DEVELOPMENT OF SUPERVISORY CONTROL FOR LUBRICANT BLENDING PROCESS USING PLC

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ELECTRICAL & ELECTRONIC ENGINEERING

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Dissertation Report submitted in partial fulfillment
of the requirement for the
Bachelor of Engineering (Hons) Electrical and Electronics

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CERTIFICATION OF APPROVAL

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TRONOH, PERAK
December 2011

CERTIFICATION OF ORIGINALITY

This is to testify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and the original work contained here have not undertaken or done by unspecified sources or persons.

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(Khairom Mustaqim Baharom)

ABSTRACT

This project is focused on the development of PLC supervisory control system to control and remotely monitor a batch blending process in lubricant blending plant. Object Linking and Embedding for Process Control (OPC) is used as a standard interface between PLC and LabVIEW's remote monitoring tool. The interface used Microsoft's Component Object Model (COM) to interact and permit a protocol for real-time information exchange between LabVIEW and PLC via a RS-232 serial cable. The aim of this project is to create a reliable remote monitoring system with user-friendly interface. The supervisory control system can improve plant's operation efficiency by providing the overview process and control capability from the monitor inside control room. It also helps to reduce risk inside plant as operator can have their job done remotely inside control room. Furthermore, this project offers an alternative and cheaper supervisory solution for batch processes compared to distributed control system (DCS).

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LIST OF ABBREVIATIONS

COM..Component Object Model
GUI..Graphical User Interface
HMI.. Human Machine Interface
HR.. Holding Relay
LabVIEW..................... Laboratory for Virtual Instruments Engineering Workbench
I/O..Input/output
NI..National Instruments
OLE..Object Linking and Embedding
OPC.. OLE for Process Control
PC.. Personal Computer
PLC.. Programmable Logic Controller
UI.. User Interface

CHAPTER 1

INTRODUCTION

1.1 Background Of Study

Lubetech Sdn Bhd is a lubricant blending plant located in Shah Alam. Its operation covers blending various grades of lubricant inside blending kettles by batch. This plant operated semi-automatically using Programmable Logic Controller (PLC) without supervisory control software.

This project will focus on development of PLC remote monitoring for lubricant blending process plant. PLC is an industrial computer used for automation processes. This controller has the ability to interact with digital and analog devices and was also designed to withstand industrial environment such as extreme temperature, excessive vibration, electrical noise and impact. This project utilized the OMRON CQM1H CPU21 PLC as a controller for the plant due to the availability of the hardware.

Various methods can be use to communicate between PLC and the host-computer such as 9-pin RS-232 serial connector, EIA-485 serial connector and RJ-45 modular connector. This project will concentrate on RS-232 serial connection port to communicate with LabVIEW remote monitoring application using Object Linking and Embedding for Process Control (OPC) protocol.

1.2 Problem Statement

In Lubetech plant, PLC was used as an interlocking system for quality control and safety procedure. An interlocking system in Lubetech prevents different grades of lubricant from mixing up during transferring and blending process. Before transferring process started, Lubetech personnel have to travel inside the plant, check the specific hand valve opening and manually open or close the valves accordingly. Transferring process will only be started if the correct valves are opened and closed.

1.3 Problem Identification

The routine activity of Lubetech personnel manually checking and open/close valve will cause delay time before transferring and blending process can start. In addition, they are exposed to loud noises, chemical fumes and many more hazards inside plant. The remote monitoring can provide remote access for personnel to open/close valves without exposing themselves to these hazards. Furthermore, supervising and controlling valve in remote room can save time.

1.4 Objective & Scope of Study

The objectives of this project are:

i. To develop supervisory control for lubricant blending process.
ii. To communicate PLC with LabVIEW supervisory control.
iii. To reduce time delay of lubricant transferring process.

The scope of study of this project will be supervisory control for lubricant blending process using PLC. This project is unique to lubricant blending process for UMW Lubetech Sdn Bhd. OMRON CQM1H CPU21 PLC is chosen as a controller for the plant due to the availability of the hardware.

Beside that, LabVIEW software will be used to create the remote monitoring interface. LabVIEW commonly use for data acquisition, instrument control, and automation in industry will be used to develop user graphical interface (GUI) for PLC supervisory control.

CHAPTER 2

LITERATURE REVIEW

Lubricant business nowadays expanding swiftly aided by rapid industrialization and rising car ownership rate. Green Planet Group reported that global lubricant demand is forecast to reach 40.5 million metric tons in 2012 (Green Planet Group, 2011). In this case, automation process that plays an important role in lubricant manufacturing process should be advancing as well.

2.1 Programmable Logic Controller

A programmable logic controller (PLC) is an industrial computer that uses programmable memory to store instructions and to implement specific functions such as logic, sequencing, timing, counting and arithmetic in order to control machines or processes (National Electrical Manufacturers Association, 2005). It has been developed since 1960s and initially it was used to replace hard-wired relay control logic system. Nowadays, PLC is widely used in factories and industries to handle their automated system because of its reliability, flexibility and robust design for industrial environment.

Basic component of PLC consist of Central Processing Unit (CPU), power supply unit, memory and input/output modules.

The CPU executes program instructions and handles the interaction with other component of the system. CPU can be configured either in program mode or run mode. In program mode, user program can be uploaded into the PLC and if all input and output signals are wired to the PLC terminals, the CPU can be put in run mode to start scanning and executing ladder logic continuously.

Power supply of the PLC distributes various ranges of AC and DC voltages to CPU and PLC components. Usually, power supply does not provide power to external devices connected to PLC. Separate power supplies are needed to power the external inputs and outputs (Stenerson, 2003). However, some small-sized PLC does have internal supply power to power up the inputs.

The memory unit of PLC stores control actions of controller and input data for processing and for the output.

The input/output (I/O) modules are where the PLC received signal from external devices and send instruction to external devices (Bolton, 2009). Common input devices are switches and sensors while the output devices can be motor starter, lights, coils and valves. Beside received and transmit signal to external devices, I/O modules also help to protect and isolate CPU from outside world. This is typically done by optical isolation. The PLC CPU and external devices are not connected literally, means that there is no electrical connection between the two (Stenerson, 2003). The CPU and external devices are separated optically. When triggered, input devices will send signal that turns on the light inside input module, and the receiver will capture the light. Receiver will turns on and send signal to the CPU to be processed.

2.2 Ladder Logic Programming

Ladder diagram is one of the common methods to program PLC for industrial automation. Engineers, technicians and maintenance electricians will use the programming language of a PLC. Therefore, the programming language should be based on techniques used in industry rather than technique used in computer programming (Parr, 2003). This programming method resembles a ladder, with two vertical lines called power rails connected by a horizontal line called *rung*. The term *rung* is invariably applied to the contacts leading to one output (Parr, 2003). Each rung must starts with at least one input and ends with at least one output.

The input of the PLC in ladder diagram is called contact (relay contact) while the output is called coil (relay coil). The input can be normally open (NO) or normally closed (NC) based on user configuration. A NO input is representing open switch at initial condition and will be close if external force was applied. A NC input is representing closed switch at initial condition and will be open if external force was applied.

In the run mode, ladder diagram is read from left to right of the rung and from top to bottom of the ladder. When all the rungs are scanned and reached end rung, the PLC will go back to the first rung and repeat the process. This procedure of going through all rungs is termed as a cycle (Bolton, 2009).

2.3 Supervisory Control

Human Machine Interaction (HMI) is defines as the study of interaction between people and computers (Lalanne & Kohlas, 2009). For this supervisory control project, HMI is implemented between PLC and personal computer (PC). User will have complete access to the PLC inputs and can control the instruments connected to PLC through graphical user interface (GUI).

To support the interoperability of supervisory control software (GUI) with hardware (PLC), Object Linking and Embedding for Process Control (OPC) Server, based on the Microsoft's component object model (COM) is used. COM allows two or more components to pass request and data with one another easily even if the components are written in different programming languages and running on different machines (Sherlock & Cronin, 2000) (Endi, Elhalwagy, & Hashad, 2010).

Object Linking and Embedding (OLE) 1.0 was developed by Microsoft© in 1990, replacing dynamic data exchange (DDE) (Ferguson, 2009). OLE allows embedding and linking of documents. HMI allow user to control and monitor PLC process remotely. By linking the PLC data with personal computer (PC) using Object Linking and Embedding (OLE), user can interact with PLC through interface on PC to give instruction or input.

2.4 Applications and Recent Development

PLC with supervisory control has been implemented into various field of industry such in water treatment plant, water supply distribution, power generation, agriculture and many more (Firoozshasi, 2010) (Jianyan, Lin , & Meiping, 2010) (Chang, Chang, Chou, & Wang, 2010). With supervisory control, PLC can provide a real-time monitoring and control in a remote workstation such as central command room.

In sewage treatment field, PLC has played an important role in their control system (Zhang, Wang , Yan, & Zhang, 2010). The sewage treatment becomes more challenging proportionally with development of a city. This is due to the water pollution problems becomes more serious as the city grow. As well as water treatment in a gas refinery, as the plant growth, the need of good water treatment system at the same time to keep operational costs low is demanding. Water treatment processes are often difficult to handle due to various physical, chemical and biological variables (Firoozshasi, 2010).

PLC based process monitoring and control system for industrial fuel alcohol production process has been implemented in Heilongjiang Hua Run Incorporated (China's largest producer of alcohol) since year 2000 (Qiang, Gao, & Zhuang, 2002). It uses WinCC as HMI host to produce GUI for the PLC. PLC-based monitoring and control implementation has significantly increase profit margin and process reliability of the plant.

In agricultural field of study, supervisory control using PLC also has been widely used to facilitate its automation needs. One example is steam-pretreated process for Agriculture Wasted Reuses (Chang, Chang, Chou, & Wang, 2010). Steam-pretreated process is a technique for the treatment of lignocelluloses raw material. By adapting GUI-based monitoring and control function, the process is significantly cost-effective and provides user friendly and reliable interaction to operators.

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

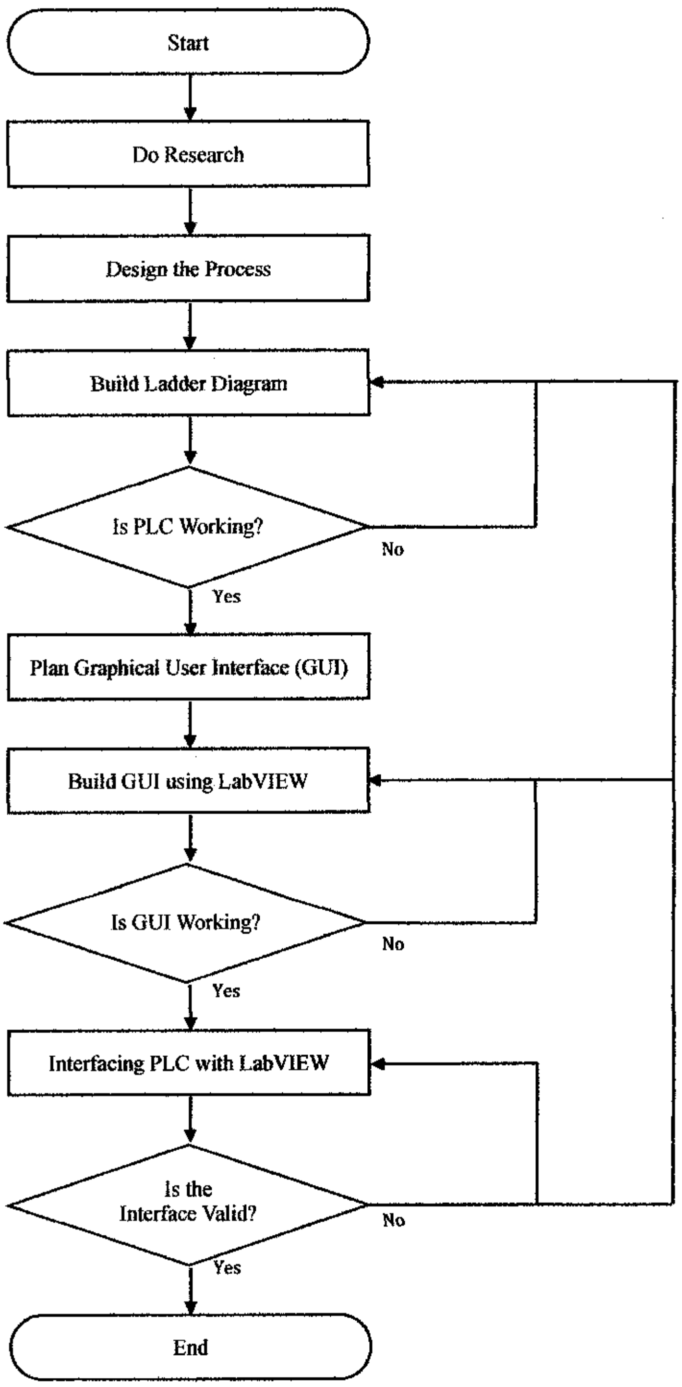

Figure 1: Procedure identification

To conduct this project, preliminary research is done using resources such as library books, technical research journal, and websites. This includes understanding Lubetech process plant, learning the PLC programming language and performing LabVIEW tutorials, which helps understanding the process and software that will be used. After that, lubricant-transferring process will be designed to simulate Lubetech's plant process.

