جامعة القاهرة كلية الهندسة
قسم هندسة القوى الميكانيكية
معمل التحكم الأوتوماتيكى

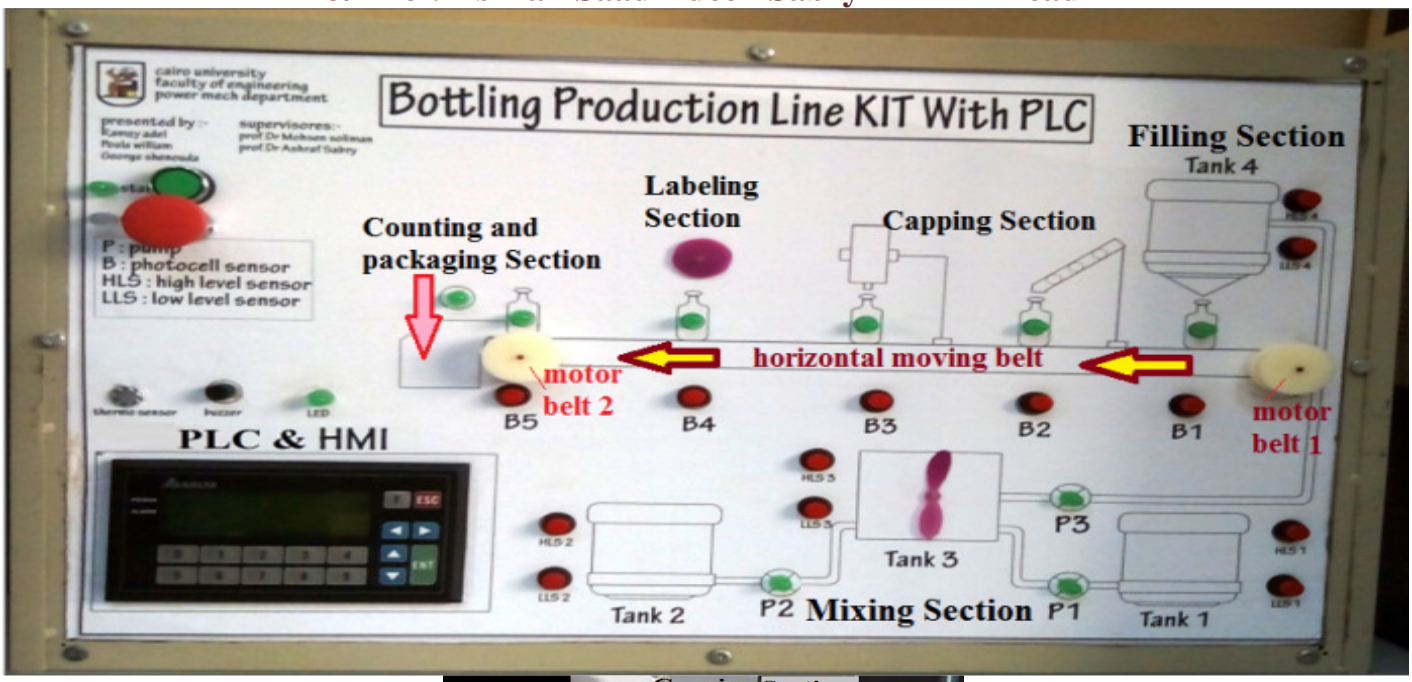
CAIRO UNIVERSITY
FACULTY OF ENGINEERING

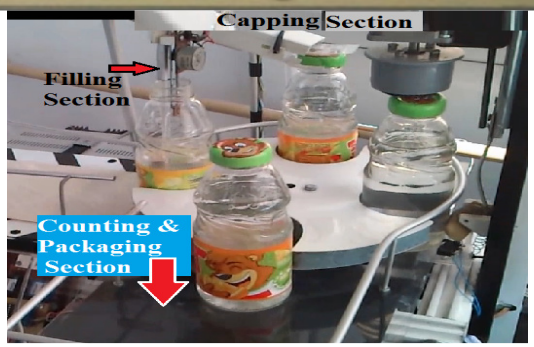
ACC Virtual Labs
Automatic Control Circuits & Virtual Labs for Mechanical Power Systems
معمل التحكم الاتوماتيكى و المعامل الافتراضية لأنظمة القوى الميكانيكية

Head Office New Mech. Power Building No.17000, 4th floor Faculty of Engineering Cairo University
Tel: 35678600/35678729 Mob:01002861989
accvlab@gmail.com www.acc-vlab.cu.edu.eg

The Training Kit was made by Engs. George Shenouda, Eng. Poula William and Eng. Ramzi Adel

Under Supervision of Associate Prof. Mohsen Sayed Soliman, ACC Manager & Prof. Ashraf SaadEldeen Sabry X-MEP Head





This Catalog was Written & Prepared by

Associate Prof. Mohsen Sayed Soliman, ACC Manager, August 2017

Introduction: **This Training Kit is an example for practical application of PLC and HMI (Programmable Logic Controller&Human Machine Interface) Systems in Mech. Power Engg. The Kit represents an introduction for investigation of various types of real control systems which are used in automatic Bottling Production Line Systems. The real systems can include micro-controller, conventional electric or Relay type control circuits, PLC, Hydraulic and pneumatic Systems. The Kit is an effort to design & execute a simplified practical training model which uses both PLC& HMI techniques in order to simulate a real Bottling system. In addition to the task of selecting a specific type of PLC & HMI which are proper for producing this model, another required task was to select & use several types of electric digital switches, Relays, LEDs & input/output I/O devices. Furthermore, in order to practice different aspects of using PLC, the training includes also running and testing practical and real PLC-Simulation software to diagnose possible errors & trouble-shooting of automatic control PLC& HMI systems of sequential programming procedure. Finally training task includes detailed and carefully prepared documentation procedure report for SFC, Sequential Function chart, LAD program & wiring of the Bottling Production Line Training Kit.**

Overview: This is an automatically controlled bottling production line system. The objective is to provide a mixed liquid which could be a juice, milk or any wanted liquid depending on demand of the factory in a simple way using both PLC & HMI

e hydraulic piston on cap lock the bottle and twist it automatically then print the label and twist it by two vertical belts.

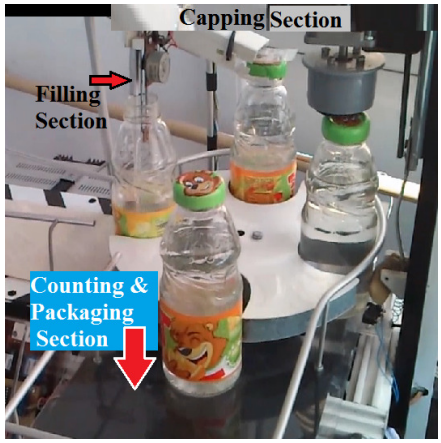
Examples of automatic Bottling Production Line Systems

المخرجات التعليمية المستهدفة من وحدة التدريب ILO's of Training Kit:

- **دراسة أساسيات ومكونات PLC والتعرف على إمكانياته وخصائصه التقنية فى عمليات التحكم الإوتوماتيكى ثم تحديد التفاصيل الفنية وعناصر النوع المناسب لكل منظومة تحكم محددة.**
- **دراسة بعض عناصر الميكاترونيكس الرقمية والتناظرية Input & Output devices for PLC (مثل أجهزة القياس والحساسات والمفاتيح وبعض أنواع أجهزة الخرج Output actuators).**
- **تعلم تقنيات وخطوات تصميم برنامج للتحكم المنطقى المتعاقب وممارسة وتنفيذ مخطط لوظائف التشغيل المتعاقب SFC: Sequential Flow Chart**
- **تنفيذ تقنيات البرمجة المتعاقبة Sequential Programming وما تتضمنه من ضرورة وجود برمجة متوازية أو إختيارية Parallel or Selective Branching حسب متطلبات عملية التحكم.**
- **تعلم عناصر لغة برمجة أجهزة PLC الخاصة بالمشروع وتعلم برامج ومهارات الكتابة والتوثيق للبرنامج PLC Ladder diagram**
- **تعلم تقنيات برامج المحاكاة PLC Simulation software لتنفيذ برنامج التحكم بالحاسب الآلى PC لتشخيص أخطاء البرمجة قبل التنفيذ العملى.**
- **تحديد كافة الحساسات والاجهزة المصاحبة المختلفة لكل من Input and Output devices التى يجب توافرها وتعلم كيفية توصيلها بأجهزة PLC لإستكمال منظومة التحكم عند تشغيل PLC.**
- **تصميم وإنشاء وتنفيذ وتوثيق جهاز تجربة معملية جديدة ووحدة تدريب دائمة بإستخدام جهاز الحاكم المنطقى المبرمج PLC مع كافة المكونات الكهربية والإلكترونية المطلوبة.**
- **إكتساب Soft skills وخبرة لعمل تقرير هندسى متكامل Technical Engineering Report وتقديم عرض presentation للجهاز ولنتائج المشروع بوسائل عرض سمعية وبصرية حديثة.**

Modeling of a real Bottling Production Line into a Training Kit:

