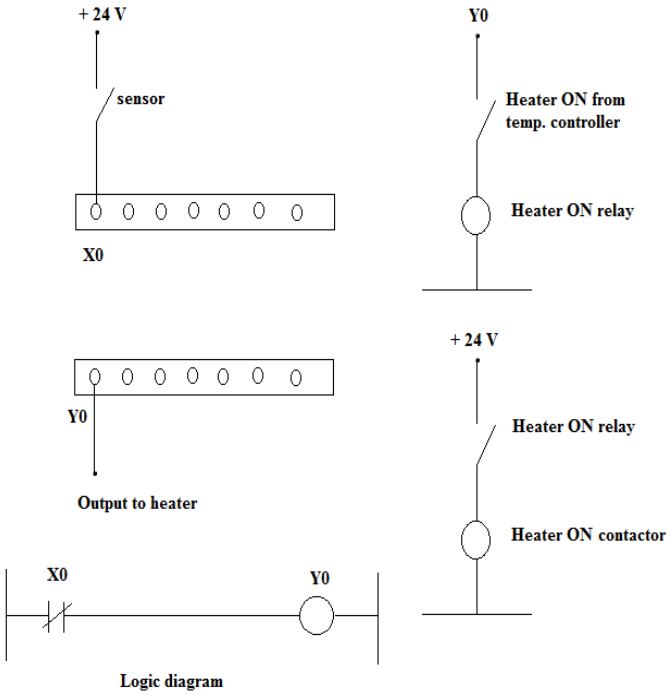

FIG. 5: CONTROL CIRCUIT

3.2. Programming a PLC

In these modern times a PC with specially dedicated software from the PLC manufacturer is used to program a PLC.The PLC can be programmed using many languages like

- Instruction list programming
- Functional block programming
- Ladder logic programming

Among the above languages the most widely used form of programming is ladder logic. Ladder logic uses symbols, instead of words, to emulate the real world relay logic control.

The completed program looks like a ladder but in actuality it represents an electrical circuit. The left and right rails indicate the positive and ground of a power supply. Each program statement is a line called the rung with inputs to the left and outputs to the right. The execution starts from the top rung, down to the last rung. The rungs represent the wiring between the different components which in the case of a PLC are all in the virtual world of the CPU.

The completed program is downloaded from the PC to the PLC using a special cable that's connected to the front of the CPU. The CPU is then put into run mode so that it can start scanning the logic and controlling the outputs. The programming is done using the software GX Works-2.

IV. RESULTS AND DISCUSSIONS

4.1. Simulation Results

The logic is implemented in GX Works – 2 software and the simulated results are verified.

