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Automation of Beverage Vending Machine using PLC and SCADA

Anubhaw Kumar*
Student
Applied Electronics & Instrumentation Engg.
Gandhi Institute of Engineering & Technology
Gunupur, Rayagada, Odisha, India

Puja Rani
Student
Applied Electronics & Instrumentation Engg.
Gandhi Institute of Engineering & Technology
Gunupur, Rayagada, Odisha, India

Anjali
Student
Applied Electronics & Instrumentation Engg.
Gandhi Institute of Engineering & Technology Gunupur, Rayagada, Odisha, India

Abstract

During this industrialization vending machines play an important role for fulfilling the process immediate needs of the society. In a challenge to competitive industrial world, a system must be flexible, efficient and cost effective; so automation in machines is very much essential. The concept of automation is so versatile that it can bring radical development in almost every field. New beverages are increasing day by day in the market, so this project provides the method of preparation of soft drinks like Fanta and Maaza in a new approach by implementing automation using PLC & SCADA for its preparation, bottling, and packaging. The objective of this work is to encourage small scale industries for the implementation of automation in beverage preparation and its bottling plant. This work will provide low power consumption, low operational cost, less men power, accuracy and flexibility to the system and at the same time it will save the operational time of an industry.

Keywords*: PLC, SCADA, Automation, Conveyor, Sensors, Valves.*

****Author for correspondence*** giet12aei095@gmail.com

1. Introduction

The project is to design and develop new approach for vending beverage using PLC & SCADA. We can operate and control automatically the beverage preparation by using PLC. We can monitor the parameter of the process in the plant using SCADA technology because SCADA system is used as supervisor or monitor for the process through an animation. In this plant, several operations will run simultaneously by the help of PLC. In the first process the pump feed the ingredients to the process ingredients tank from the reservoir. In the second process the liquid concentrate of different beverages (Orange and Mango) are mixed with the ingredients in their respective tanks. In the third process the bottles filled with the beverages moves to the packaging

unit by a conveyor which will by a conveyor motor. These are all automated processes leads to more accuracy and flexibility of the system.

A. PLC used as a System Controller

The operation of a programmable controller is relatively simple. The input/output (I/O) system is physically connected to the field devices that are encountered in the machine or that are used in the process control. These field devices may be discrete or analog input/output devices, such as limit switches, pressure transducers, push buttons, motor starters, solenoids etc. The I/O interfaces provide the connection between the CPU with the information providers (inputs) and controllable devices (outputs). During its operation, the CPU completes three processes: (1) it reads, or accepts, the input data from the field devices via the input interfaces, (2) it executes, or performs, the control program stored in the memory system, and (3) it writes, or updates, the output devices via the output interfaces. This process of sequentially reading the inputs, executing the program in memory, and updating the outputs is known as scanning.

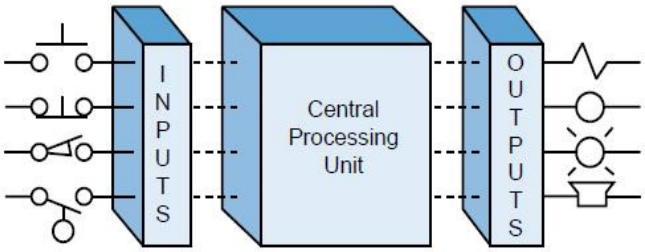


Fig. 1: Basic PLC Operation Process

B. Modern SCADA Systems

SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely user friendly software that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware modules, SCADA encompasses the collecting of the information, transferring it back to the central site, carrying out any necessary analysis and control and then displaying that information on a number of operator screens or displays. The required control actions are then conveyed back to the process.

2. PLC and its related Software

Here, with hardware of PLC manufacturer Allen Bradley Micrologix 1000 Analog have used. The programming software for this PLC is RSLOGIX500 of the version 7.30.10(CPR9). In Allen Bradley Micrologix 1000 Analog model of PLC, there are total 11 inputs and 8outputs.The MicroLogix 1000 micro-PLC can handle a wide variety of big-time applications at 32 I/o or below, while using only a fraction of the space of a full size controller. RS-232 communication channel allows for simple connectivity to a personal computer for program upload, download and monitoring using multiple protocols, including DF1 Full-Duplex.