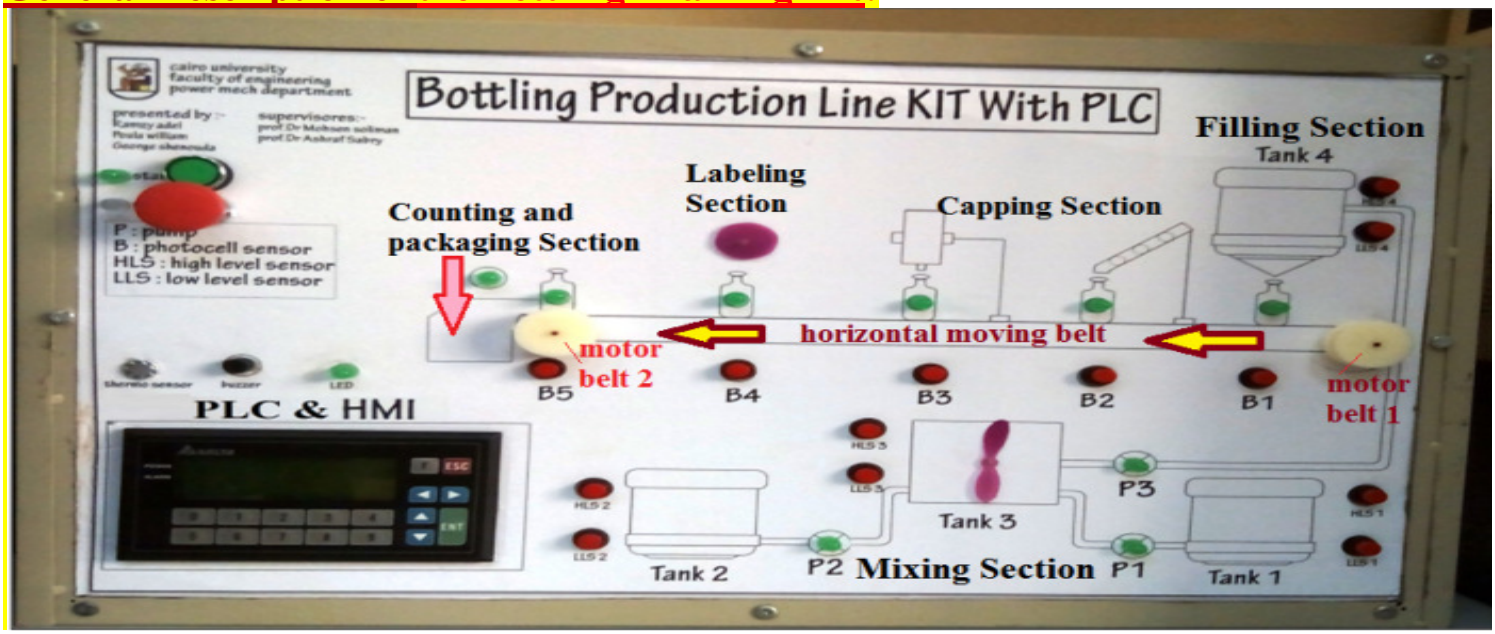
Next fig. shows some sections of a typical real bottling production line which may include micro-controller, conventional electric or Relay type control circuits, PLC, HMI, Hydraulic and pneumatic Systems. The input components for the control system of a real bottling production line should include: IR Photo-cell Sensors, Liquid Level sensors, Limit Switches, ON/OFF Push Buttons, HMI, Temperature and Pressure sensors, …etc. The output components for the control system of a real bottling production line include: Solenoid Flow Control Valves, Pumps, Motors, Relays, linear Conveyors, rotating disk, Timers, Counters, Display LEDs and HMI,….etc.



In order to have a simplified PLC&HMI control system in the Training Kit, the real signals of IR Photo-cell Sensors are simulated by ON/OFF Push Buttons to get some of the PLC-inputs. All real controller outputs to the field devices & actuators are simulated in the Kit by Display LEDs & some DC-motors which come ON if PLC-outputs are activated. Timers and Counters are included as part of the PLC & HMI.

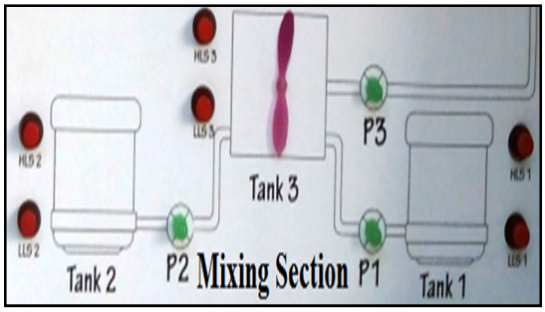
The Kit uses a 24VDC Delta-PLC with built-in HMI. The PLC has 16 digital inputs&16 digital outputs. All real input IR Photo-cell Sensors, Liquid Level sensors, Limit Switches are modeled in the Kit by15 Push-buttons. A real Temperature sensor (Thermistor) is also used as one input. All real output control signals to Relays, hydraulic or any electric-mechanical actuators are modeled by many display LEDs, 3-DC motors and an alarm Buzzer (all 16 outputs are used).

General Description of the Bottling Training-Kit:



As seen on fig. the Kit is divided into 4 main sections (in addition to last Sec. part for counting & packaging).

All the sections seen on Training Kit include and operate as follows:

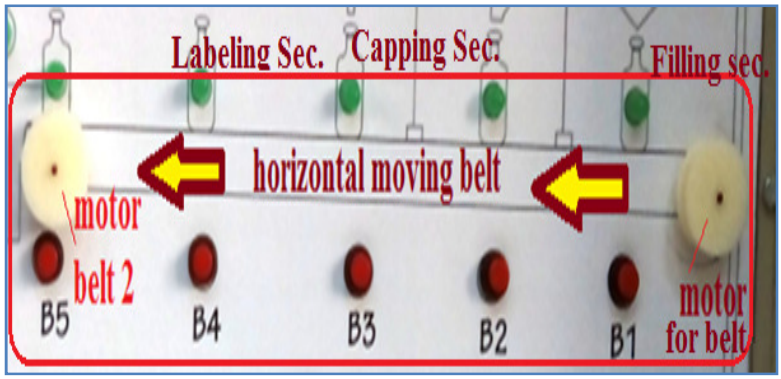


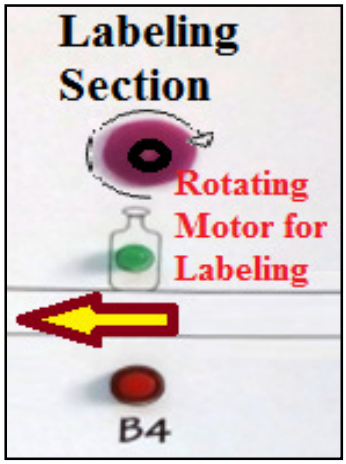
1) Mixing section: when power is ON & the Start PB is pushed, the 1st process begins by starting the 2 pumps P1&P2 to draw & feed liquids from tanks 1&2 to mixing

tank 3. Both pumps are assumed to have same capacity. If a High Level sensor in any tank HLS1/HLS2 is pushed, the tank's pump stops to prevent over-flow. If a Low Level sensor LLS1/LLS2 in any tank is pushed, the tank's pump stops to protect the pump. Mixer in tank 3 is used to mix the 2 liquids. To save time, mixer may start running (at any specified time in the LAD) after starting the two pumps 1&2. After mixing, liquid is drawn from thank 3 to feed the Filling tank4. High & Low Level sensors HLS3&LLS3 are used to control time of starting or stopping the feeding pump 3.

2) Filling process: when the mixture in feeding tank4 reaches to Low Level sensor LLS4, all operation stops to prevent having empty bottles. When the mixture in feeding tank4 reaches High Level sensor HLS4 all operation stops to prevent overflow of Tank4. In both cases the filling process can be resumed only if the liquid in Tank4 is above LLS4 and below HLS4. and the2 pumps has to both run to fill the main tank3 again the same process starts to happen again.

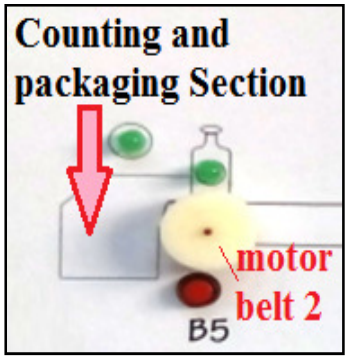
3) Bottle moving on the belt: as shown on next fig., we have 4 input PBs that correspond to 4 photocells B1, B2, B3, B4 located along the belt bath. Each photocell detects the passing of one bottle in a specific section (Filling, Capping then Labeling). In order to move the belt, the motor has to run (by PLC output from the LAD) after Tank 4 is filled. If we push PB-B1 at the Filling location, LED is ON at filling bottle Sec. If we push PB-B2 at capping sec. 1st LED is ON & if PB-B3 is then pushed, 2nd LED is ON. If PB-B4 is pushed, LED at capping sec. is ON as the belt moving motor is activated ON.