Next step is to construct ladder logic diagram for the process using CX Programmer. This ladder logic diagram is based on the process designed on the previous step. The contacts and coils addressing of the programming is referred to OMRON CQM1H PLC.

After that, a GUI modeled from the Lubetech plant was developed to deliver inputs and receive outputs from PLC. The GUI was built by using G-programming which is consisting of block diagram and front panel elements. The GUI then linked with PLC programming via OPC server and OPC client tool. Finished GUI allows supervisory control for the plant.

Lastly, a series of software development, trial and improvements is made regularly to perfecting the remote monitoring interface by using LabVIEW. The procedure identification for this project is shown in Figure 1.

3.2 Gantt Chart Semester 1

No	Detail/Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Selection of Project Topic								Mid-semester break							
2	Preliminary Research Work															
3	Developing ladder programming						√									
4	Test programming on hardware (PLC)															
5	Developing Graphical User Interface (GUI)															
6	Test the GUI validity														√	
7	Submission of Interim Report															√

√ Milestone

Process

3.3 Gantt Chart Semester 2

No	Detail/Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14	15
1	Interfacing PLC with GUI	■	■	■	■	■			Mid-semester break								
2	Verify GUI validity with PLC program					V											
3	Modification and add value to project						■	■		■	■	■					
4	Pre-EDX												V				
5	Submission of Draft Report													V			
6	Submission of Dissertation (Soft Bound)														V		
7	Submission of Technical paper														V		
6	Oral Presentation															V	
7	Submission of Project Dissertation																V

V	Milestone
■	Process

3.4 OPC Linking Procedure

Before developing the GUI, linkage between PLC and LabVIEW need to be tested in order to validate its connectivity through NI OPC server. To make PLC able to receive signal from software button, the input addresses from ladder logic diagram must be in HR, which is a "software" relay. Figure 2 shows a simple ladder program that was used to test the PLC and LabVIEW connectivity.

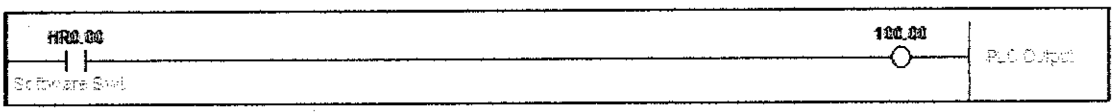

Figure 2: Ladder diagram with a holding relay

After that, a new project is created in NI OPC server window and added a new channel as a new communication medium between OPC server and PLC. In the channel configuration popup, parameters as in Table 1 are being assigned.

Channel Name	RS-232
Device Driver	Omron Host Link
Diagnostics	Disabled
Communication Parameters	
Serial ID	COM 1
Baud Rate	9600
Data Bits	7
Parity	Even
Stop Bits	2
Flow Control	None
Report Errors	Yes
Optimization Method	Write only latest value for all tags
Duty Cycle	Perform 10 writes for every 1 read

Table 1: Channel configuration

Next step, a new device is added in OPC server. The device represents PLC which the server will communicate. The PLC can be added using New Device

Wizard. Table 2 shows the summary of configuration made for the device used in this project which is OMRON CQM1H-CPU21.

Device Name	OMRONforFYP
Device Model	CQM1
Device ID	0 (Decimal)
Connect Timeout	3s
Request Timeout	1000ms
Fail After	3 successive timeouts
Inter-request delay	0ms
Enable auto device demotion	No
Intercharacter delay	0ms

Table 2: Device configuration

After finished creating a device, next is adding tags into OPC server. A tag represents addresses within the PLC or other hardware device that the server communicates with. Figure 3 shows the tag created that will represent HR0.00 from the previous ladder diagram.

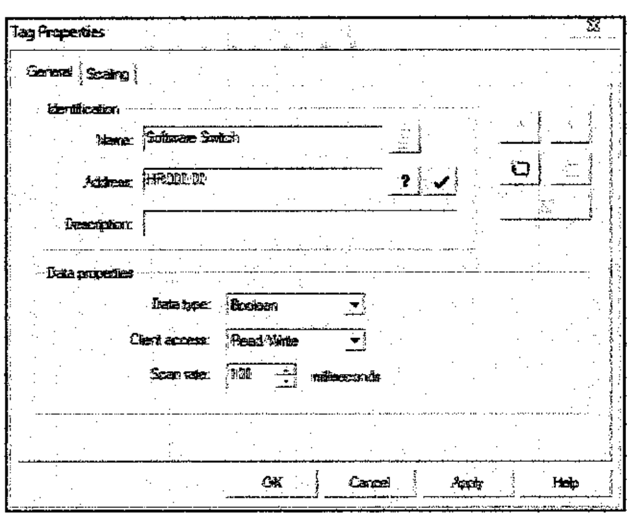

Figure 2: Tag Properties window

Then, OPC Quick Client is being opened by opening *Tools>OPC Quick Client* in OPC server window to check the signal quality from the PLC. The signal quality column in OPC Quick Client for the tag created should display "Good" as shown in Figure 4 indicating the OPC server now ready to receive and send signal to the PLC.

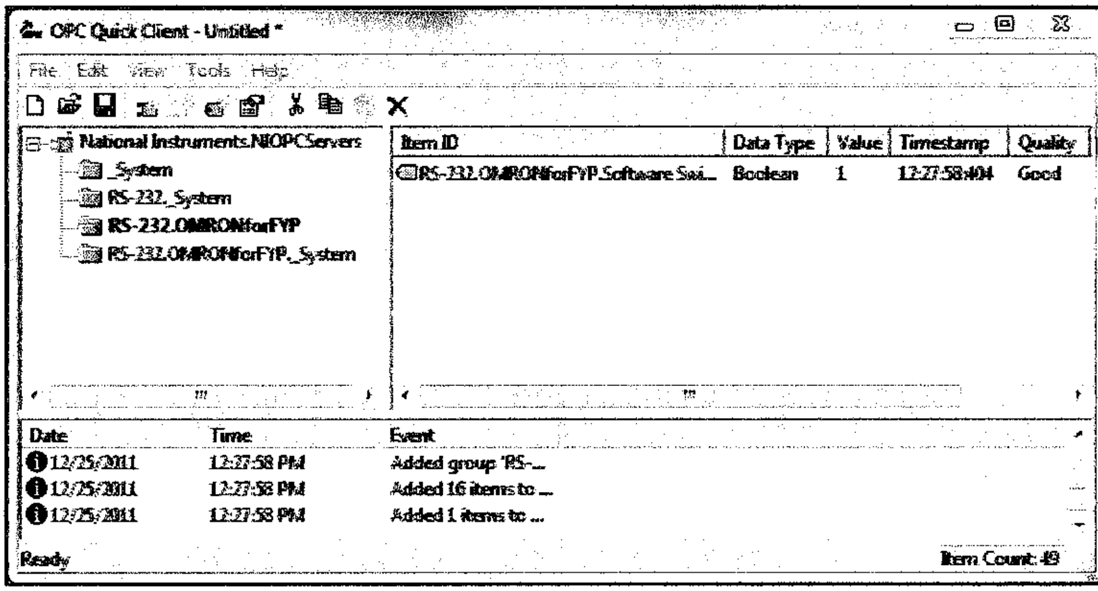

Figure 4: OPC Quick Client window

In LabVIEW windows, a new project is being created to linking the tag from OPC server with control button in LabVIEW front panel by opening File>New>Project>Empty Project from LabVIEW window. After that, an OPC I/O server is added into the project by right click on *My Computer>New>I/O Server* as shown in Figure 5 below.

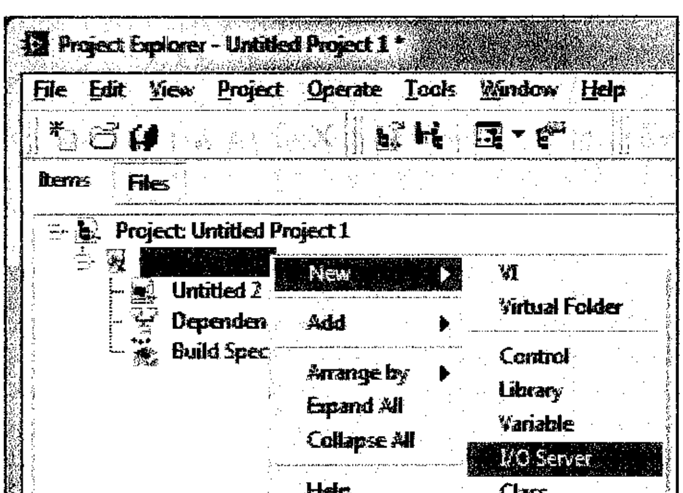

Figure 5: Creating an I/O server in LabVIEW project explorer

In the I/O Server configuration, OPC Client was chose to be I/O Server Type. Table 3 shows the parameter of OPC Client I/O Server configurations.

Browse	Machine
Machine	localhost
Registered OPC servers	National Instruments.NIOPCServers
Update rate	100ms
Deadband (%)	0

Table 3: OPC Client I/O Server configuration

Next, a new library is added into the project by opening *File>New>Other Files>Library* from the project window. After created the library, the tag created in OPC Server is added into the new library by right click on the new library>Create Bound Variables. The tag was added by clicking the *Add*>> button in the Create Bound Variables window as shown in Figure 6.

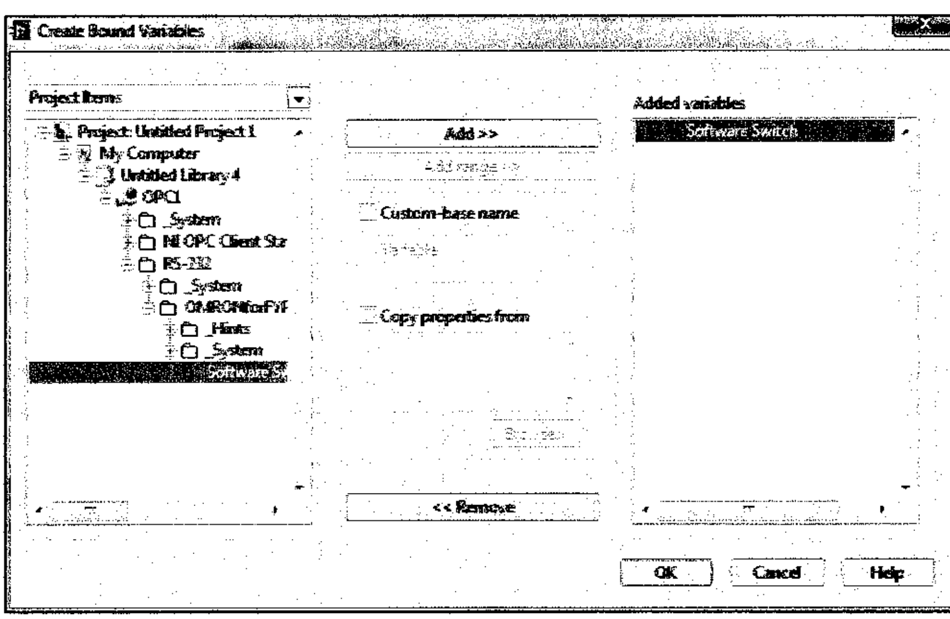

Figure 6: Create Bound Variable window

A blank VI is added into the project after that by opening *File>New>VI>Blank VI* from the project window. From the LabVIEW Project Explorer, the variable created can be dragged into the Blank VI to be used to control the PLC using interface that will be developed.