Proximity Sensors: Proximity sensors are available in two types namely: inductive sensors and capacitive sensors. Inductive sensors are cheaper and allow detection of metal objects whereas capacitive sensors are costly and allow detection of metal, plastic and glass objects as well. *Variable frequency drive*: Adding a variable frequency drive (VFD) to a motor-driven system can offer potential energy savings in a system in which the loads vary with time. VFDs belong to a group of equipment called adjustable speed drives or variable speed drives.

3. Process Operation

A. Description using SCADA system

This work represents a complete application of automation. The various process of this system is controlled by PLC and monitored using SCADA. PLC and SCADA are the heart of the system. The system is controlled according to the programmed PLC. To monitor the processing of the entire plant SCADA is used. Figure 2 shows the SCADA view of the whole process. This is specially designed for the preparation of beverages like cold coffee and ice tea. We are using purified water, liquid concentrate for beverages. In the above process when we switch on all the switches (Start, tea, coffee) then the liquid concentrate are start fill in their respective tank and the water tank is filled by the help of pump from the reservoir. Then the water valve open automatically and the water pass to the two mixing tank for a given time which was already programmed as per the tank volume and our requirement. Then the valve of the two beverages tank open and the concentrate liquid for the beverages are passing to their respective mixing tanks for a given amount of time. The ratio of two different liquids will decided as per the required mixed liquid that we needed in the bottle. Timer is set in the programmed for the valves opening and closing as per the tanks volume. There is a stirrer motor is also fitted to mix these two liquids of definite amount in the mixing tank, when the mixing of the water and the concentrate liquid completed then the stirrer motor stop. Then in the next process the conveyor motor starts and the filling bottles comes right below to the outlet valve of tea and coffee. The position of the bottles detects at the exert point by a proximity sensor at that time conveyor motor stops and filling process starts for a given amount of time then the filling stops and conveyor motor starts. Then the bottles go to the packaging unit by a robotic arm or by a conveyor belt. This process continues till mixing tank is empty. Then the whole process starts again. The opening and closing of the all solenoid valves are controlled by the timer range used in the program.