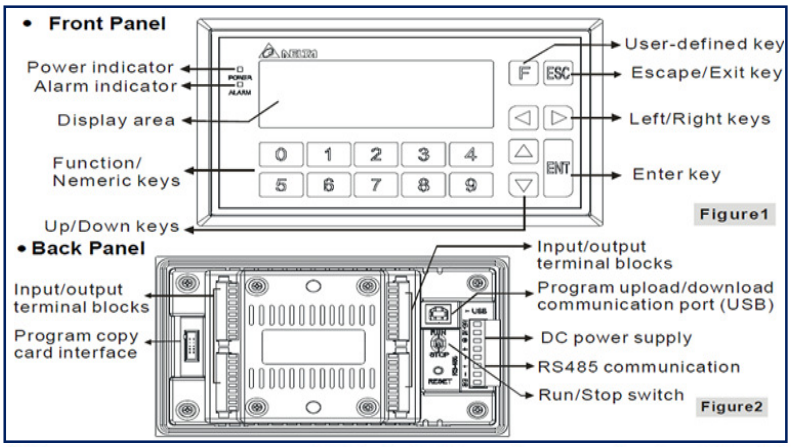


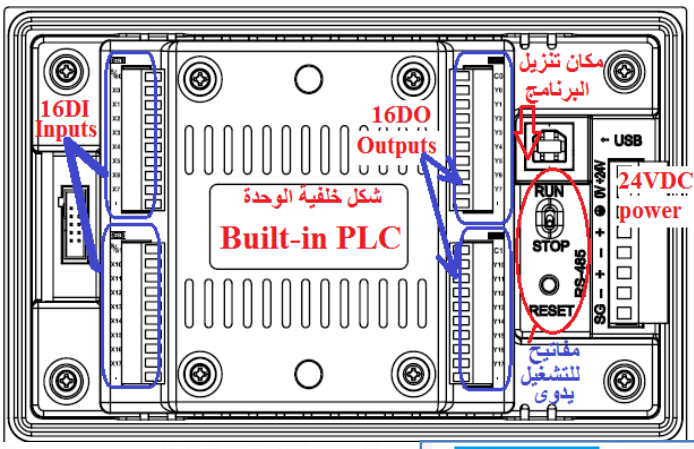
4) Capping and labeling: In a real Bottling line, there are several methods for capping and labeling. As shown, capping for our Kit is done by pushing B2 then B3. The Labeling sec. includes a rotating motor to do this task. Motor is activated to run by PLC output from the LAD after the PB-B4 is pushed. LED on bottle is ON indicating the progress of Labeling process. Depending on the sequence of pushing B1, B2, B3, B4, we may have all filling, capping and labeling are done at the same time on different bottles. This should be indicated by all LEDs are turned ON and is staying ON while motor belt is activated ON indicating progress of a belt motion in the shown direction.

5) Counting & Packaging Section: as shown, a 2nd motor belt 2 is provided to perform the packaging process. This step is initiated and started by pushing PB-B5. The motor belt 2 is ON to run by PLC output from the LAD after PB-B5 is pushed. As a result the LED becomes ON indicating the progress of counting and packaging process. At the same time the HMI unit shows a counter display of number of bottles which have been counted in one package.



Technical data &wiring Diag. of Delta-PLC with built-in HMI(TP04P-32TP1R)used in the Kit:

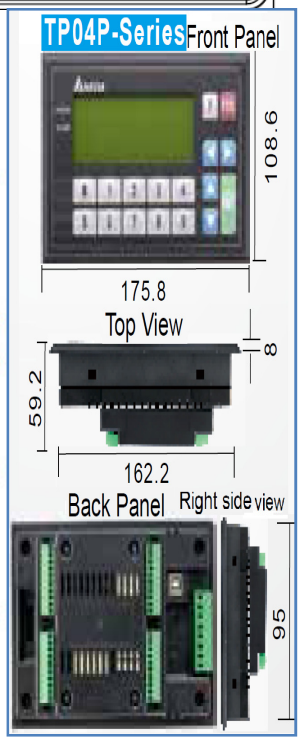




What is TP04P-32TP1R Delta TP series products. TP04P is composed of a text panel and a PLC. It supports abundant instructions. The capacity of the program memory it supports is 8K steps. TP04P features the same program download port shared by both PLC and TP editing software: WPLSoft/ISPSoft and TPEditor. It also offers various graphical objects for developing the program. The user can also obtain higher efficiency by purchasing additional extension cards, which increase the program portability and save the program download time. Please ensure to use TP series with Delta power supply module, DVPPS01, DVPPS02 or DVPPS05.

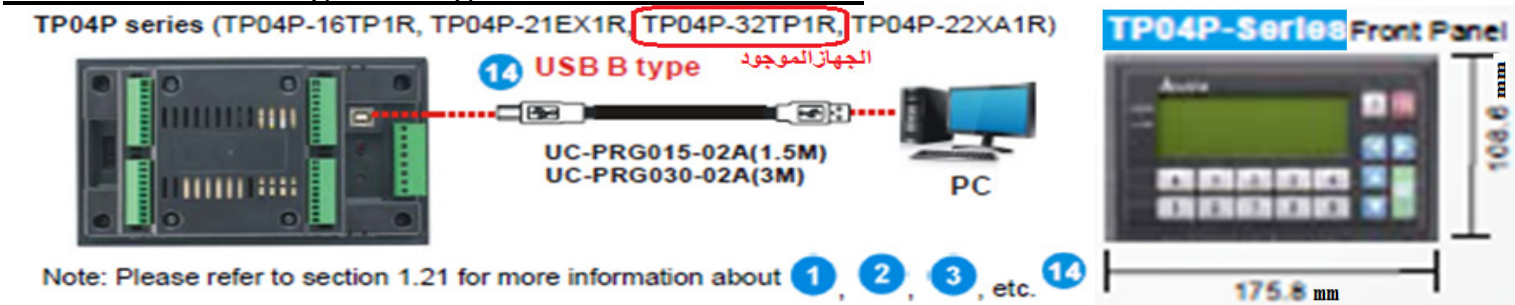
EN ✗ TP04P is an OPEN-TYPE device. It should be installed in a control cabinet free of airborne dust, humidity, electric shock and vibration. To prevent non-maintenance staff from operating TP04P, or to prevent an accident from damaging TP04P, the control cabinet in which TP04P is installed should be equipped with a safeguard. For example, the control cabinet in which TP04P is installed can be unlocked with a special tool or key.

EN ✗ DO NOT connect AC power to any of I/O terminals, otherwise serious damage may occur. Please check all wiring again before TP04P is powered up. After TP04P is disconnected, Do NOT touch any terminals in a minute. Make sure that the ground terminal ⏚ on TP04P is correctly grounded in order to prevent electromagnetic interference.



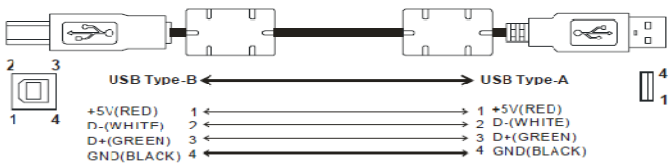
Delta PLC/HMI Cable Selection Guide

Cables for PLC Programming & Serial Communication

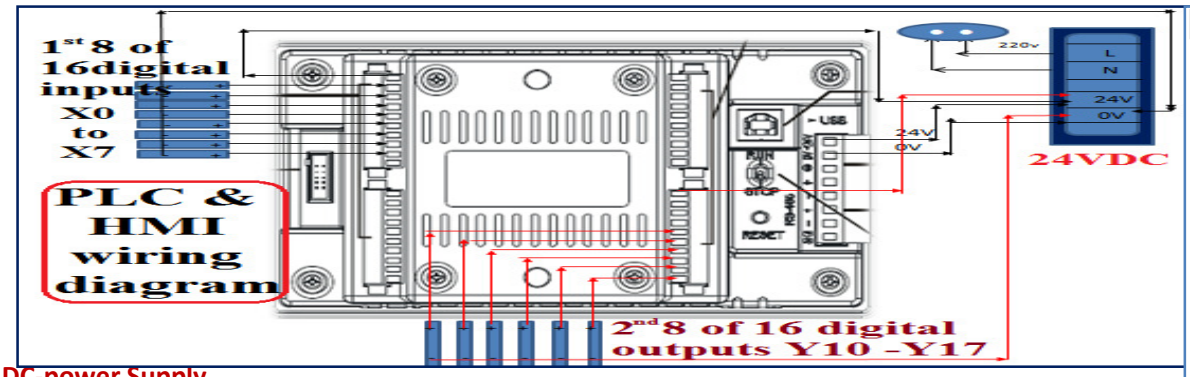


14 USB Type-B	Cable	Machine connected
CPU	USB Type-B ↔ USB Type-A	
TP	UC-PRG015-02A (1.5 m) (Figure 19)	PC
Adapter	UC-PRG030-02A (3 m) (Figure 19)	
	Module/Interface card	

Figure 19	UC-PRG015-02A (1.5 m) UC-PRG030-02A (3 m) UC-PRG050-02A (5M) (only for DOP)	USB Type-B ↔ USB Type-A



◆ Note: UC-PRG050-02A is used for transferring input signals between the interface panel and the controller. The cable is used exclusively for all-electric injection molding machines.