1. When high level is sensed and temperature is at the safe limit, the heater is in ON state.

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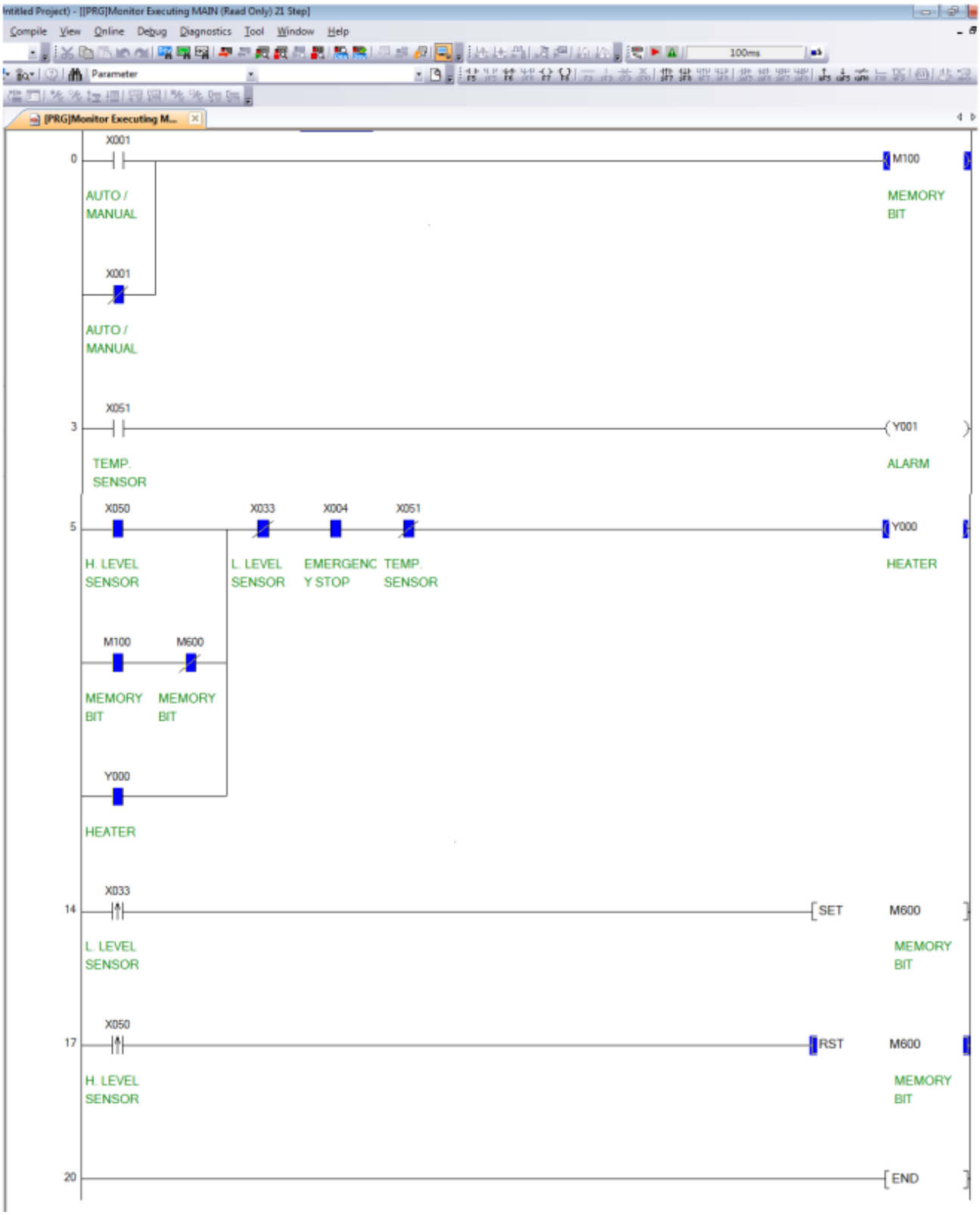

FIG. 6: SIMULATION RESULT WHEN HIGH LEVEL IS SENSED AND TEMPERATURE IS AT SAFE LIMIT

2. When high level is sensed but temperature is above the safe limit, the heater is in OFF state and it is indicated with an alarm.