3.5 Software and Tool

There are several software and tools that will be used throughout the development of this project. The software will be used to develop ladder logic diagram and supervisory control interface while the tool is used to run the actual testing and simulation.

3.5.1 CX Programmer 3.0

This software will be used to develop the ladder logic programming for OMRON CQM1H CPU21 programmable logic controller.

3.5.2 LabVIEW 8.6 Evaluation

Remote monitoring software is programmed and builds using LabVIEW 8.6. Several toolkits such as Data Logging and Supervisory Control (DCS) module and OPC Server also needed to complete the interfacing between PLC and LabVIEW.

3.5.3 OMRON CQM1H CPU21 PLC Training Kit

Real simulation and testing are done using CQM1H programmable logic controller.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Ladder diagram

A ladder programming for this project was developed in two phases, which are hardware-ready and software-ready. In hardware-ready, the PLC instruction was programmed to receive input from hardware device such as push button and limit switches. This phase enables author to check the PLC instruction validity on hardware before proceed to the software phase (interfacing).

After hardware-ready programming has been validated, PLC instruction will be modified to receive input from software-build button. The modifications made were at input addresses. The addresses of hardware input devices were changed into holding relay (HR) addresses to allow user to interact with PLC using LabVIEW software button. Figure 7 shows an abstract from the software phase ladder diagram.

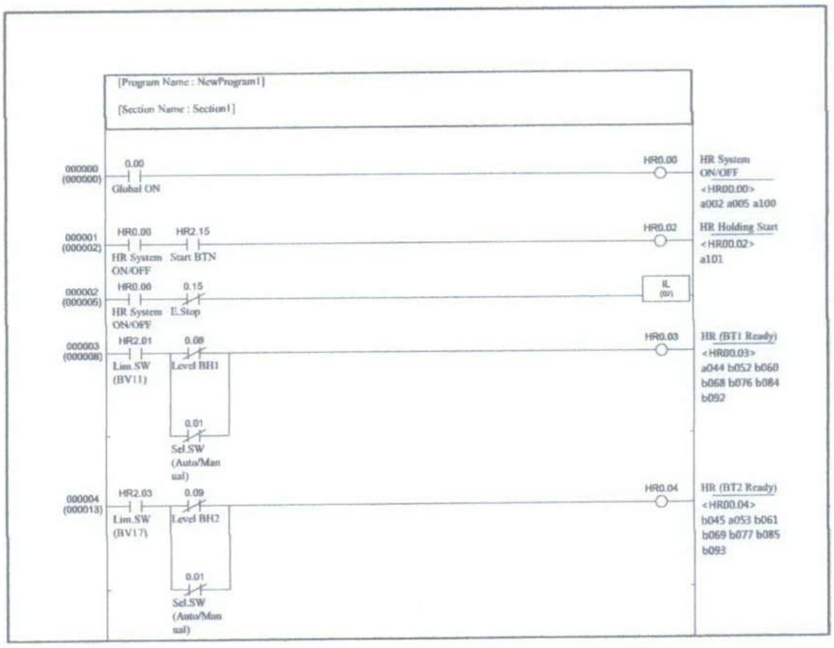

Figure 7: Extract of software-phase Ladder diagram

4.2 Object Linking and Embedding for Process Control (OPC)

Before proceed to the development of program interface, author has done a simple simulation to test the connectivity of LabVIEW interface with PLC. The testing was performed by creating a simple block diagram on a new LabVIEW Virtual Instrument (VI) window that would energize PLC output when soft button on screen is clicked. The association between soft button and PLC was linked using OPC server and OPC client tools. The linking is successful if the PLC output responds when the soft button is toggled. Figure 8 shows the Front Panel setup to test connection functionality between LabVIEW and PLC.

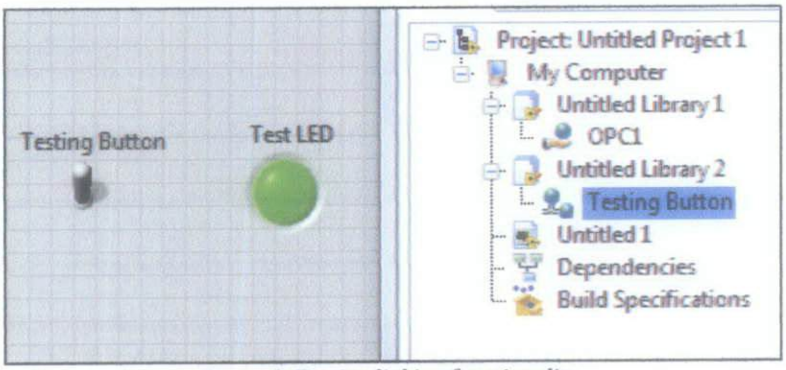

Figure 8: Testing linking functionality

4.3 Front Panel Interface

The front panel of GUI for this project needs to be user-friendly as it is where the interaction between Lubetech's operators and instruments occurs. For this project, author chooses to imitate Lubetech's current MIMIC diagram and use it as the main page of the interface as shown in Figure 9. It is because the operator already familiar with current layout of the plant. The GUI designed has sets of buttons and valves that are clickable to control plant operation. These buttons and valves have similar function and behavior like a latched switch.

Author also decided to set apart the loader process and unloader process by applying tabbed UI. Tabbed UI is a feature to enhance operator's control experience.

Figure 10 shows the loader and unloader control that are placed into different tab to simplify the UI layout thus minimizing human error.

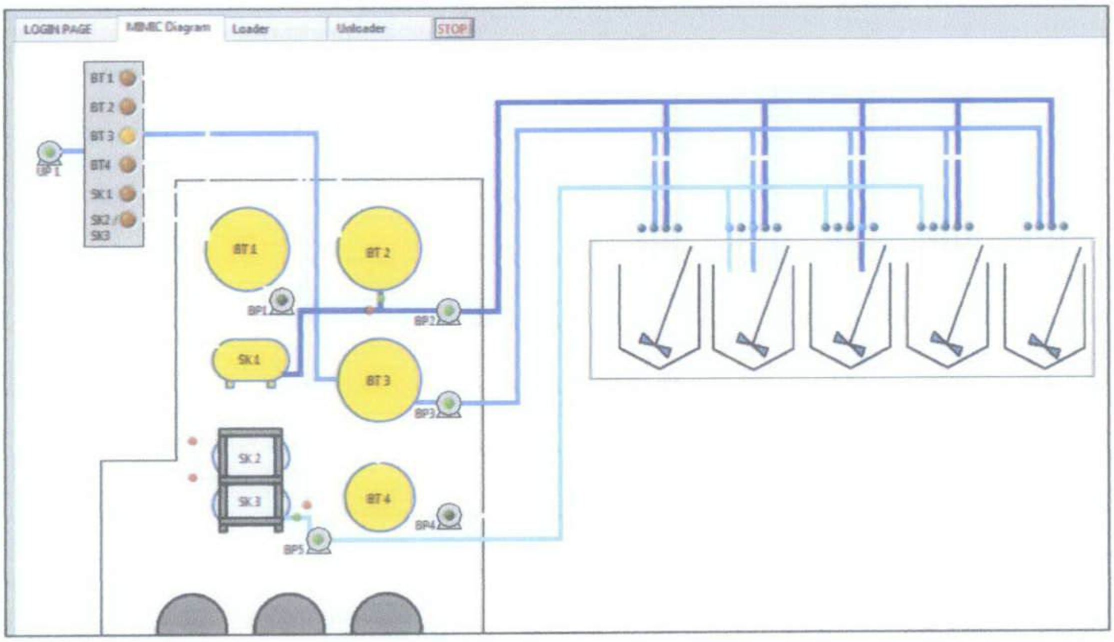

Figure 9: MIMIC diagram for the GUI.

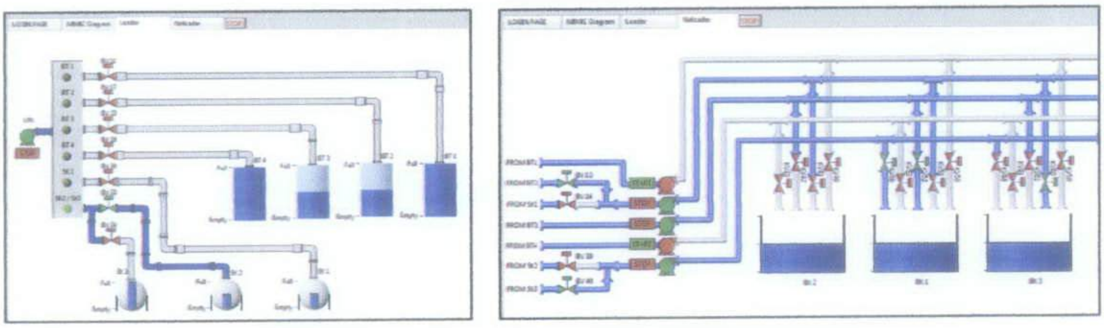

Figure 10: Loader and unloader control placed on different tab.

4.4 PLC interface using LabVIEW

After completing the interface with fundamental elements, the GUI was ready to be linked to PLC I/O through NI OPC server tool. Full linking between software-ready PLC program and GUI elements has been completed successfully. Figure 11 and 12 below show the project setup and signal quality from PLC addresses to OPC quick client windows.

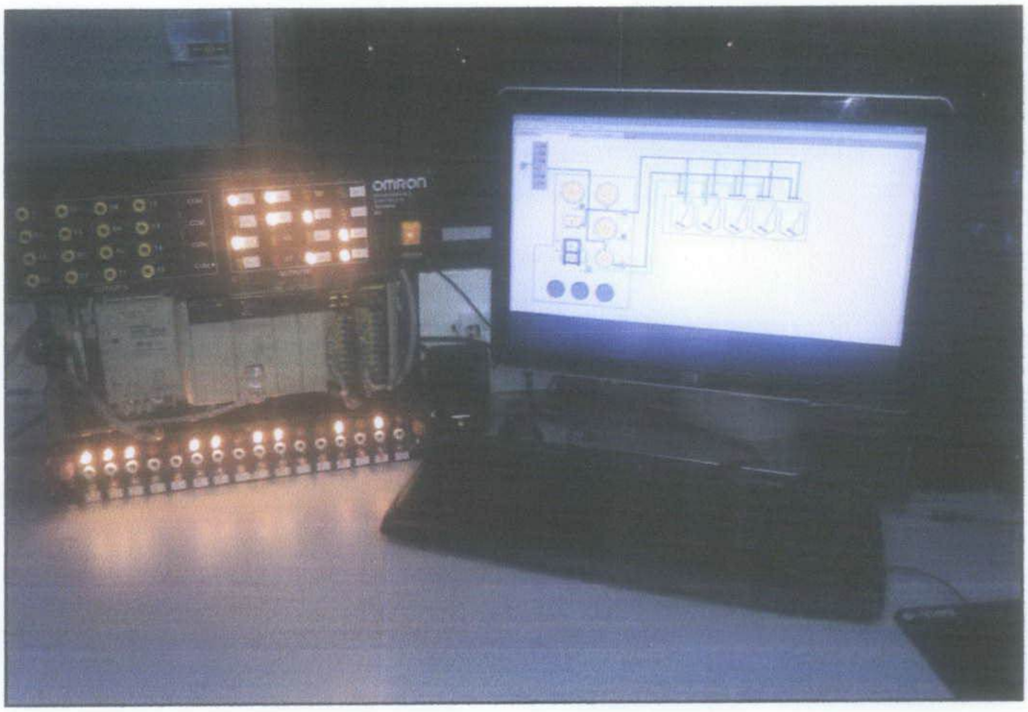

Figure 11: PLC connected to GUI.