I/O Configuration
TP04P-32TP1R/T
(16DI/16DO)

(Fig7)

S/S0	C0
X0	Y0
X1	Y1
X2	Y2
X3	Y3
X4	Y4
X5	Y5
X6	Y6
X7	Y7
•	•
S/S1	C1
X10	Y10
X11	Y11
X12	Y12
X13	Y13
X14	Y14
X15	Y15
X16	Y16
X17	Y17

DC-power Supply

Signal Conditioning

The output of the sensors cannot be given directly to the PLC as the input voltage to the PLC should be 24V. Hence they are given through signal conditioning circuits which condition the input signals and in turn give it as an input to the PLC . For safety purposes the input are given directly to the PLC .They are given through relay circuits . The relay consists of 3 terminals-common. NO and NC . the 24V which is to be inputted into the PLC will be available in the common terminal .

▪ Function Specifications

Model / Spec.	TP04P series
PLC program capacity	8k steps
Screen type/Display color	STN-LCD/Monochromatic
Driver	Delta automation products
Function/Numeric keys	0~9, ESC, F, Enter and Up/Down/Left/Right keys
Alarm LED indicator (Red)	Power indication (Blinking for three times)/Communication error alarm/User program indication
Backlight	Automatically turning off the backlight: 1~99 minutes (0: The backlight is not turned off.) (The life span of the backlight is about 50,000 hours at a temperature of 25°C)
Contrast adjustment	Set by software, 10 levels of adjustment
Language/Font	ASCII: (Code page 850) Alphanumeric code (including European characters) Taiwan: Traditional Chinese fonts China: Simplified Chinese fonts
Resolution	192 × 64 dots
Display range	101.8 mm (W) × 35.24 mm (H); 4.1" (diagonal)
Font size	ASCII: 5 × 8, 8 × 8, 8 × 12, 8 × 16
Display text	5×8 dots: 38 characters × 8 rows | 8×12 dots: 24 characters × 5 rows 8×8 dots: 24 characters × 8 rows | 8×16 dots: 24 characters × 4 rows
Program upload/download communication port USB (COM1)	Transmission method: Virtual communication port Data length: 7 or 8 bits, Stop bits: 1 or 2 bits, Parity: None/Odd/Even Baud rate: 9,600 bps~115,200 bps USB: USB (Type B) terminal
Extension communication port RS485 (COM2) RS485 (COM3)	Asynchronous transmission method: RS-485 Data length: 7 or 8 bits, Stop bits: 1 or 2 bits, Parity: None/Odd/Even Baud rate: 9,600 bps~115,200 bps RS-485: 8 PIN-removable terminal block
Download & Monitoring method	Download program to TP through virtual COM port

Model / Spec.	TP04P series
Extension interface	Slot for a program copy card
Panel components	**Description**
Alarm LED indicator (Red)	Status 1: when turning on the power, this LED will start blinking slowly and when the power is ON, this LED will be off. Status 2: when the user-defined conditions are met, LED will blink every 1 second along with an alarm sound.
Power LED indicator (Green)	When the power is ON, this LED will be ON.
Display area	LCD module; it is used to display current program status.
Numeric keys	Keys 0~9 can be used for inputting constants. Users can also define the keys by themselves.
Function keys	Users can define the keys.
Enter key (ENT)	If the input value is correct, press the key to confirm the setting. Users can define the key in the user page.
Arrow keys	Up: for increasing the setting value or go to the previous page Down: for decreasing the setting value or go the next page Left/Right: for selecting the position of the setting value Users can redefine functions of the arrow keys in the user page.

Ladder Diagram " ISPsoft " In This project we used ISPsoft to be the ladder diagram program used .

ISPSoft V2.0 Highly Accessible Programming Software

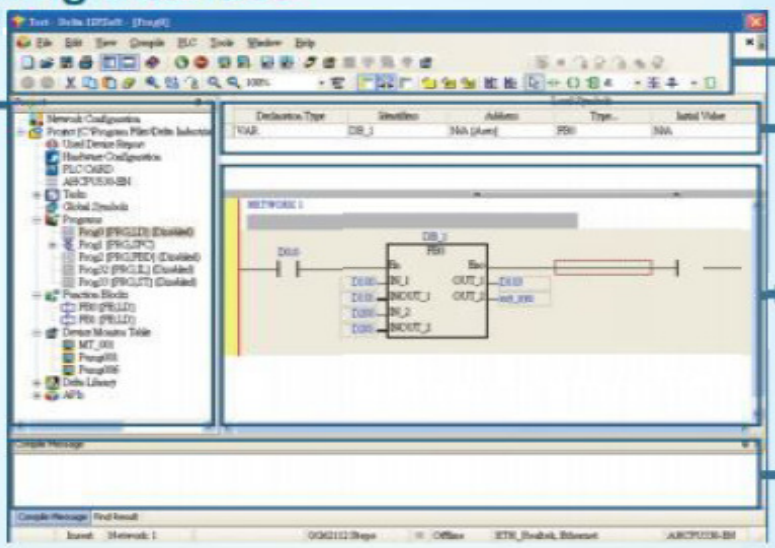
Fully Integrated Interface

Advanced Programming Interface + Visualized Hardware Configuration + Simplified Network Configuration

Advanced Programming Interface

Project Management Window

- **New functions:** Network configuration, hardware configuration and PLC card
- Supports 5 programming languages (LD/FBD/SFC/IL/ST)
- **Function Blocks:** Symbols can be introduced in call-by-value or call-by-reference types. Function blocks can be called in function block for up to 32 levels
- **Monitor Table:** It can be stored and managed separately. Multiple monitor tables can be stored in a single project
- **User Library:** Users can design frequently used instructions for specific applications in different industries
- **Task:** Supports cyclic, I/O interrupt, timer interrupt, external interrupt, etc. Software will provide the usable tasks for different CPU



يوجد 4 برامج إضافية لإستخدام PLC&TextPanel ضمن عمليات شبكة تحكم مركبة ومتقدمة

DELTA_IA-PLC_ISPSoft-V3-02_SW_20160801.zip

3 برامج إضافية مع كتالوجاتها

DELTA_IA-TP_TPEditor-V1-89_SW_20170208.zip

DELTA_IA-PLC_TP-USB-Driver_SW_20150824.zip

DELTA_IA-PLC_COMMGR-V1-07_SW_20161214.zip

DELTA_IA-PLC_ISPSoft_UM_EN_20160518.pdf كتالوج البرنامج الأساسى

Delta_WPLSoft_V2.30.zip برنامج رابع إضافى مع الوحدة

كل البرامج مع كتالوجاتها موجودة على موقع معمل التحكم الأوتوماتيكى ACC

We must install USB-driver for TP-data cable in order to do communications between PLC & PC

Details of all Inputs and Outputs of the Training Kit

All 16 PLC Input signals

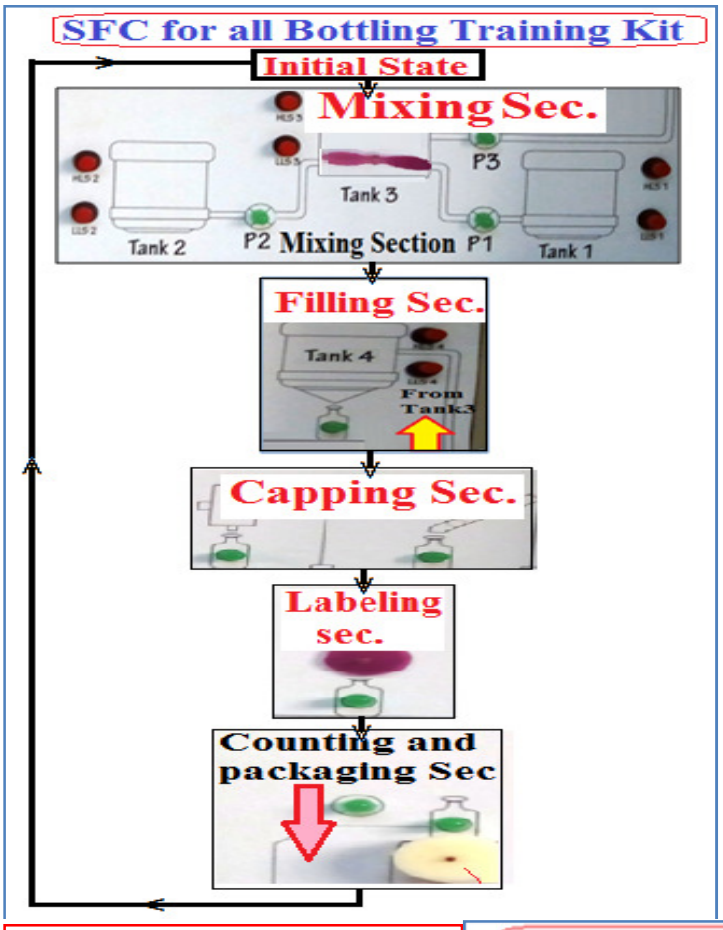
X0 start
X1 stop
X6 HLS1 : high level sensor one
X12 LLS1 : low level sensor one
X7 HLS2 : high level sensor two
X13 LLS2 : low level sensor two
X10 HLS3 : high level sensor three
X14 LLS3 : low level sensor three
X11 HLS 4 : high level sensor four
X15 LLS 4 : low level sensor four
X2 B1 : photoelectric sensor one
X3 B2 : photoelectric sensor two
X4 B3 : photoelectric sensor three
X5 B4 : photoelectric sensor four
X16 B5 : photoelectric sensor five
X17 Thermo sensor TTs (in fire case)