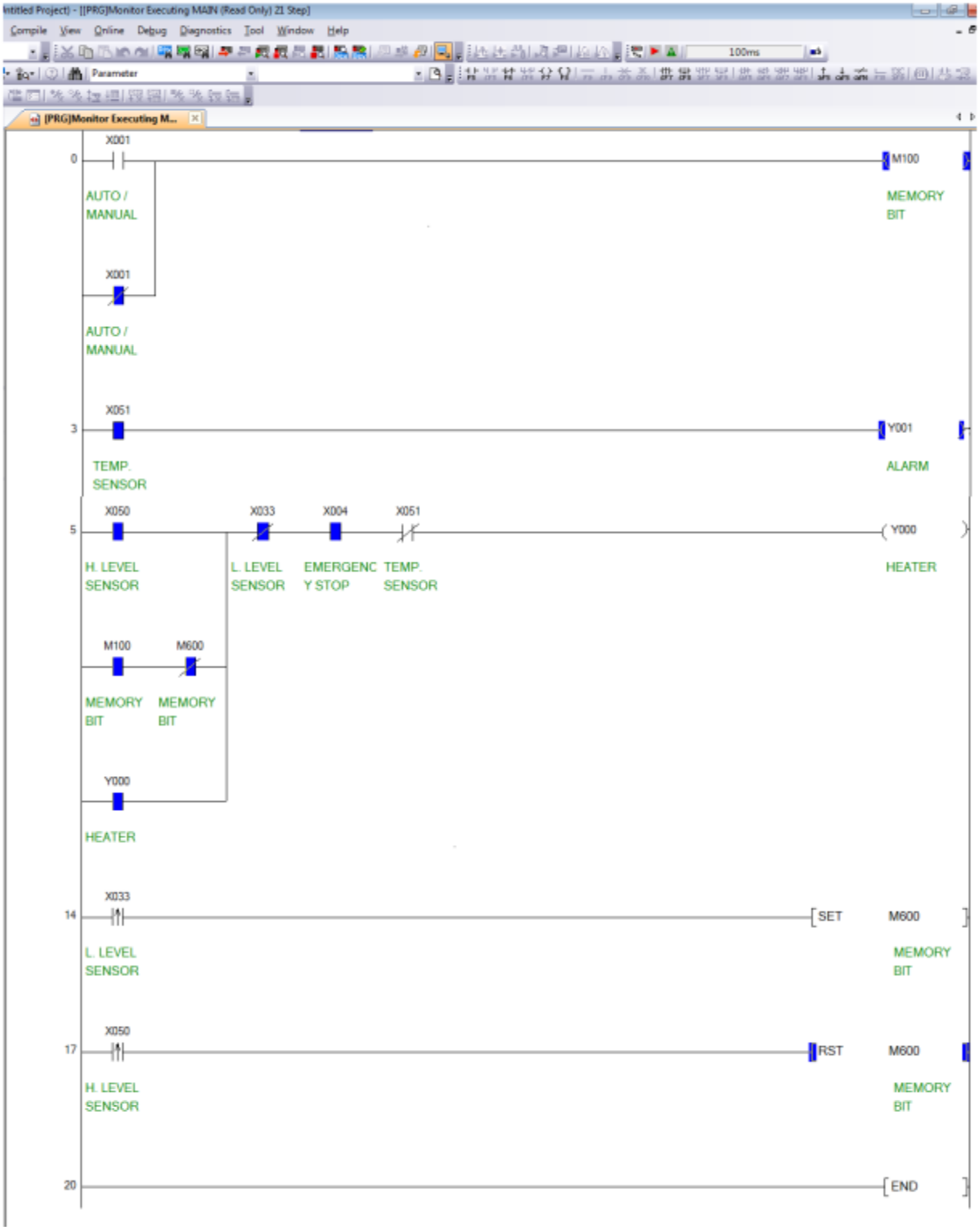

FIG. 7: SIMULATION RESULT WHEN HIGH LEVEL IS SENSED AND TEMPERATURE EXCEEDS SAFE LIMIT

3. When low level is sensed and temperature is either above or below the safe limit, the heater turns OFF.

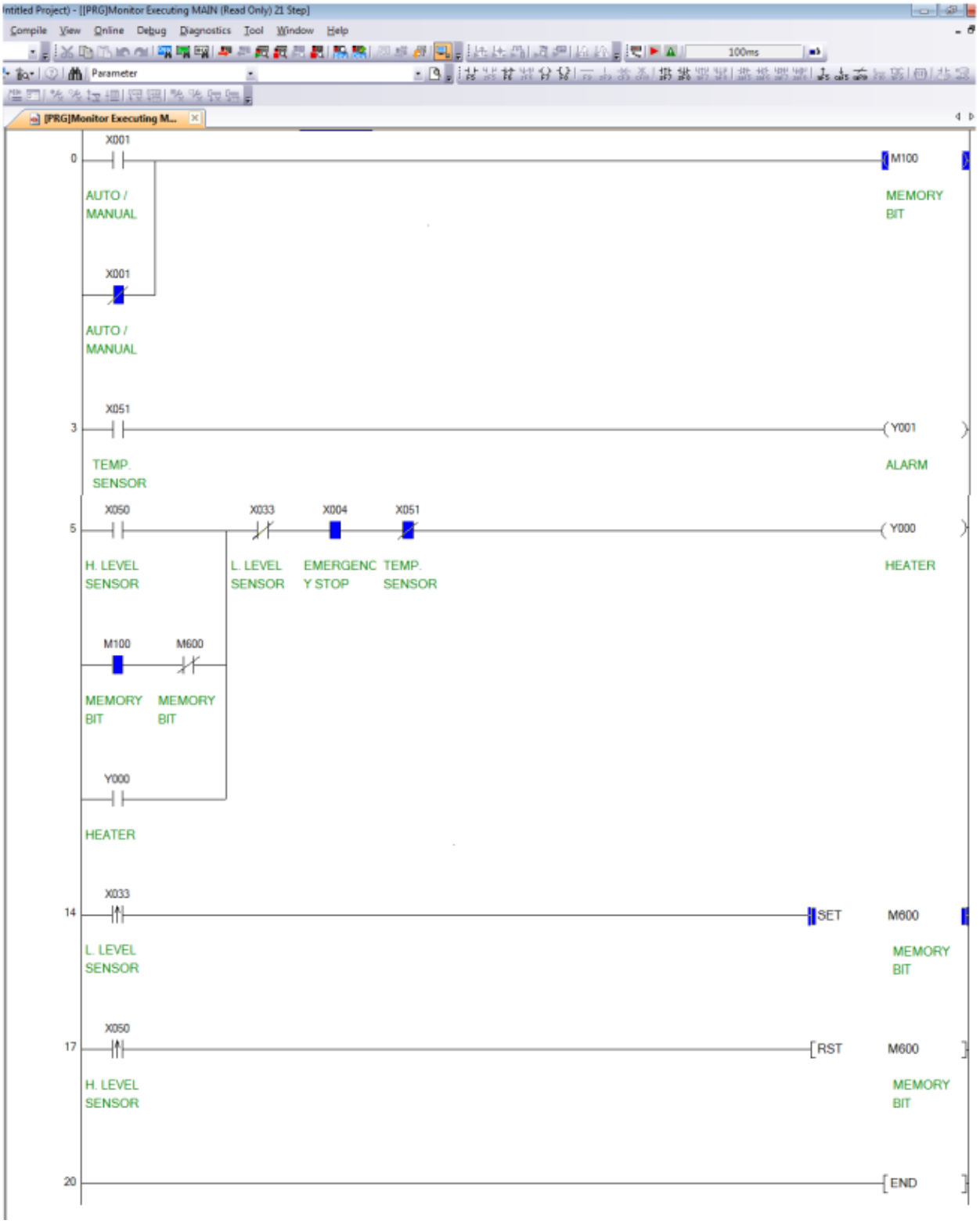

FIG. 8: SIMULATION RESULT WHEN LOW LEVEL IS SENSED

4.2. Hardware Implementation

Initially, connections are given as per the circuit diagram in the external circuitry and then it is implemented in the machine. Then PC is interfaced with the PLC and the ladder logic is loaded in it for interlocking and the following conditions are checked.

TABLE 1
STATE OF HEATER AT DIFFERENT CONDITIONS

LEVEL	TEMPERATURE	HEATER STATE
High level	Low/Moderate temperature	ON
High level	High temperature	OFF
Low level	High/Low temperature	OFF

In the demonstration kit, when the sensor is not sensed, the heater is in ON state which is indicated through an LED.

FIG. 9: HEATER – ON STATE

FIG. 10: HEATER – OFF STATE

When the sensor is sensed, the heater turns OFF which is illustrated in the figure below.

FIG. 11: LEVEL SENSOR IN THE MACHINE

FIG. 12: MMI INDICATING LOW LEVEL

V. CONCLUSION

Thus the level sensor and temperature sensor are used in the washing machine to avoid heater failure by interlocking mechanism. The ladder logic was developed using GX Works – 2 software and the results were simulated. The hardware

circuitry for the proposed model was implemented and the developed logic was interfaced with PLC via an RS485 cable. Hence the quality of the machine is enhanced.

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