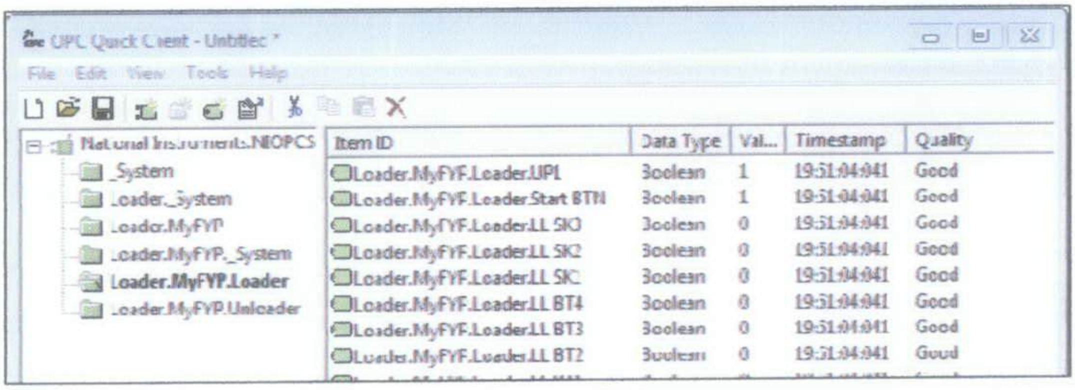

Figure 12: OPC quick client indicating good signal quality from PLC.

4.4 Additional Features

To make the program more reliable, there are several features that have been considered to be included in the project such as security user login and history log file. Security user login enables administrator to manage and limit the control actions of the plant to the authorized personnel only. This feature is important to make sure only authorized and competent persons are handling the plant operation.

Figure 13: Security login popup.

Besides that, this system is capable to generate a dated history log file with user logged-in. The system can log all activities by the user and can be retrieved at any time for debugging and future reference.

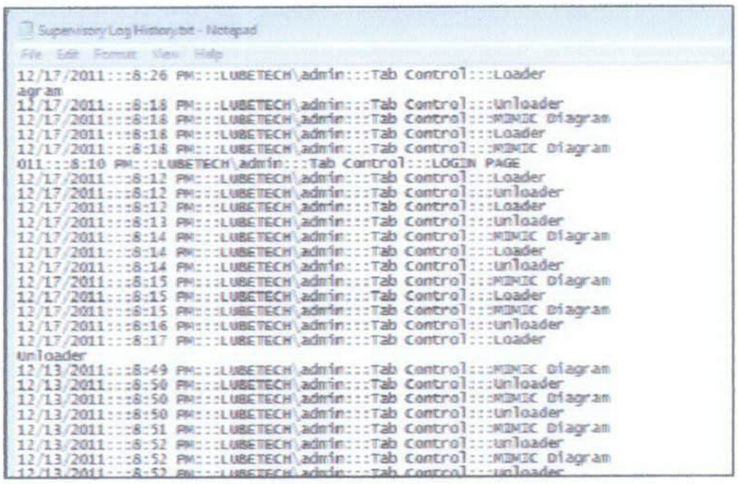

Figure 14: Dated history log with username.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The contribution of this project is creating a user-friendly interface to remotely control and monitor lubricant blending process plant especially UMW Lubetech by generating a LabVIEW-compatible PLC ladder programming. It also provide cheaper alternative to distributed control system (DCS) for batch processes. The important aspect of this project is comprehension of reading and writing PLC memory through LabVIEW graphical programming language in order to control the plant process.

The main objectives of this project had been successfully achieved. This project enable user to monitor and control lubricant blending process on a screen. It is also allow user to interact with field instruments through a PLC and host computer. Remote control and monitoring software can save time to initiate process and reduce safety risk in industrial environment.

This project has been presented and demonstrated to UMW Lubetech and Lubetech authority has verified this project's interlocking system to be similar to its current process control.

5.2 Recommendations

The GUI for this project can be further improved in the future. It can be enhanced with a confirmation box feature and integrate it with process set point input. Confirmation box feature would be nice to have since it will prevent unintended action on the GUI as well as the plant process. This program also can be improved by integrating it with transmitter to receive user set point for the process to make it a complete integrated supervisory control for lubricant blending plant.

A major achievement of this project is when it is viable to be implemented into UMW Lubetech plant as well as other lubricant blending plant. A more advance programming may include an integration of inputs to control the PLC. This may include Plug-and Play features for the software to be ready any time for any type of PLC.

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APPENDICES

INPUT

mment	Address
›bal ON	0.00
l.SW (Auto/Manual)	0.01
'1 Fuse	0.02
vel KH1	0.03
vel KH2	0.04
vel KH3	0.05
vel KH4	0.06
vel KH5	0.07
vel BH1	0.08
vel BH2	0.09
vel BH3	0.10
vel BH4	0.11
vel BH5	0.12
vel BH6	0.13
vel BH7	0.14
;top	0.15
›p (BT1)	1.00
›p (BP2)	1.01
›p (BP3)	1.02
›p (BP4)	1.03
›p (BP5)	1.04
·M1	1.05
·M5	1.06
·M3	1.07
·M4	1.08
·M10	1.09
l.SW (Auto:BP1)	3.01
l.SW (Auto:BP2)	3.02
l.SW ((Auto:BP3)	3.03
l.SW ((Auto:BP4)	3.04
l.SW (Auto:BP5)	3.05
l.SW (Manual:BP1)	3.06
l.SW (Manual:BP2)	3.07
l.SW (Manual:BP3)	3.08
l.SW (Manual:BP4)	3.09
l.SW (Manual:BP5)	3.10

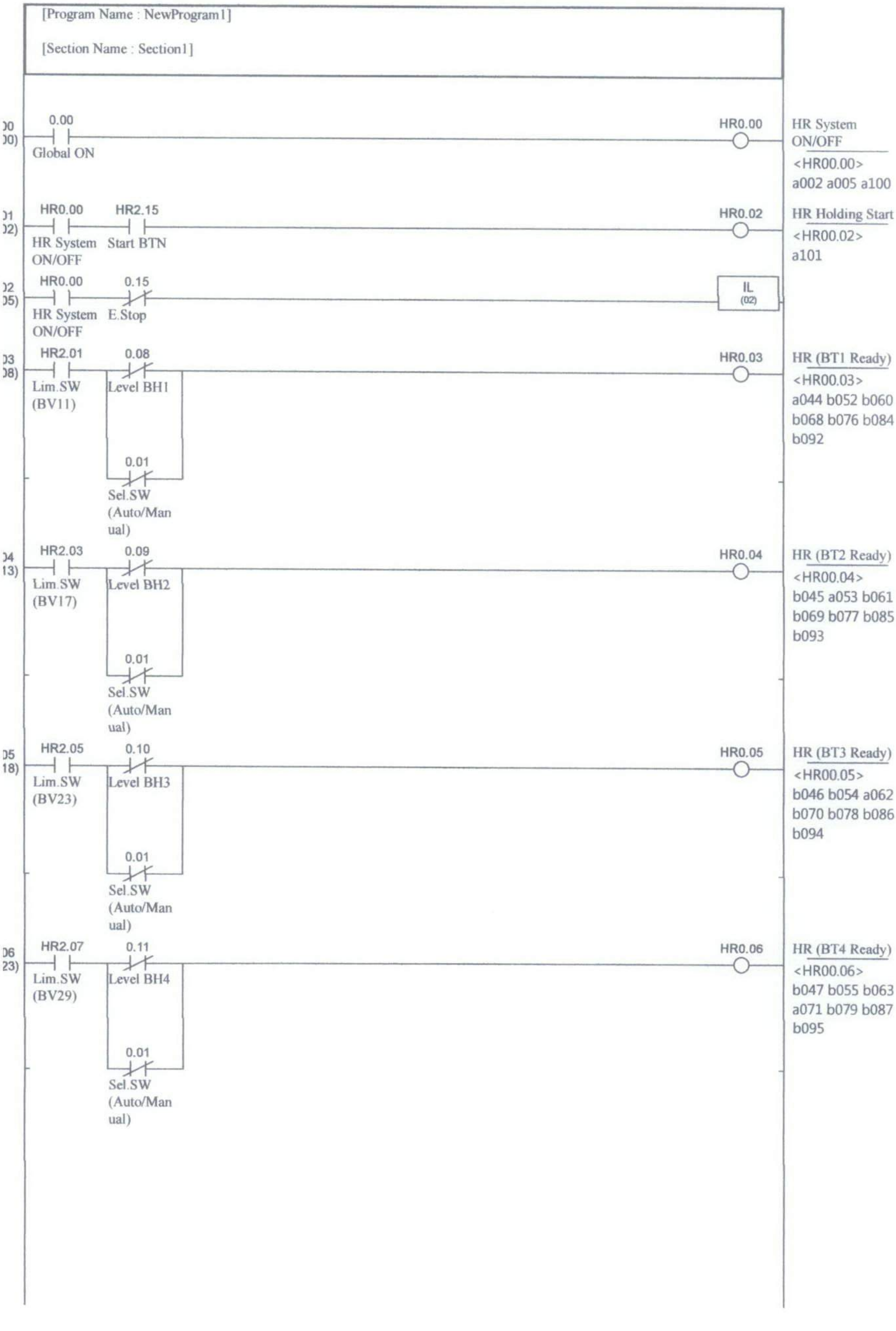
OUTPUT

mment	Address
'1	100.00
1	100.01
2	100.02
3	100.03
4	100.04
5	100.05
ЛF1-2	100.09
ЛF2-2	100.10
ЛF3-2	100.11
ЛF4-2	100.12
'85	100.13
'87	100.14
'89	100.15

HOLDING RELAY

mment	Address
: System ON/OFF	HR0.00
: Loader Ready	HR0.01
: Holding Start	HR0.02
: (BT1 Ready)	HR0.03
: (BT2 Ready)	HR0.04
: (BT3 Ready)	HR0.05
: (BT4 Ready)	HR0.06
: (SK1 Ready)	HR0.07
: (SK2 Ready)	HR0.08
: (SK3 Ready)	HR0.09
1	HR0.11
2	HR0.12
3	HR0.13
4	HR0.14
5	HR0.15
Γ BT1	HR1.00
Γ BT2	HR1.01
Γ BT3	HR1.02
Γ BT4	HR1.03
Γ SK1	HR1.04
Γ SK2	HR1.05
Γ SK3	HR1.06
n.SW (BV11)	HR2.01
BT1	HR2.02
n.SW (BV17)	HR2.03
BT2	HR2.04
n.SW (BV23)	HR2.05
BT3	HR2.06
n.SW (BV29)	HR2.07
BT4	HR2.08
n.SW (BV30)	HR2.09
SK1	HR2.10
n.SW (BV33)	HR2.11
SK2	HR2.12
n.SW (BV34)	HR2.13
SK3	HR2.14
art BTN	HR2.15
UP1	HR3.00
: (BP1 Ready)	HR10.01
: (BP2 Ready)	HR10.02
: (BP3 Ready)	HR10.03
: (BP4 Ready)	HR10.04
: (BP5 Ready)	HR10.05
: (BT2/SK1 Ready)	HR10.06
: (SK2/SK3 Ready)	HR10.07
: (Auto:BP1)	HR11.01
: (Manual:BP1)	HR11.02
: (Auto:BP2)	HR11.03
: (Manual:BP2)	HR11.04
: (Auto:BP3)	HR11.05
: (Manual:BP3)	HR11.06
: (Auto:BP4)	HR11.07
: (Manual:BP4)	HR11.08
: (Auto:BP5)	HR11.09
: (Manual:BP5)	HR11.10
art (BT1)	HR12.00
'50	HR12.01