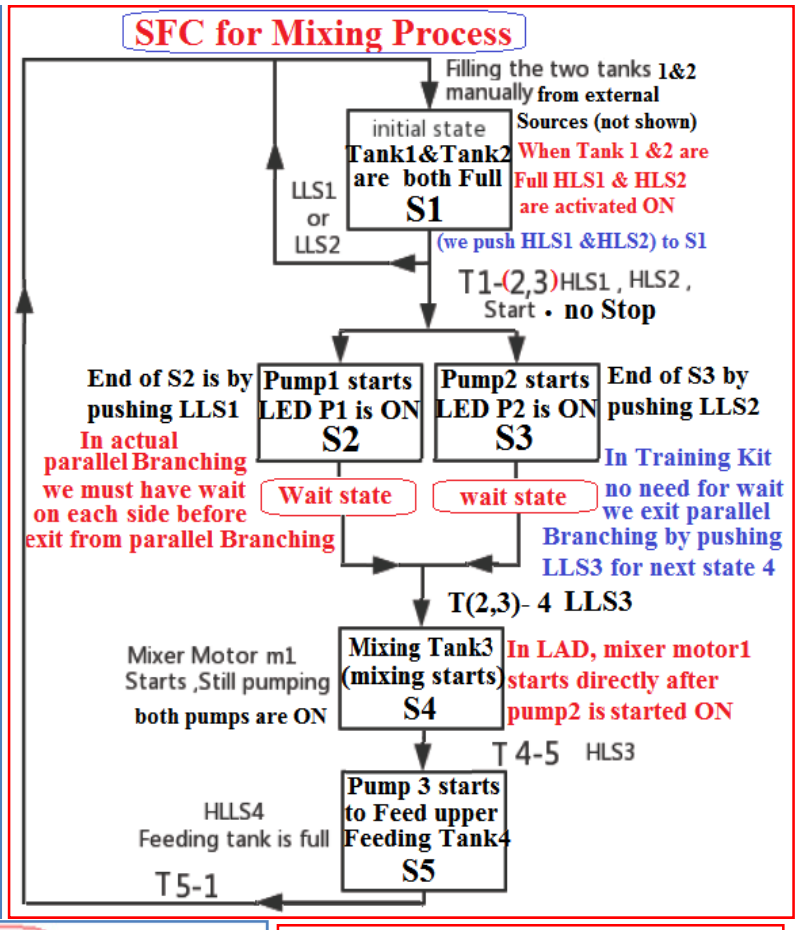
All 16 PLC Output signals

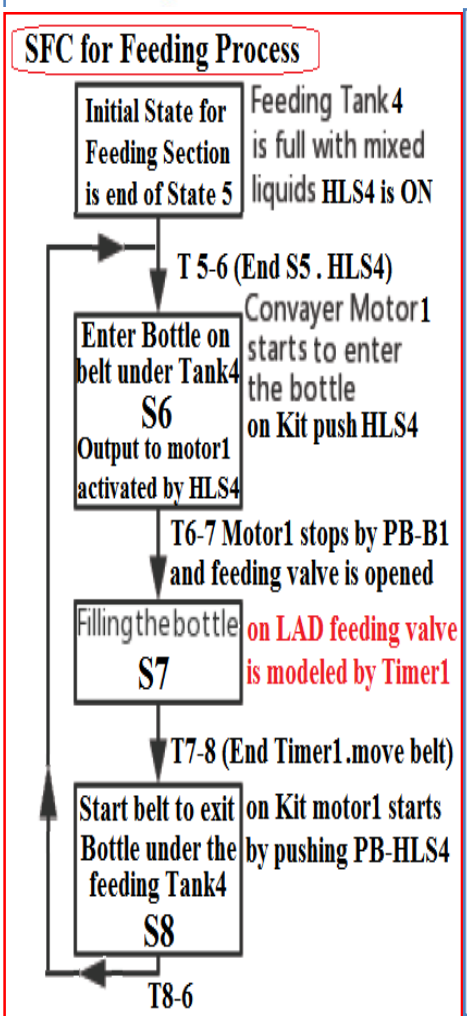
Y0 P1 : pump 1 **LED**
Y1 P2 : pump 2 **LED**
Y2 P3 : pump 3 **LED**
Y3 M1 : motor one (mixing motor)
Y4 M2 : motor two (belt Motor)
Y5 M3 : motor three (labeling motor)
Y6 M4 : motor four (labeling motor)
Y7 M5 : motor five (packing motor)
Y10 V1 : valve **LED**
Y13 Buzzer (real sound)
Y11 Display **LED** for the Buzzer
Y12 Led of capping process,**Cap**
Y14 Led of labeling process
Y15 led of start pushbutton
Y16 led of stop pushbutton
Y17 led of thermo sensor

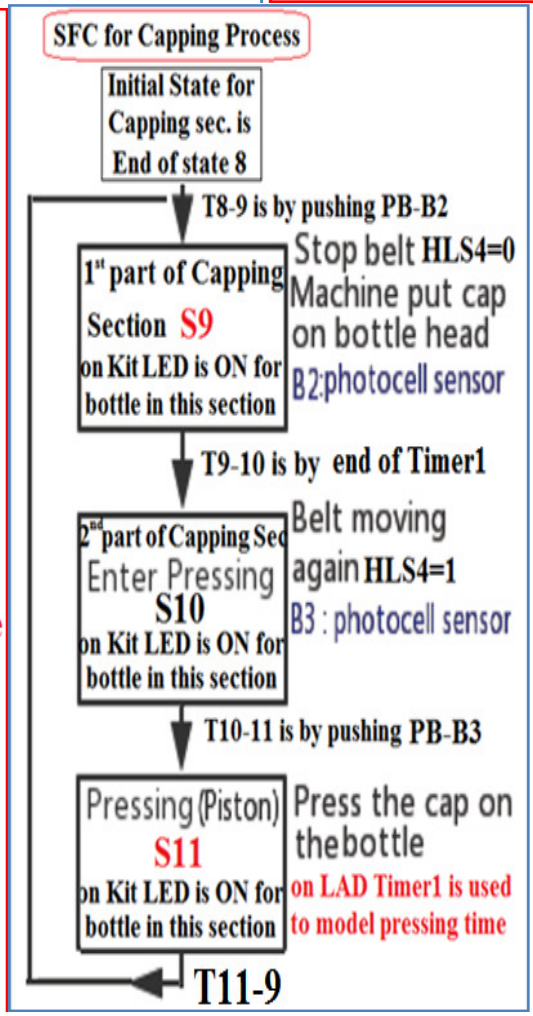
Relays used for Transitions & States in the LAD

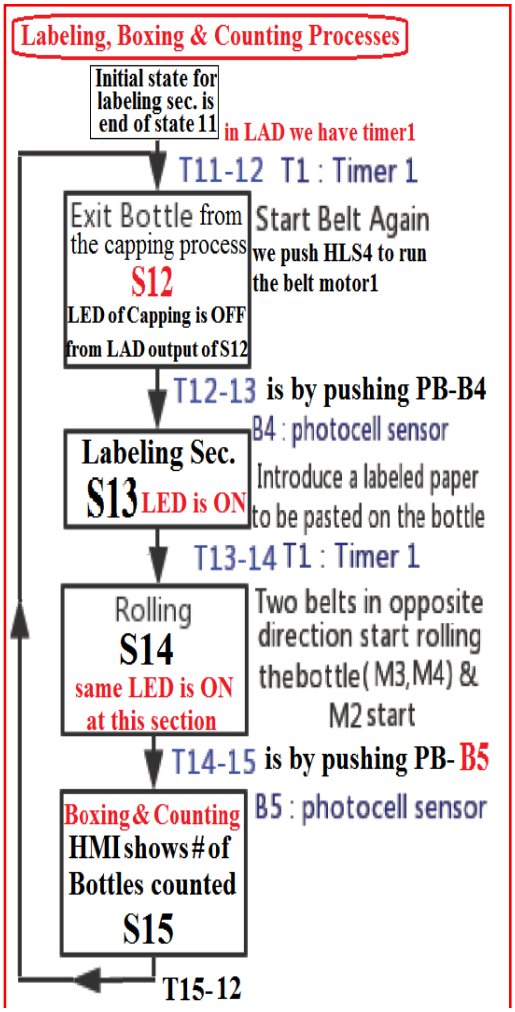
Identifiers	Addres	Identifiers	Addres	Identifiers	Addres
cc	C0	SS8	M23	T1011	M39
start_enab	M0	TT56	M24	ss3	M4
ss1	M1	TT67	M26	T1112	M40
hs1	M10	TT78	M27	T1213	M41
hs2	M11	TT89	M28	T1314	M42
hs3	M12	SS9	M29	T1415	M43
hs4	M13	SS10	M30	TT151	M44
LS1	M14	SS11	M31	ss4	M5
LS2	M15	SS12	M32	ss5	M6
LS3	M16	SS13	M33	T1_23	M7
LS4	M17	SS14	M34	T23_4	M8
SSTOP	M18	SS16	M35	TT45	M9
ss2	M2	SS15	M36	timer1	T1
SS6	M20	SS17	M37	timer2	T2
SS7	M21	T910	M38		