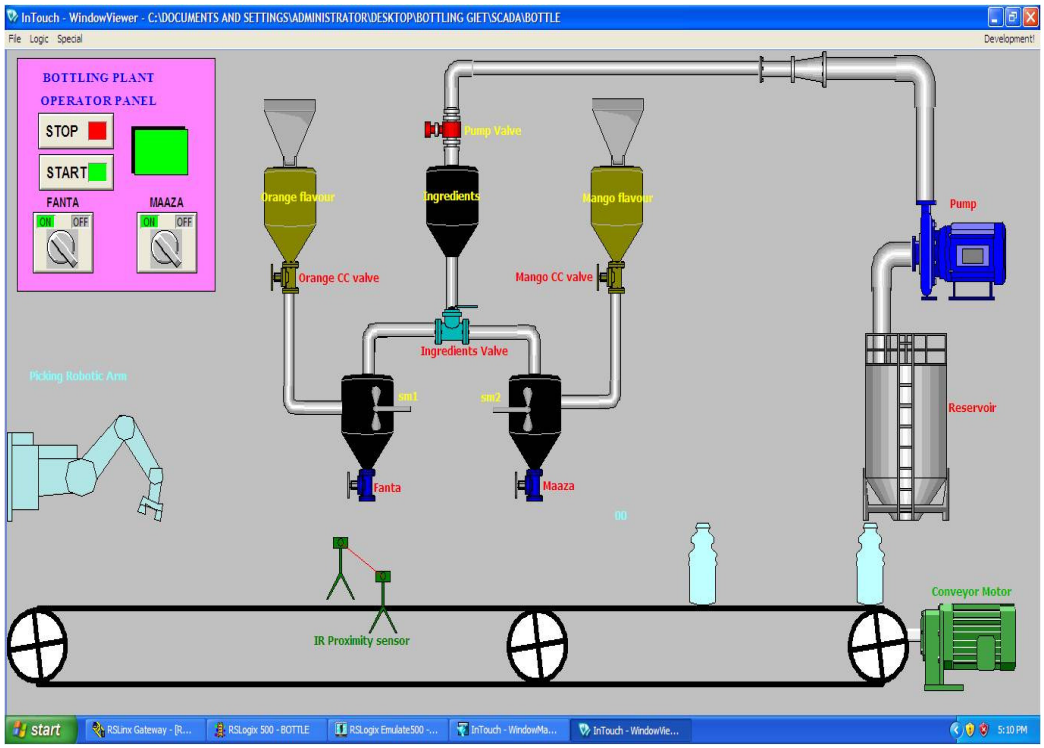
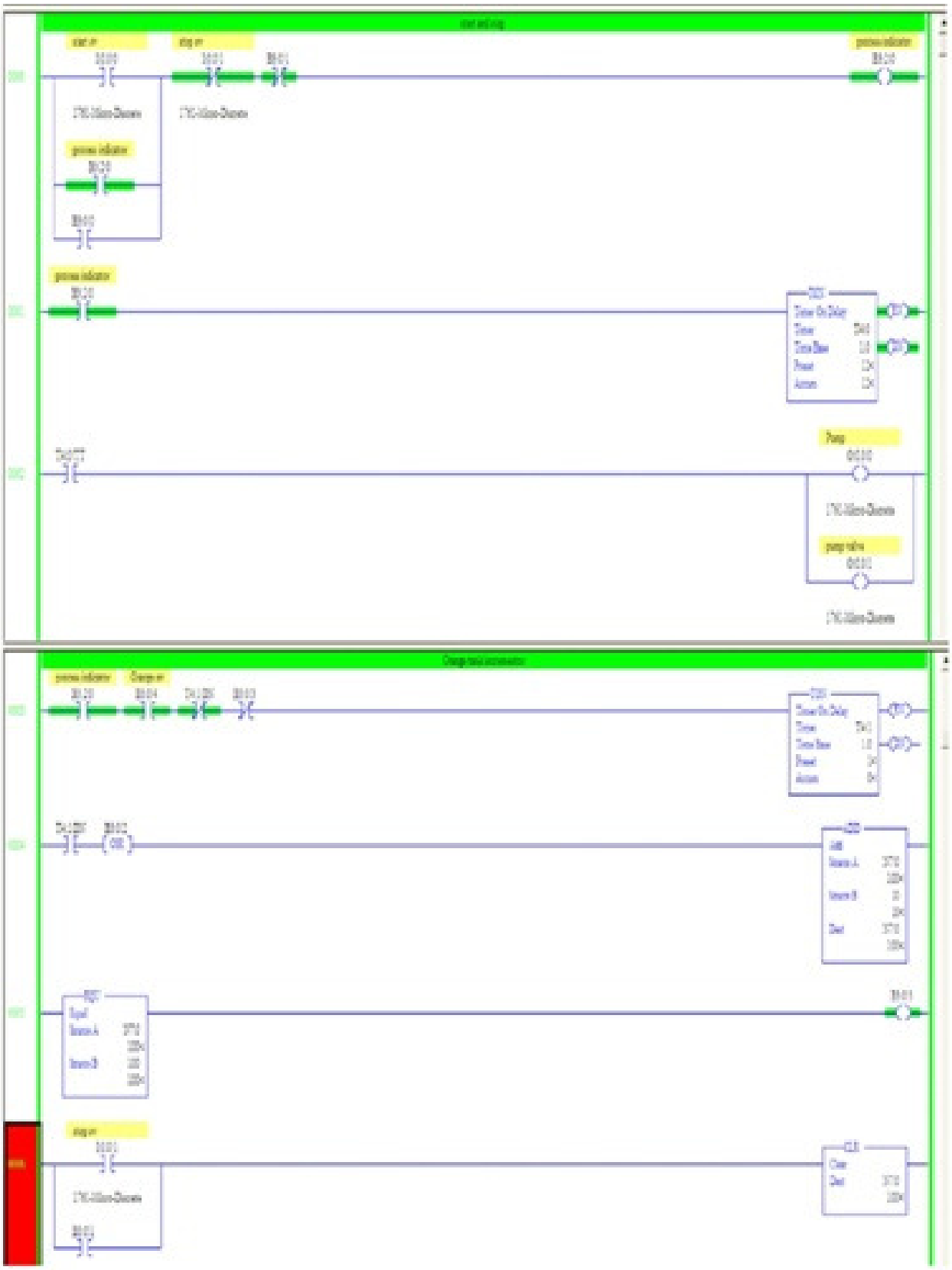