40	HR12.02
59	HR12.03
67	HR12.04
76	HR12.05
rt (BP2)	HR12.10
51	HR12.11
41	HR12.12
60	HR12.13
68	HR12.14
77	HR12.15
rt (BP3)	HR13.00
52	HR13.01
42	HR13.02
61	HR13.03
69	HR13.04
78	HR13.05
rt (BP4)	HR13.10
53	HR13.11
43	HR13.12
91	HR13.13
70	HR13.14
79	HR13.15
rt (BP5)	HR14.00
86	HR14.01
88	HR14.02
90	HR14.03
13	HR14.05
14	HR14.06
39	HR14.07
40	HR14.08
BP1	HR20.01
BP2	HR20.02
BP3	HR20.03
BP4	HR20.04
BP5	HR20.05


[Program Name : NewProgram1]
[Section Name : Section1]
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Global ON
HR0.00
HR System ON/OFF
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a002 a005 a100
HR0.00
HR2.15
HR System ON/OFF
Start BTN
HR0.02
HR Holding Start
<HR00.02>
a101
HR0.00
0.15
HR System ON/OFF
E.Stop
IL
(02)
HR2.01
0.08
Lim.SW (BV11)
Level BH1
0.01
Sel.SW (Auto/Manual)
HR0.03
HR (BT1 Ready)
<HR00.03>
a044 b052 b060 b068 b076 b084 b092
HR2.03
0.09
Lim.SW (BV17)
Level BH2
0.01
Sel.SW (Auto/Manual)
HR0.04
HR (BT2 Ready)
<HR00.04>
b045 a053 b061 b069 b077 b085 b093
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0.10
Lim.SW (BV23)
Level BH3
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Sel.SW (Auto/Manual)
HR0.05
HR (BT3 Ready)
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HR2.07
0.11
Lim.SW (BV29)
Level BH4
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Sel.SW (Auto/Manual)
HR0.06
HR (BT4 Ready)
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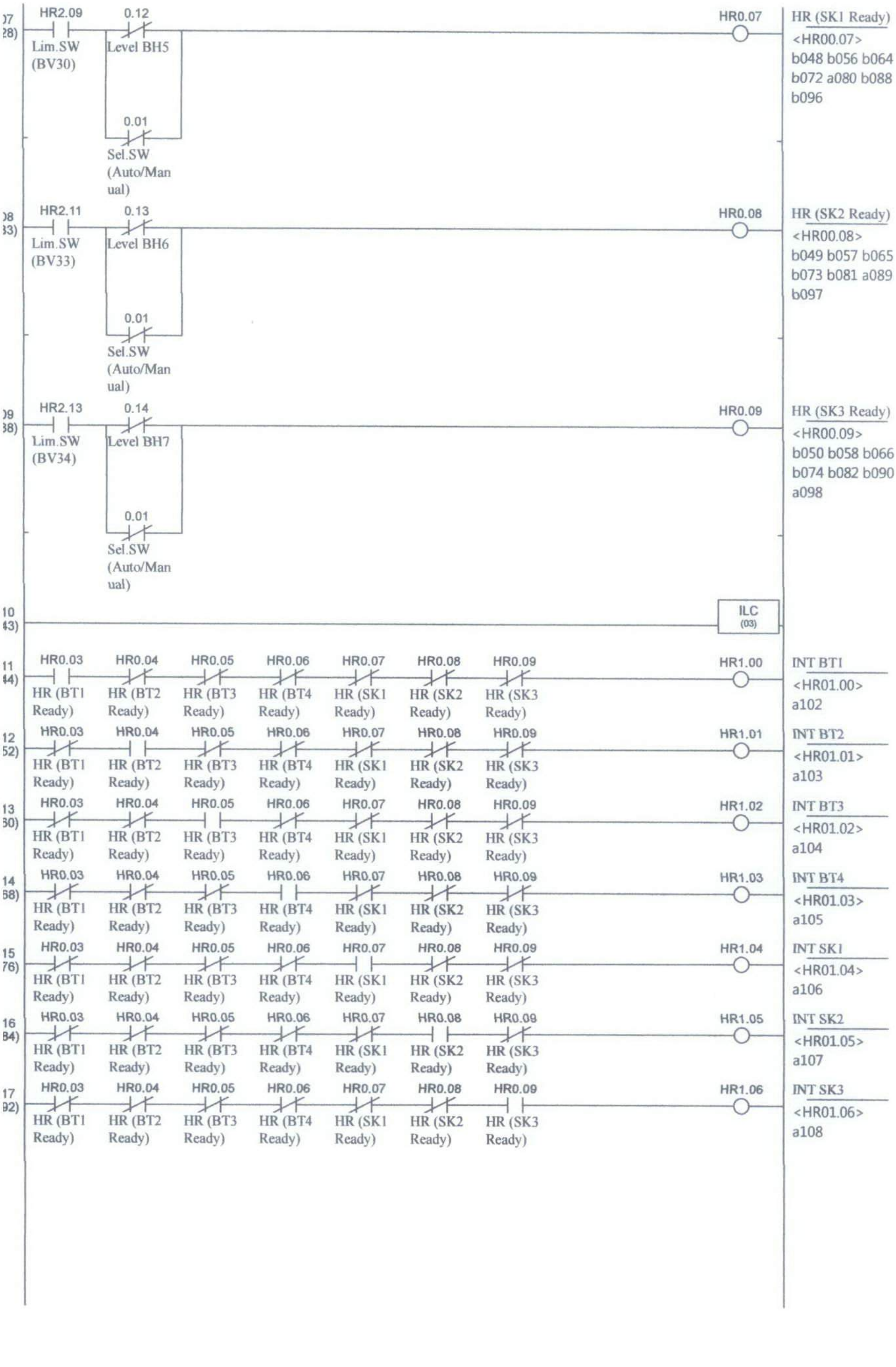
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Lim.SW (BV30)
0.12
Level BH5
0.01
Sel.SW (Auto/Manual)
HR0.07
HR (SK1 Ready)
<HR00.07>
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HR2.11
Lim.SW (BV33)
0.13
Level BH6
0.01
Sel.SW (Auto/Manual)
HR0.08
HR (SK2 Ready)
<HR00.08>
b049 b057 b065 b073 b081 a089 b097
HR2.13
Lim.SW (BV34)
0.14
Level BH7
0.01
Sel.SW (Auto/Manual)
HR0.09
HR (SK3 Ready)
<HR00.09>
b050 b058 b066 b074 b082 b090 a098
10
ILC (03)
11
HR0.03 HR (BT1 Ready)
HR0.04 HR (BT2 Ready)
HR0.05 HR (BT3 Ready)
HR0.06 HR (BT4 Ready)
HR0.07 HR (SK1 Ready)
HR0.08 HR (SK2 Ready)
HR0.09 HR (SK3 Ready)
HR1.00
INT BT1
<HR01.00>
a102
12
HR1.01
INT BT2
<HR01.01>
a103
13
HR1.02
INT BT3
<HR01.02>
a104
14
HR1.03
INT BT4
<HR01.03>
a105
15
HR1.04
INT SK1
<HR01.04>
a106
16
HR1.05
INT SK2
<HR01.05>
a107
17
HR1.06
INT SK3
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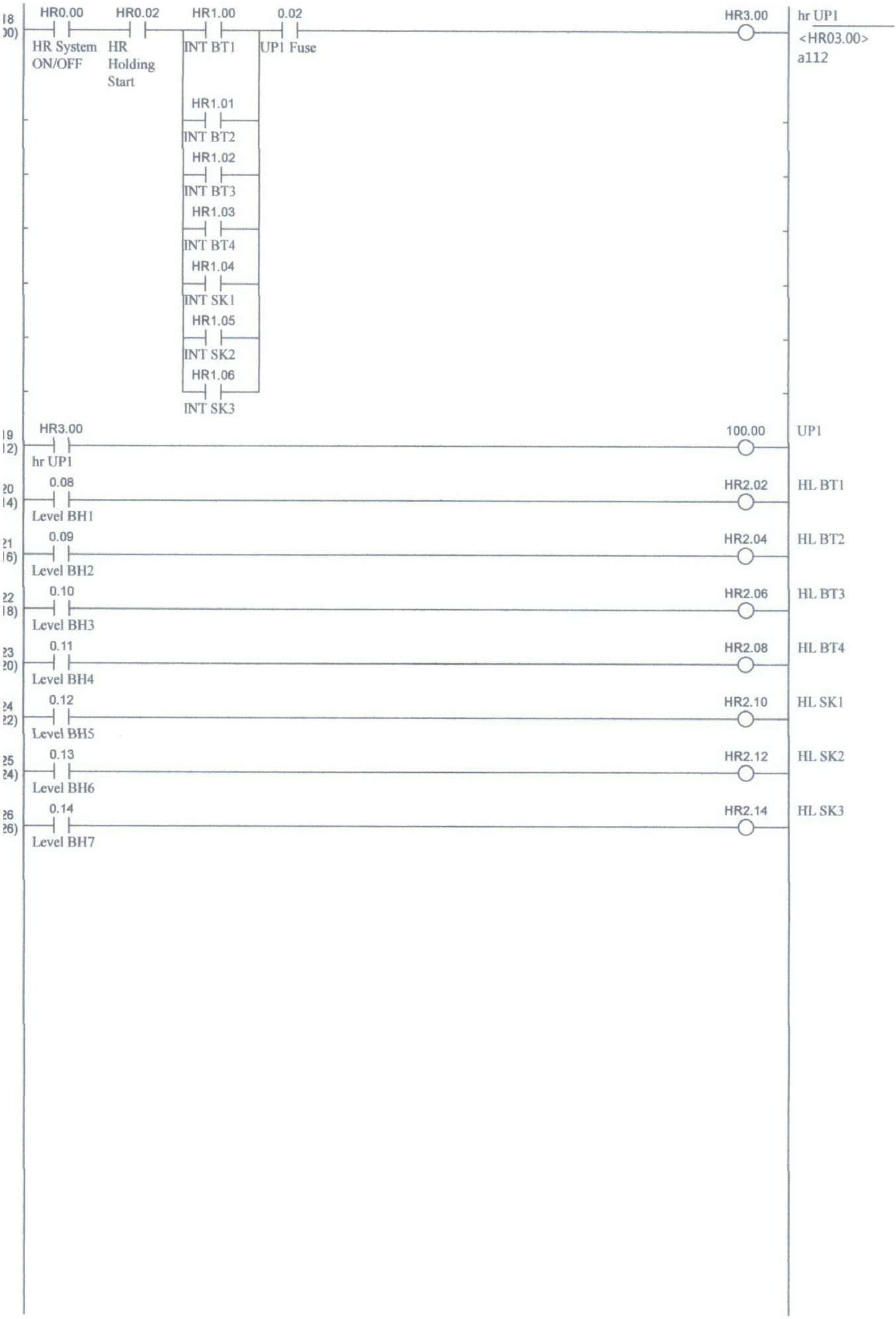
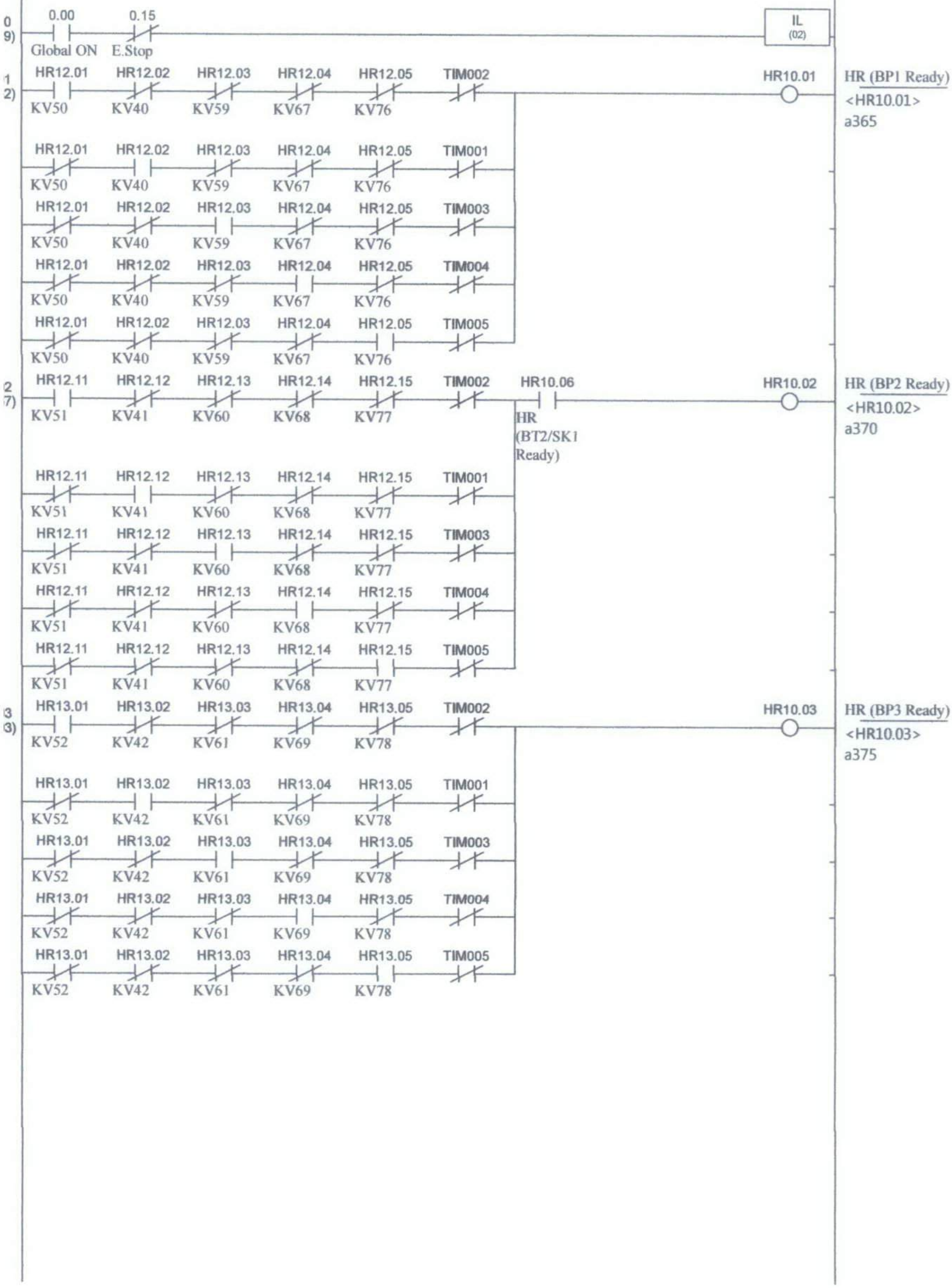
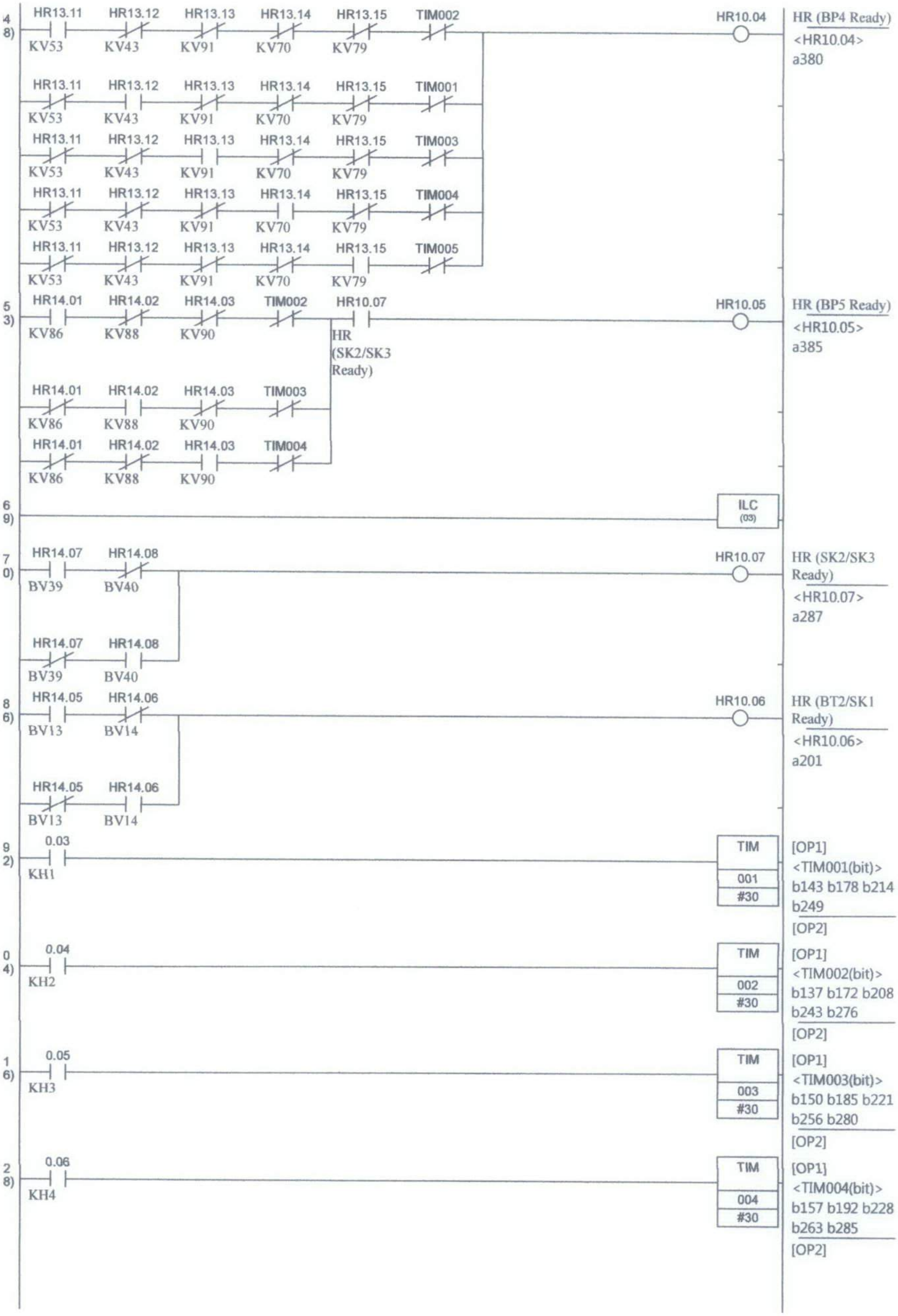
a108