SFC for all Bottling Training Kit
Initial State
Mixing Sec.
Tank 3
P3
Tank 2
P2 Mixing Section P1
Tank 1
Filling Sec.
Tank 4
From Tank3
Capping Sec.
Labeling sec.
Counting and packaging Sec


SFC for Mixing Process
Filling the two tanks 1&2 manually from external Sources (not shown)
initial state
Tank1&Tank2 are both Full
S1
When Tank 1 &2 are Full HLS1 & HLS2 are activated ON
LLS1 or LLS2
(we push HLS1 &HLS2) to S1
T1-(2,3) HLS1 , HLS2 , Start • no Stop
End of S2 is by pushing LLS1
Pump1 starts LED P1 is ON
S2
Pump2 starts LED P2 is ON
S3
End of S3 by pushing LLS2
In actual parallel Branching we must have wait on each side before exit from parallel Branching
Wait state
wait state
In Training Kit no need for wait we exit parallel Branching by pushing LLS3 for next state 4
T(2,3)- 4 LLS3
Mixer Motor m1 Starts ,Still pumping both pumps are ON
Mixing Tank3 (mixing starts)
S4
In LAD, mixer motor1 starts directly after pump2 is started ON
T 4-5 HLS3
HLLS4 Feeding tank is full
Pump 3 starts to Feed upper Feeding Tank4
S5
T 5-1


SFC for Feeding Process
Initial State for Feeding Section is end of State 5
Feeding Tank4 is full with mixed liquids HLS4 is ON
T 5-6 (End S5 . HLS4)
Enter Bottle on belt under Tank4
S6
Output to motor1 activated by HLS4
Convayer Motor1 starts to enter the bottle on Kit push HLS4
T6-7 Motor1 stops by PB-B1 and feeding valve is opened
Filling the bottle
S7
on LAD feeding valve is modeled by Timer1
T7-8 (End Timer1.move belt)
Start belt to exit Bottle under the feeding Tank4
S8
on Kit motor1 starts by pushing PB-HLS4
T8-6


SFC for Capping Process
Initial State for Capping sec. is End of state 8
T8-9 is by pushing PB-B2
1st part of Capping Section S9
on Kit LED is ON for bottle in this section
Stop belt HLS4=0 Machine put cap on bottle head
B2:photocell sensor
T9-10 is by end of Timer1
2nd part of Capping Sec Enter Pressing
S10
on Kit LED is ON for bottle in this section
Belt moving again HLS4=1
B3 : photocell sensor
T10-11 is by pushing PB-B3
Pressing (Piston)
S11
on Kit LED is ON for bottle in this section
Press the cap on the bottle
on LAD Timer1 is used to model pressing time
T11-9


Labeling, Boxing & Counting Processes
Initial state for labeling sec. is end of state 11
in LAD we have timer1
T11-12 T1 : Timer 1
Exit Bottle from the capping process
S12
LED of Capping is OFF from LAD output of S12
Start Belt Again we push HLS4 to run the belt motor1
T12-13 is by pushing PB-B4
B4 : photocell sensor
Labeling Sec.
S13 LED is ON
Introduce a labeled paper to be pasted on the bottle
T13-14 T1 : Timer 1
Rolling
S14
same LED is ON at this section
Two belts in opposite direction start rolling the bottle(M3,M4) & M2 start
T14-15 is by pushing PB- B5
Boxing & Counting
HMI shows # of Bottles counted
S15
B5 : photocell sensor
T15-12

Steps to run all the process of Bottling Production Line

- To start all processes push on start pushbutton

- filling the two tanks (tank 1 and 2) manually to HLS1 and HLS2 and make sure all the pumps does not work

- when the HLS1 and HLS2 activated by push on HLS1 pushbutton and HLS2 pushbutton the two pumps (P1 , P2) start to work(the leds will light up) and filling the mixing tank

- when the LLS3 activated by push on it the mixing motor (M1) will start to work and the two pumps still working

- when the HLS3 activated by push on it the P1 , P2 and M1 will stop

- then the pump three (P3)(led will lights up) will start to send the liquid to the feeding tank

- when the HLS 4 in the feeding tank activated by push on it the P3 will stop

- then the conveyer motor M2 will work and first bottle enters to the filling process

- when the photo sensor (B1) activated by push on it the M2 will stop and the bottle will stop under the feeding tank and the valve will (V1) open and fill the bottle for time (T1)

- when T1 ended the M2 will work and the bottle will move to the capping process

- when the B2 activated by push on it the M2 will stop and the bottle stop under the capping machine for the same time T1

- when T1 ended the M2 will work again and the bottle will move to the next process

- when B3 activated by push on the M2 will stop and the bottle will stop under the piston and will compress the cap on the bottle and will wait for T1

- when the T1 will ended the M2 will work and the bottle will move to the labeling process

- when B4 activated by push on the labeling motors M3 , M4 will start to work

- the label will stick on the bottle

- the M3 and M4 will drive a belt to press on the label

- when the B5 activated by push on the led will lights up and show on the front panal (HMI) counter number of passes bottles

- at the end the bottle fall on the box

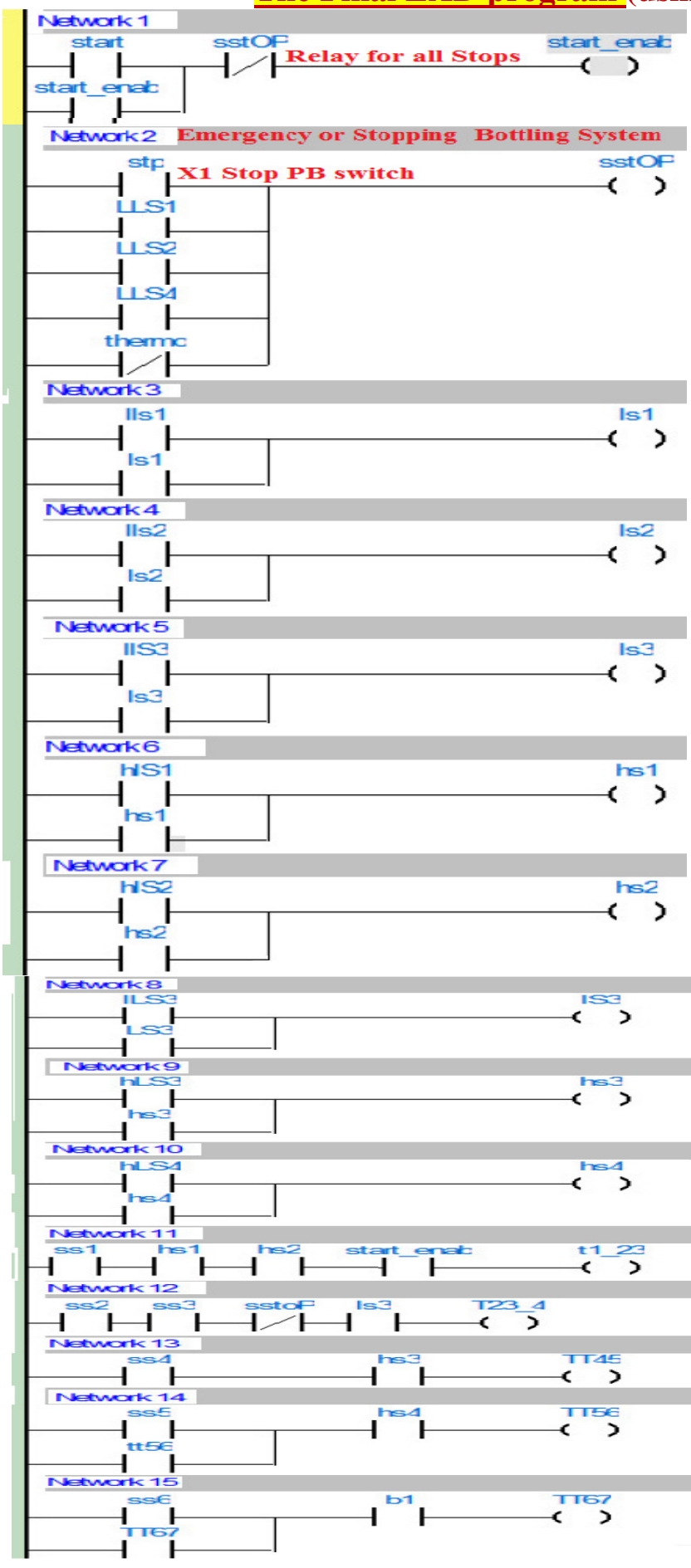
- when the number of passes bottles reach to 6 the M5 will drive a belt and another box enters to hold the bottles

- when fire happens the thermo sensor send a signal to the buzzer and the led will lights up and the all processes will stop

- when the LLS 1 and LLS2 and LLS3 activated by push on one of them the all processes will stop