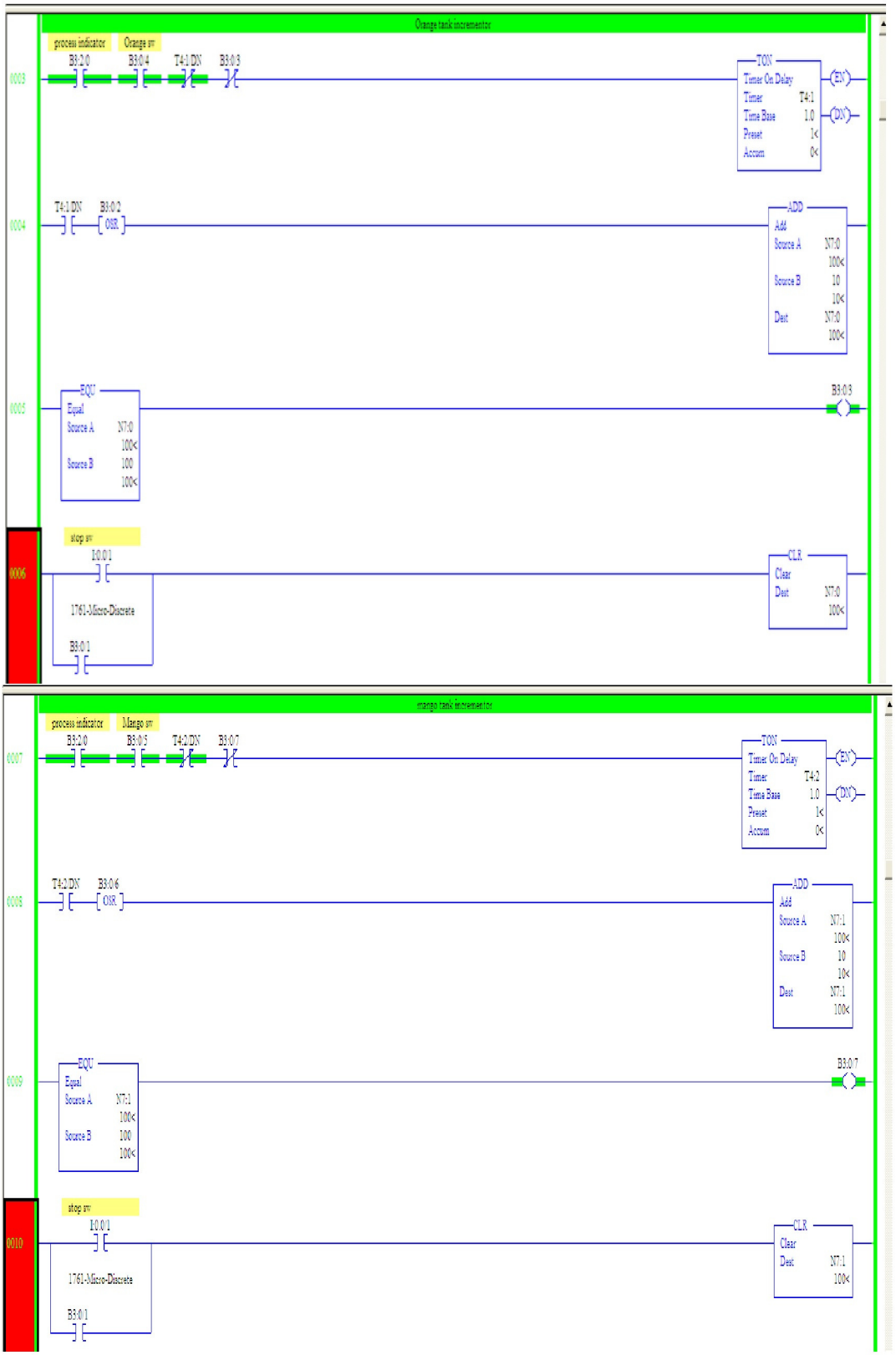