18
HR0.00
HR System ON/OFF
HR0.02
HR Holding Start
HR1.00
INT BT1
HR1.01
INT BT2
HR1.02
INT BT3
HR1.03
INT BT4
HR1.04
INT SK1
HR1.05
INT SK2
HR1.06
INT SK3
0.02
UP1 Fuse
HR3.00
hr UP1
<HR03.00>
a112
19
HR3.00
hr UP1
100.00
UP1
20
0.08
Level BH1
HR2.02
HL BT1
21
0.09
Level BH2
HR2.04
HL BT2
22
0.10
Level BH3
HR2.06
HL BT3
23
0.11
Level BH4
HR2.08
HL BT4
24
0.12
Level BH5
HR2.10
HL SK1
25
0.13
Level BH6
HR2.12
HL SK2
26
0.14
Level BH7
HR2.14
HL SK3

[Program Name : NewProgram1]

[Section Name : Section2]





4 8)
HR13.11 KV53
HR13.12 KV43
HR13.13 KV91
HR13.14 KV70
HR13.15 KV79
TIM002
HR10.04
HR (BP4 Ready)
<HR10.04>
a380
TIM001
TIM003
TIM004
TIM005
5 3)
HR14.01 KV86
HR14.02 KV88
HR14.03 KV90
TIM002
HR10.07
HR (SK2/SK3 Ready)
HR10.05
HR (BP5 Ready)
<HR10.05>
a385
TIM003
TIM004
6 9)
ILC (03)
7 0)
HR14.07 BV39
HR14.08 BV40
HR10.07
HR (SK2/SK3 Ready)
<HR10.07>
a287
8 6)
HR14.05 BV13
HR14.06 BV14
HR10.06
HR (BT2/SK1 Ready)
<HR10.06>
a201
9 2)
0.03 KH1
TIM 001 #30
[OP1]
<TIM001(bit)>
b143 b178 b214 b249
[OP2]
0 4)
0.04 KH2
TIM 002 #30
[OP1]
<TIM002(bit)>
b137 b172 b208 b243 b276
[OP2]
1 6)
0.05 KH3
TIM 003 #30
[OP1]
<TIM003(bit)>
b150 b185 b221 b256 b280
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2 8)
0.06 KH4
TIM 004 #30
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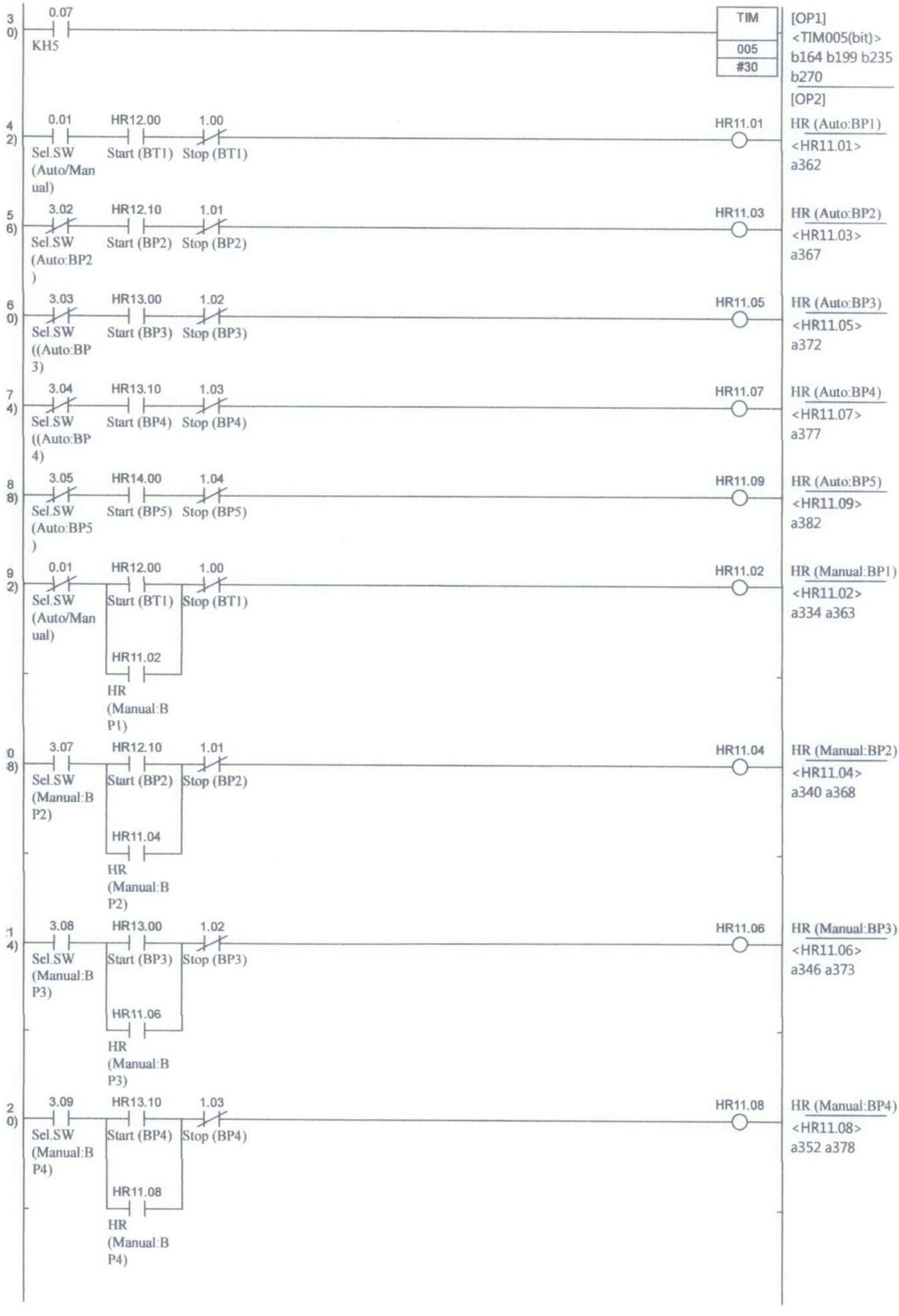
b157 b192 b228 b263 b285
[OP2]