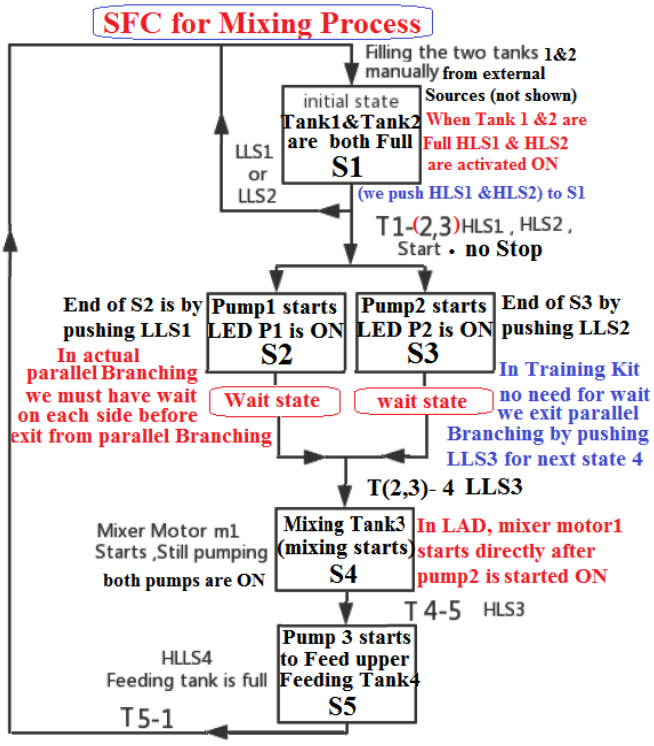
when push on the stop pushbutton the all processes will stop

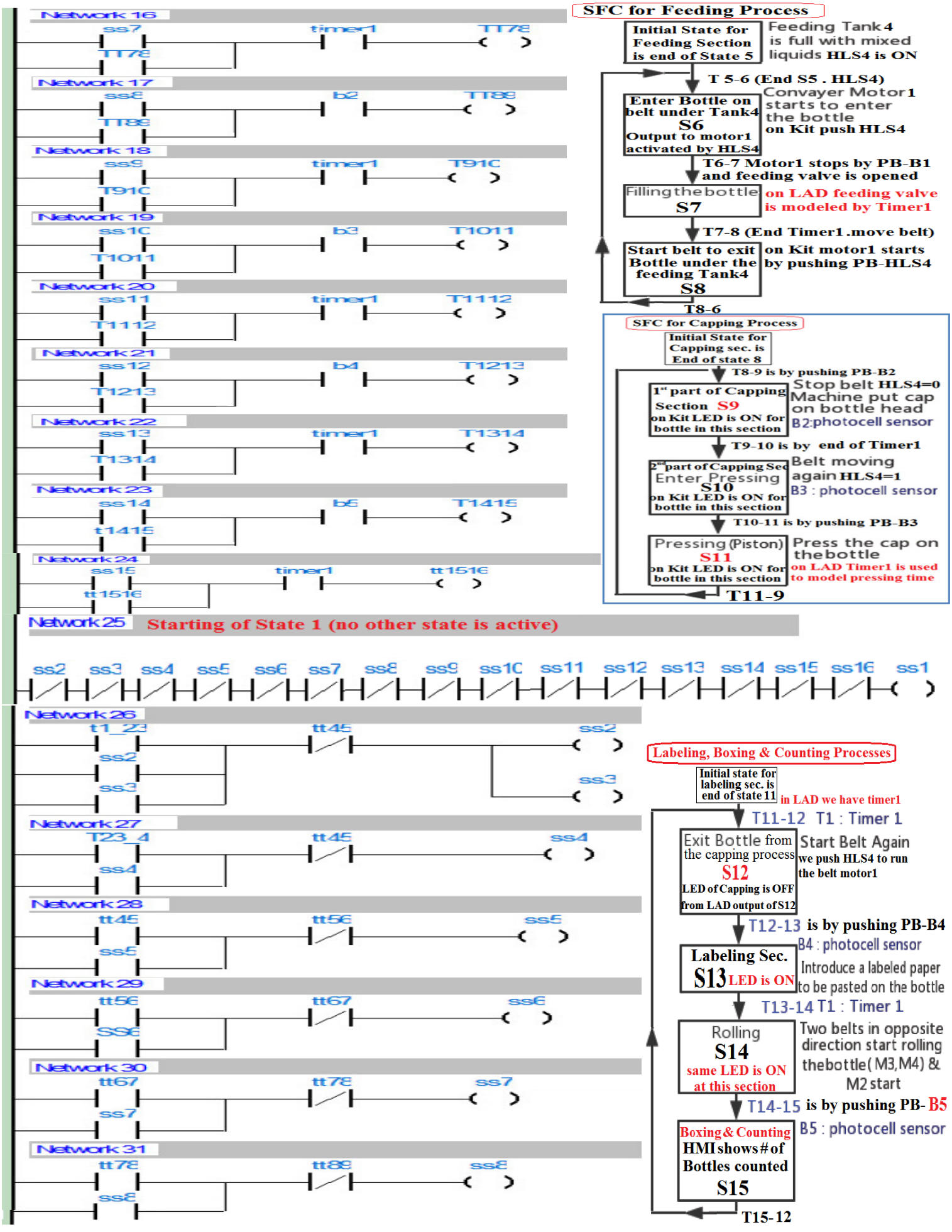
The Final LAD program (using ISP Software V3.02)



Variable	Address	Variable	Address
cc	CO_COUNTER	start	X0
start_enab	M0	stp	X1
ss1	M1	HLS3	X10
hs1	M10	HLS4	X11
hs2	M11	LLS1	X12
hs3	M12	LLS2	X13
hs4	M13	LLS3	X14
LS1	M14	LLS4	X15
LS2	M15	b5	X16
LS3	M16	Thermo	X17
LS4	M17	b1	X2
SSTOP	M18	b2	X3
ss2	M2	b3	X4
SS6	M20	b4	X5
SS7	M21	HLS1	X6
SS8	M23	HLS2	X7
TT56	M24	pump1	Y0
TT67	M26	pump2	Y1
TT78	M27	valve	Y10
TT89	M28	diaplay	Y11
SS9	M29	cap	Y12
SS10	M30	startLed	Y13
SS11	M31	stopLed	Y14
SS12	M32	thermoLED	Y15
SS13	M33	Bazzer	Y16
SS14	M34	Pack	Y17
SS16	M35	pump3	Y2
SS15	M36	motor1	Y3
SS17	M37	motor2	Y4
T910	M38	motor3	Y5
T1011	M39	motor4	Y6
ss3	M4	piston	Y7
T1112	M40		
T1213	M41		
T1314	M42		
T1415	M43		
TT1516	M44		
ss4	M5		
ss5	M6		
T1_23	M7		
T23_4	M8		
TT45	M9		
timer1	T1		
timer2	T2		
packingTimer	T3		