Fig 2: Process Monitoring through SCADA Screen

B. PLC Ladder Program of Process Operation




Orange tank incrementor
process indicator
Orange sw
B3:2/0
B3:0/4
T4:1/DN
B3:0/3
TON
Timer On Delay
Timer T4:1
Time Base 1.0
Preset 1<
Accum 0<
EN
DN
T4:1/DN
B3:0/2
OSR
ADD
Add
Source A N7:0
100<
Source B 10
10<
Dest N7:0
100<
EQU
Equal
Source A N7:0
100<
Source B 100
100<
B3:0/3
stop sw
I:0.0/1
1761-Micro-Discrete
B3:0/1
CLR
Clear
Dest N7:0
100<
mango tank incrementor
process indicator
Mango sw
B3:2/0
B3:0/5
T4:2/DN
B3:0/7
TON
Timer On Delay
Timer T4:2
Time Base 1.0
Preset 1<
Accum 0<
EN
DN
T4:2/DN
B3:0/6
OSR
ADD
Add
Source A N7:1
100<
Source B 10
10<
Dest N7:1
100<
EQU
Equal
Source A N7:1
100<
Source B 100
100<
B3:0/7
stop sw
I:0.0/1
1761-Micro-Discrete
B3:0/1
CLR
Clear
Dest N7:1
100<