3
0)
0.07
KH5
TIM
005
#30
[OP1]
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b164 b199 b235
b270
[OP2]
4
2)
0.01
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(Auto/Man
ual)
HR12.00
Start (BT1)
1.00
Stop (BT1)
HR11.01
HR (Auto:BP1)
<HR11.01>
a362
5
6)
3.02
Sel.SW
(Auto:BP2
)
HR12.10
Start (BP2)
1.01
Stop (BP2)
HR11.03
HR (Auto:BP2)
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6
0)
3.03
Sel.SW
((Auto:BP
3)
HR13.00
Start (BP3)
1.02
Stop (BP3)
HR11.05
HR (Auto:BP3)
<HR11.05>
a372
7
4)
3.04
Sel.SW
((Auto:BP
4)
HR13.10
Start (BP4)
1.03
Stop (BP4)
HR11.07
HR (Auto:BP4)
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a377
8
8)
3.05
Sel.SW
(Auto:BP5
)
HR14.00
Start (BP5)
1.04
Stop (BP5)
HR11.09
HR (Auto:BP5)
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9
2)
0.01
Sel.SW
(Auto/Man
ual)
HR12.00
Start (BT1)
1.00
Stop (BT1)
HR11.02
HR
(Manual:B
P1)
HR11.02
HR (Manual:BP1)
<HR11.02>
a334 a363
0
8)
3.07
Sel.SW
(Manual:B
P2)
HR12.10
Start (BP2)
1.01
Stop (BP2)
HR11.04
HR
(Manual:B
P2)
HR11.04
HR (Manual:BP2)
<HR11.04>
a340 a368
1
4)
3.08
Sel.SW
(Manual:B
P3)
HR13.00
Start (BP3)
1.02
Stop (BP3)
HR11.06
HR
(Manual:B
P3)
HR11.06
HR (Manual:BP3)
<HR11.06>
a346 a373
2
0)
3.09
Sel.SW
(Manual:B
P4)
HR13.10
Start (BP4)
1.03
Stop (BP4)
HR11.08
HR
(Manual:B
P4)
HR11.08
HR (Manual:BP4)
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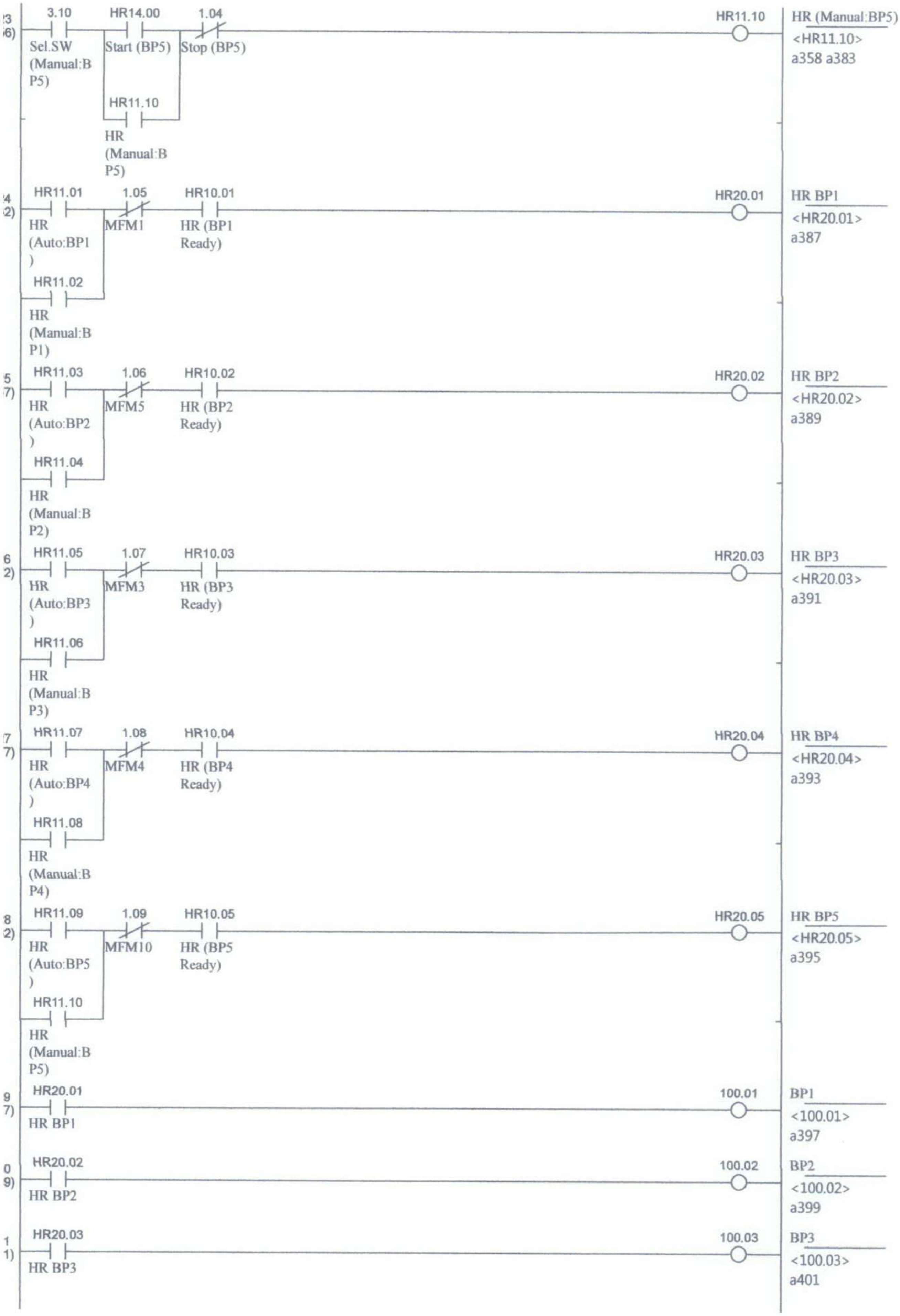
a352 a378