SFC for Mixing Process




Network 16
ss7
TT7E
timer1
TT7E
Network 17
ss8
TT8E
b2
TT8E
Network 18
ss9
T91C
timer1
T91C
Network 19
ss1C
T1011
b3
T1011
Network 20
ss11
T1112
timer1
T1112
Network 21
ss12
T1213
b4
T1213
Network 22
ss13
T1314
timer1
T1314
Network 23
ss14
t1415
b5
T1415
Network 24
ss15
tt1516
timer1
tt1516
SFC for Feeding Process
Initial State for Feeding Section is end of State 5
Feeding Tank 4 is full with mixed liquids HLS4 is ON
T 5-6 (End S5 . HLS4)
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1" part of Capping Section S9
on Kit LED is ON for bottle in this section
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B2:photocell sensor
T9-10 is by end of Timer1
2"part of Capping Sec
Enter Pressing
S10
on Kit LED is ON for bottle in this section
Belt moving again HLS4=1
B3 : photocell sensor
T10-11 is by pushing PB-B3
Pressing (Piston)
S11
on Kit LED is ON for bottle in this section
Press the cap on the bottle
on LAD Timer1 is used to model pressing time
T11-9
Network 25
Starting of State 1 (no other state is active)
ss2 ss3 ss4 ss5 ss6 ss7 ss8 ss9 ss1C ss11 ss12 ss13 ss14 ss15 ss16 ss1
Network 26
t1_23
ss2
ss3
tt45
ss2
ss3
Network 27
T23_4
ss4
tt45
ss4
Network 28
tt45
ss5
tt56
ss5
Network 29
tt56
SS6
tt67
ss6
Network 30
tt67
ss7
tt7E
ss7
Network 31
tt7E
ss8
tt8E
ss8
Labeling, Boxing & Counting Processes
Initial state for labeling sec. is end of state 11
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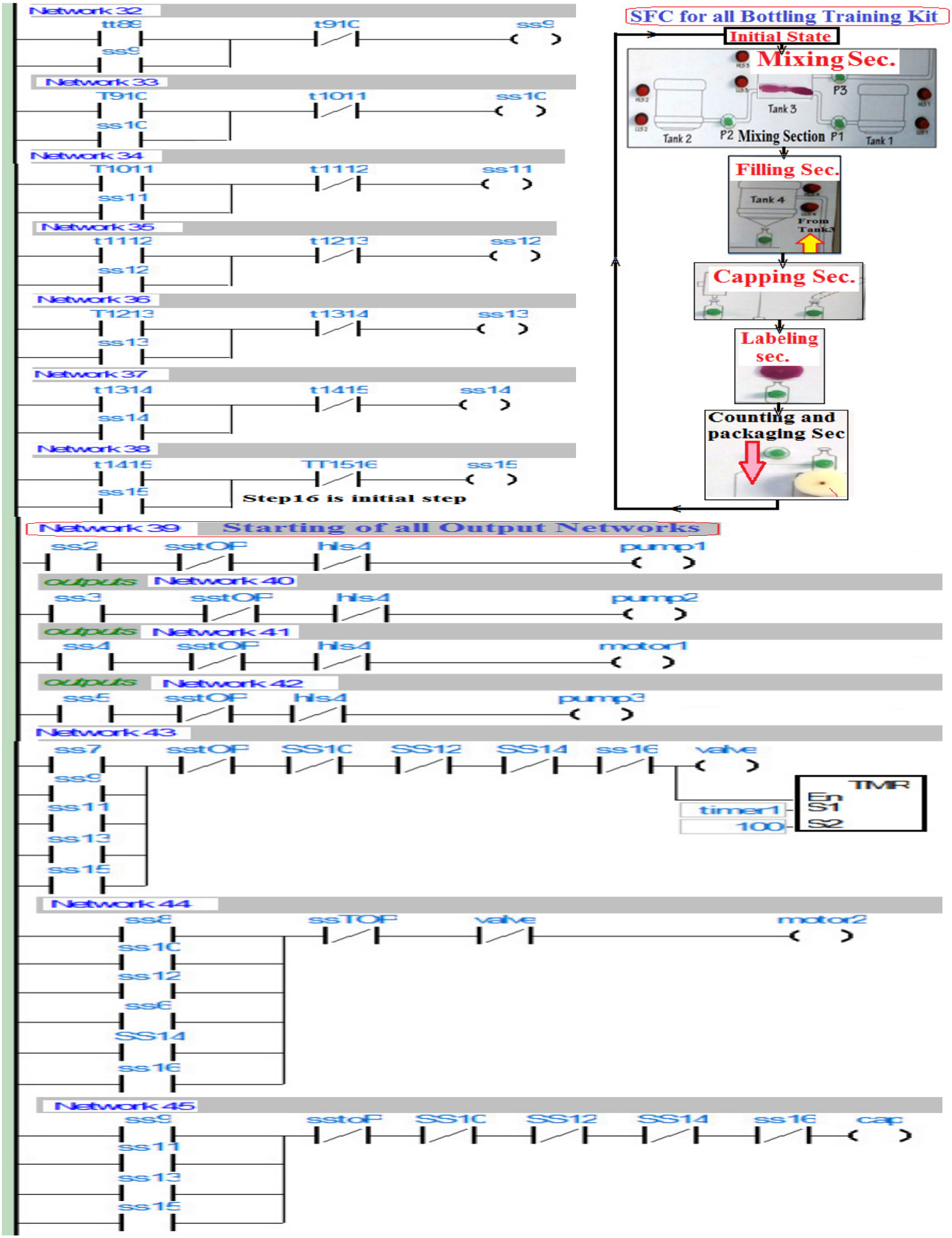
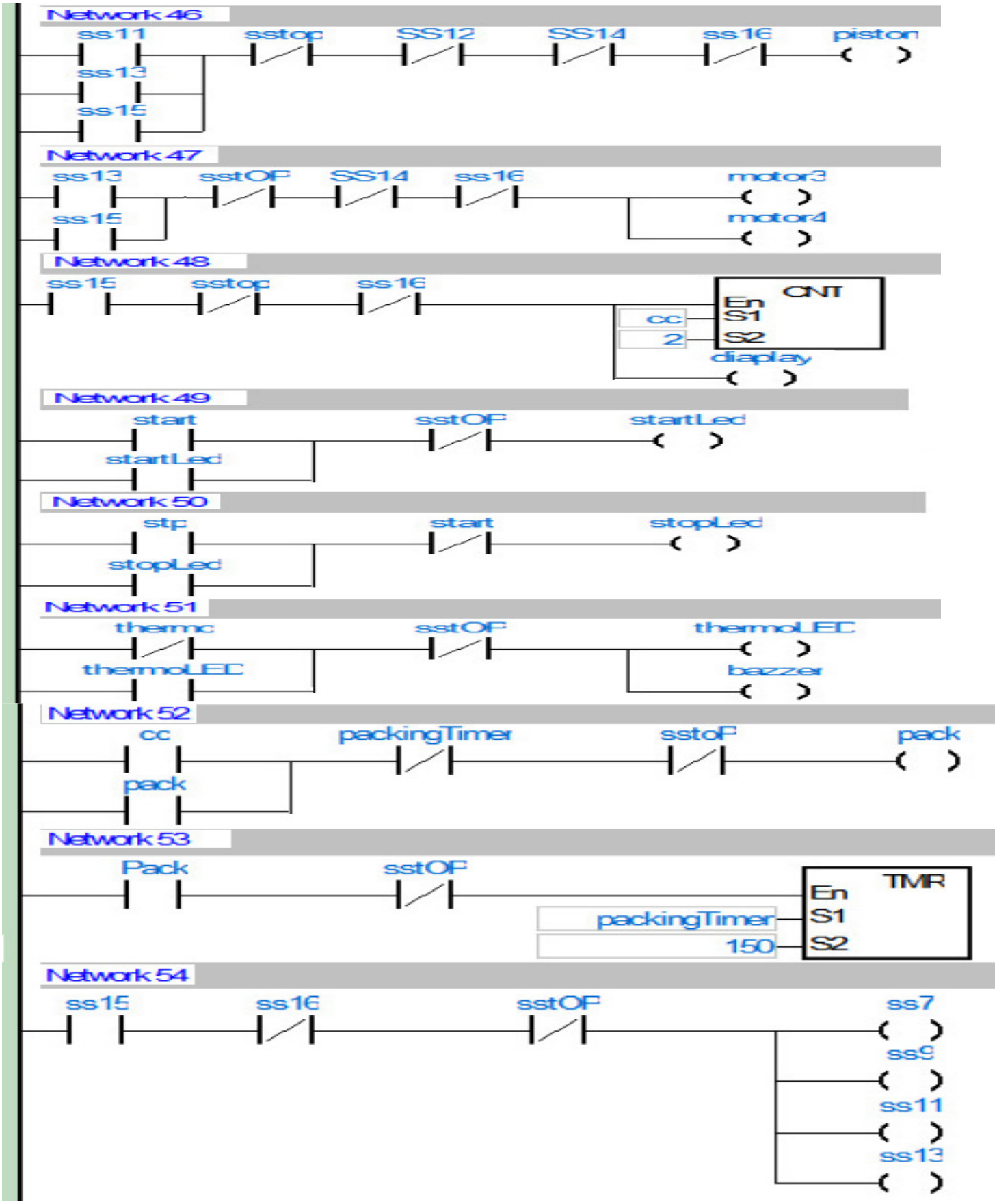
HMI shows # of Bottles counted
S15
B5 : photocell sensor
T15-12


Network 32
tt88
ss9
t91C
ss9
Network 33
T91C
ss1C
t1011
ss1C
Network 34
T1011
ss11
t1112
ss11
Network 35
t1112
ss12
t1213
ss12
Network 36
T1213
ss13
t1314
ss13
Network 37
t1314
ss14
t1415
ss14
Network 38
t1415
ss15
TT1516
ss15
Step16 is initial step
SFC for all Bottling Training Kit
Initial State
Mixing Sec.
Tank 3
P3
Tank 2
P2 Mixing Section P1
Tank 1
Filling Sec.
Tank 4
From Tank3
Capping Sec.
Labeling sec.
Counting and packaging Sec
Network 39
Starting of all Output Networks
ss2
sstOF
Hls4
pump1
outputs
Network 40
ss3
sstOF
Hls4
pump2
outputs
Network 41
ss4
sstOF
Hls4
motor1
outputs
Network 42
ss5
sstOF
Hls4
pump3
Network 43
ss7
sstOF
SS1C
SS12
SS14
ss16
valve
ss9
ss11
ss13
ss15
timer1
100
TMR
En
S1
S2
Network 44
ss8
ssTOF
valve
motor2
ss1C
ss12
ss6
SS14
ss16
Network 45
ss9
sstoF
SS1C
SS12
SS14
ss16
cap
ss11
ss13
ss15



End of LAD diagram

Modifications& Recommendations for Future Work

The main objective of this paper was to develop a bottling filling and packing system based on certain specifications. This is was successfully implemented. We consider this paper a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report .

We have a future vision we can apply to this project as a part of progress and technologies application to the production line system .

Trouble Shooting of the Kit

1) if any bottle not entrance or there is no next bottle during the system working , the sensor B1 has not signal and the filling valve stop

2) if the bottle has not complete liquid , there is a sensor to detect this case and then the horizontal piston get rid of it out of the belt

3) if the bottle is not capped there is a sensor with capping piston stop the piston motion and the horizontal piston push this bottle out of system

4) if there is a fire in a system place or in the line , the thermo sensor detect it and shut off the system

5)if the labeling paper is finished , the buzzer gives alarm sound to quickly replace the new one

Multi-Mixing Technique

Although proposed system illustrates the mixing process of two liquids , any number of liquids may be mixed in varying portions as we can use more than two tanks with other portions of liquids .

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