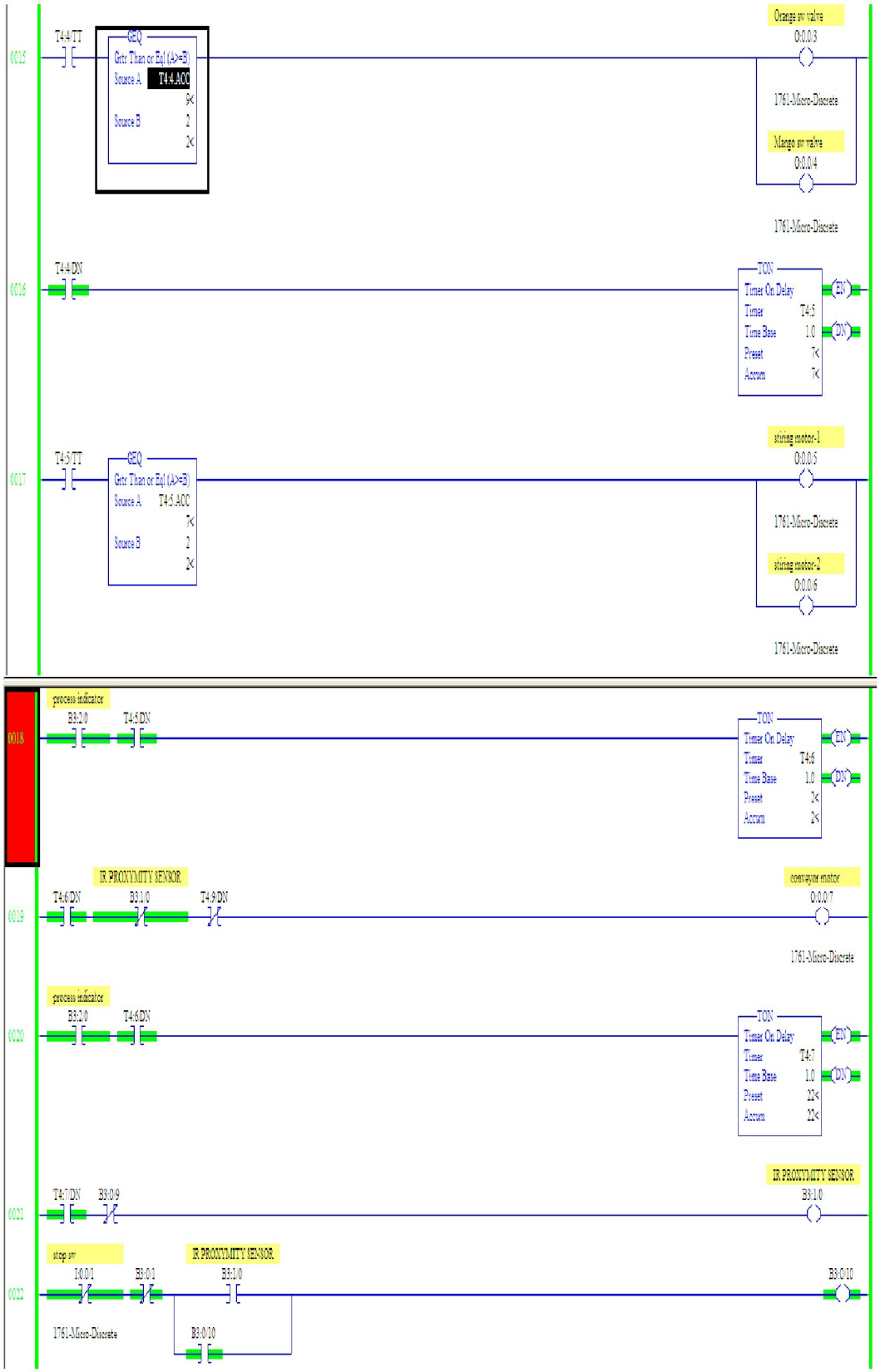

0015
T4:4/TT
GEQ
Grtr Than or Eql (A>=B)
Source A T4:4.ACC
9<
Source B 2
2<
Orange sw valve
O:0.0/3
1761-Micro-Discrete
Mango sw valve
O:0.0/4
1761-Micro-Discrete
0016
T4:4/DN
TON
Timer On Delay
Timer T4:5
Time Base 1.0
Preset 7<
Accum 7<
EN
DN
0017
T4:5/TT
GEQ
Grtr Than or Eql (A>=B)
Source A T4:5.ACC
7<
Source B 2
2<
stirring motor-1
O:0.0/5
1761-Micro-Discrete
stirring motor-2
O:0.0/6
1761-Micro-Discrete
0018
process indicator
B3:2/0
T4:5/DN
TON
Timer On Delay
Timer T4:6
Time Base 1.0
Preset 2<
Accum 2<
EN
DN
0019
IR PROXYMITY SENSOR
T4:6/DN
B3:1/0
T4:9/DN
conveyor motor
O:0.0/7
1761-Micro-Discrete
0020
process indicator
B3:2/0
T4:6/DN
TON
Timer On Delay
Timer T4:7
Time Base 1.0
Preset 22<
Accum 22<
EN
DN
0021
T4:7/DN
B3:0/9
IR PROXYMITY SENSOR
B3:1/0
0022
stop sw
I:0.0/1
B3:0/1
IR PROXYMITY SENSOR
B3:1/0
B3:0/10
1761-Micro-Discrete
B3:0/10

Fig. 3: PLC ladder logic for the machine

4. Conclusion

Effort has been given for an automated way of beverage preparation. The above setup provides a great deal of application in the field of automation. In the field of mass production where all unit need to be processed and monitored in a short period of time which leads to increase in production. This project presents a scope for vending machine to introduce automation by help of PLC and SCADA in the field of beverage preparation. For the setup of an automated machine like this by using PLC and SCADA, the initial cost may be high but it offers many advantages that overcome its cost. It leads to high production rate, using of less manpower, saving the operational time in the plant. Another additional feature of the proposed system is the use of SCADA that makes it controlled through a remote location. The complete monitoring is made by SCADA system. We can start and stop the system by using SCADA at the SCADA screen by sitting at a distance of the process. This concept helps in error detection in a process.

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