3.10
Sel.SW (Manual:BP5)
HR14.00
Start (BP5)
1.04
Stop (BP5)
HR11.10
HR (Manual:BP5)
HR11.10
HR (Manual:BP5)
<HR11.10>
a358 a383
HR11.01
HR (Auto:BP1)
1.05
MFM1
HR10.01
HR (BP1 Ready)
HR11.02
HR (Manual:BP1)
HR20.01
HR BP1
<HR20.01>
a387
HR11.03
HR (Auto:BP2)
1.06
MFM5
HR10.02
HR (BP2 Ready)
HR11.04
HR (Manual:BP2)
HR20.02
HR BP2
<HR20.02>
a389
HR11.05
HR (Auto:BP3)
1.07
MFM3
HR10.03
HR (BP3 Ready)
HR11.06
HR (Manual:BP3)
HR20.03
HR BP3
<HR20.03>
a391
HR11.07
HR (Auto:BP4)
1.08
MFM4
HR10.04
HR (BP4 Ready)
HR11.08
HR (Manual:BP4)
HR20.04
HR BP4
<HR20.04>
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HR11.09
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1.09
MFM10
HR10.05
HR (BP5 Ready)
HR11.10
HR (Manual:BP5)
HR20.05
HR BP5
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HR20.01
HR BP1
100.01
BP1
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a397
HR20.02
HR BP2
100.02
BP2
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a399
HR20.03
HR BP3
100.03
BP3
<100.03>
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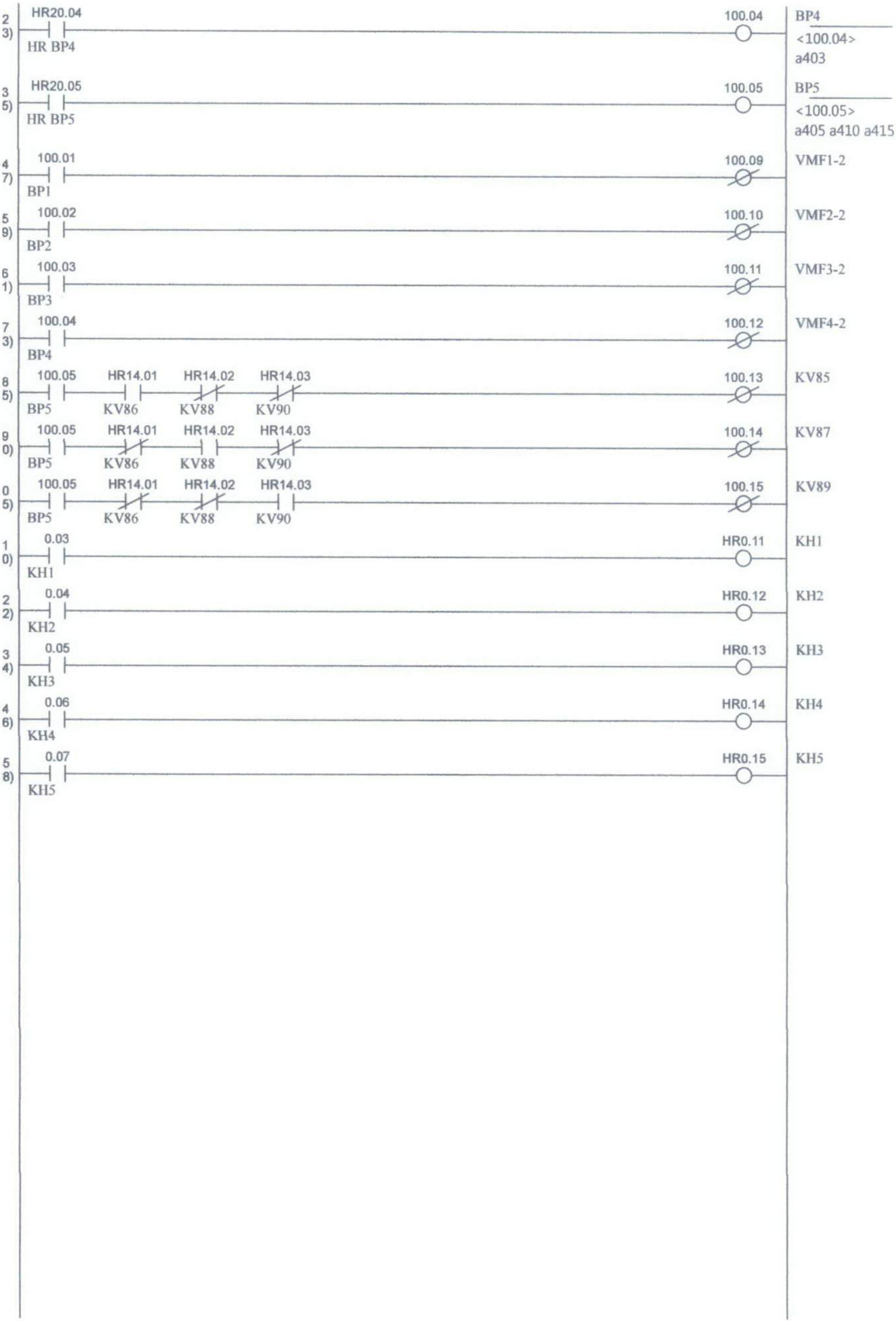
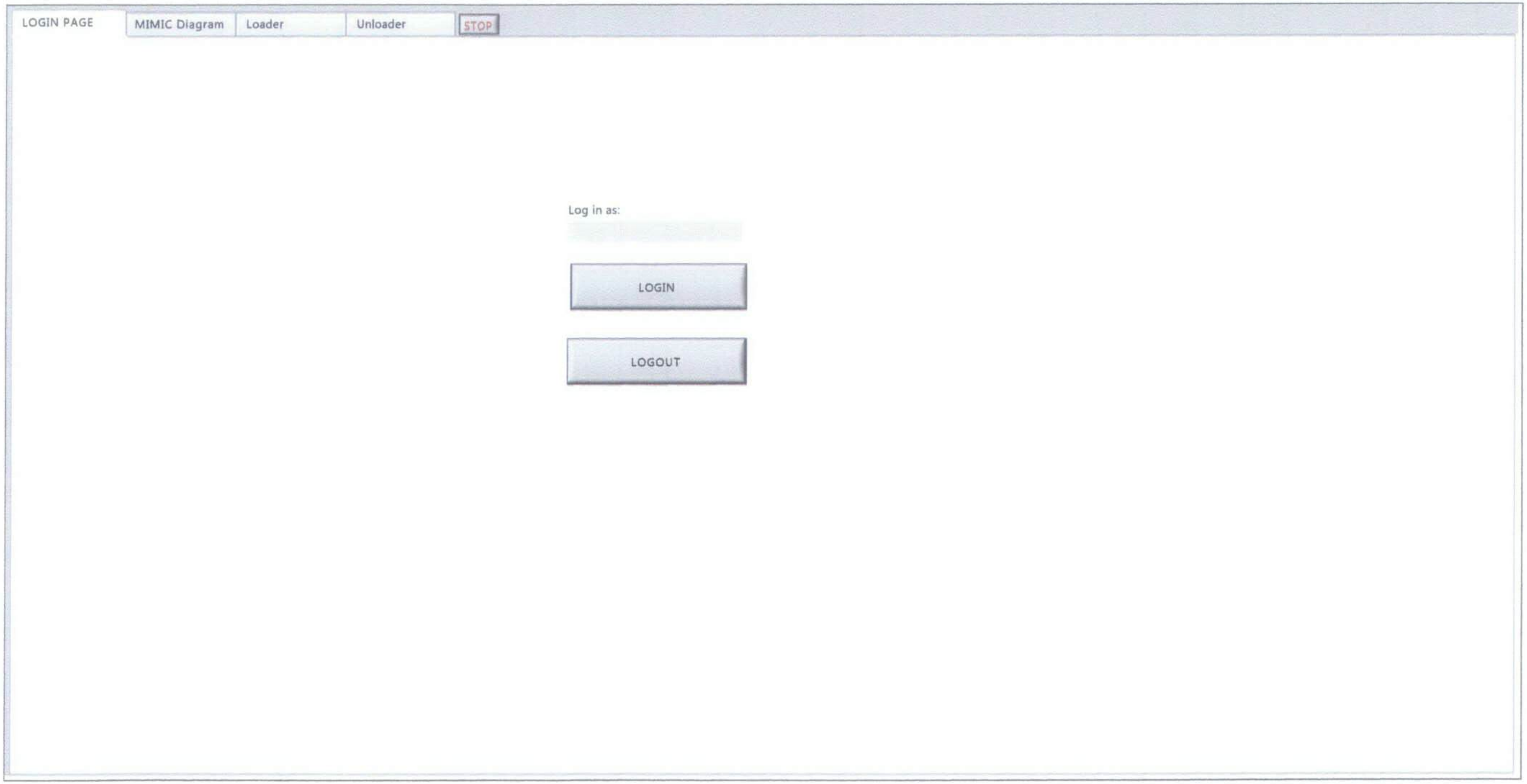
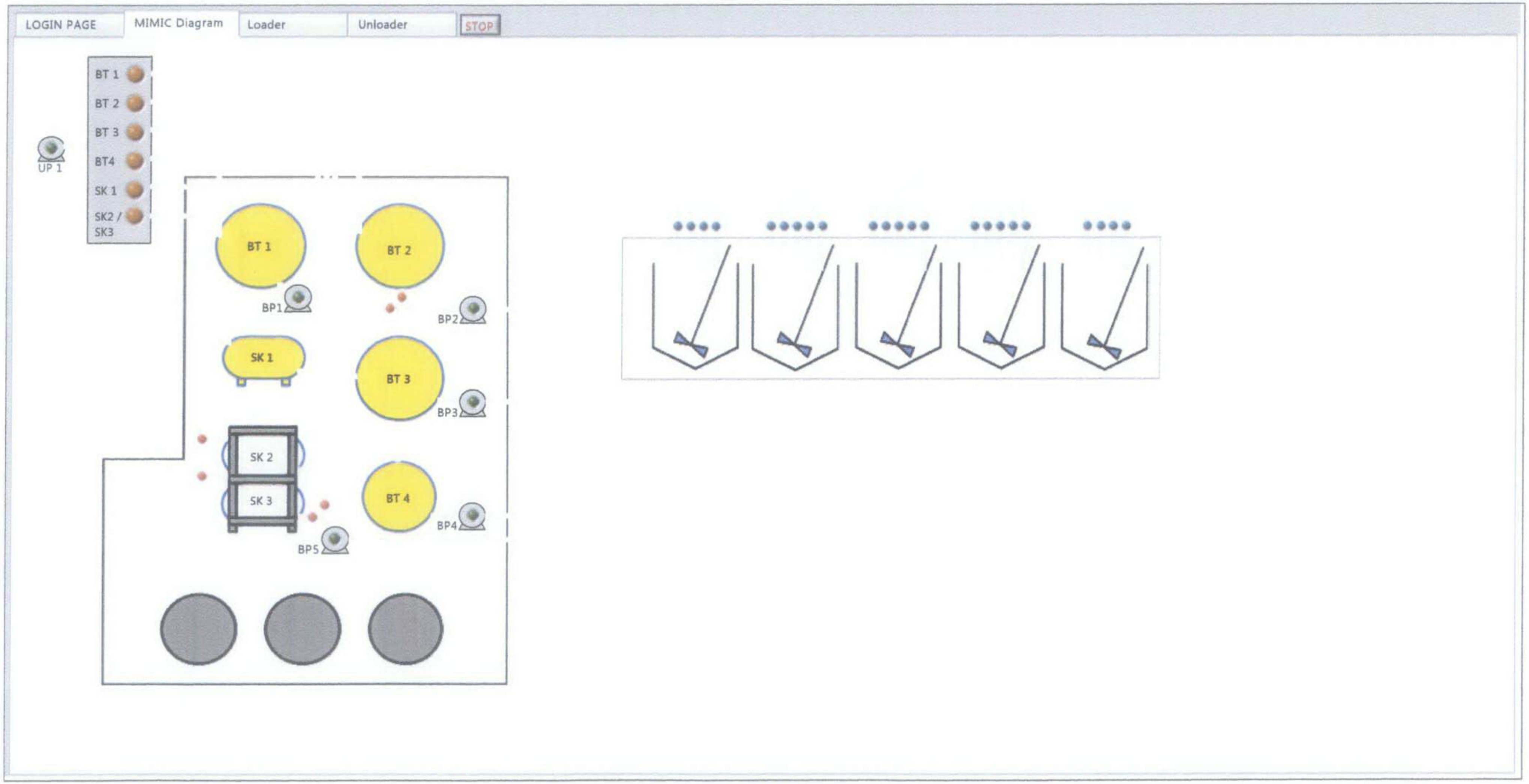


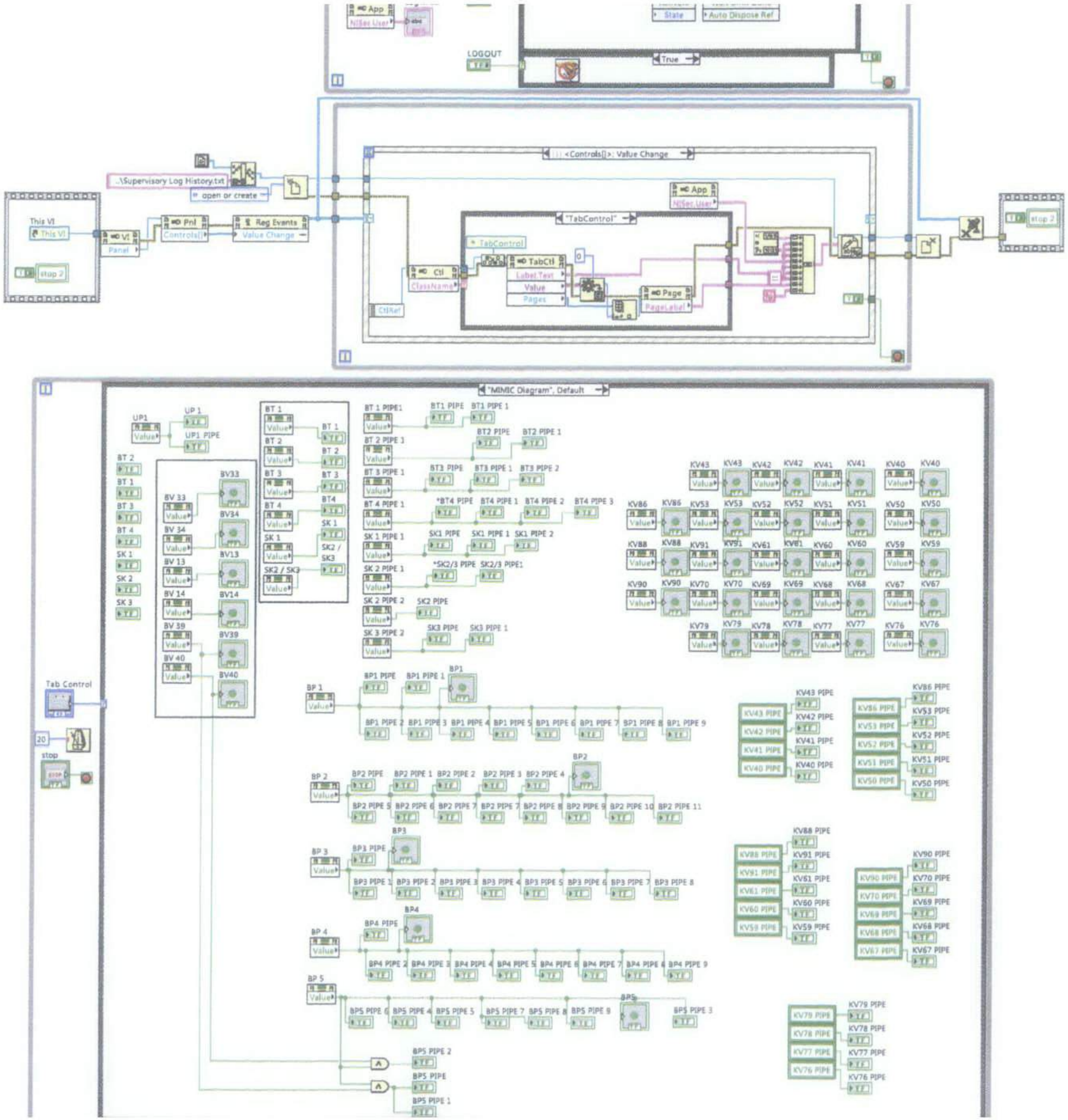
2 3) HR20.04 HR BP4 100.04 BP4 <100.04> a403
3 5) HR20.05 HR BP5 100.05 BP5 <100.05> a405 a410 a415
4 7) 100.01 BP1 100.09 VMF1-2
5 9) 100.02 BP2 100.10 VMF2-2
6 1) 100.03 BP3 100.11 VMF3-2
7 3) 100.04 BP4 100.12 VMF4-2
8 5) 100.05 BP5 HR14.01 KV86 HR14.02 KV88 HR14.03 KV90 100.13 KV85
9 0) 100.05 BP5 HR14.01 KV86 HR14.02 KV88 HR14.03 KV90 100.14 KV87
0 5) 100.05 BP5 HR14.01 KV86 HR14.02 KV88 HR14.03 KV90 100.15 KV89
1 0) 0.03 KH1 HR0.11 KH1
2 2) 0.04 KH2 HR0.12 KH2
3 4) 0.05 KH3 HR0.13 KH3
4 6) 0.06 KH4 HR0.14 KH4
5 8) 0.07 KH5 HR0.15 KH5

Front Panel


LOGIN PAGE
MIMIC Diagram
Loader
Unloader
STOP
Log in as:
LOGIN
LOGOUT

Front Panel


LOGIN PAGE
MIMIC Diagram
Loader
Unloader
STOP
BT 1
BT 2
BT 3
BT4
SK 1
SK2 / SK3
UP 1
BT 1
BT 2
BP1
BP2
SK 1
BT 3
BP3
SK 2
SK 3
BT 4
BP4
BP5



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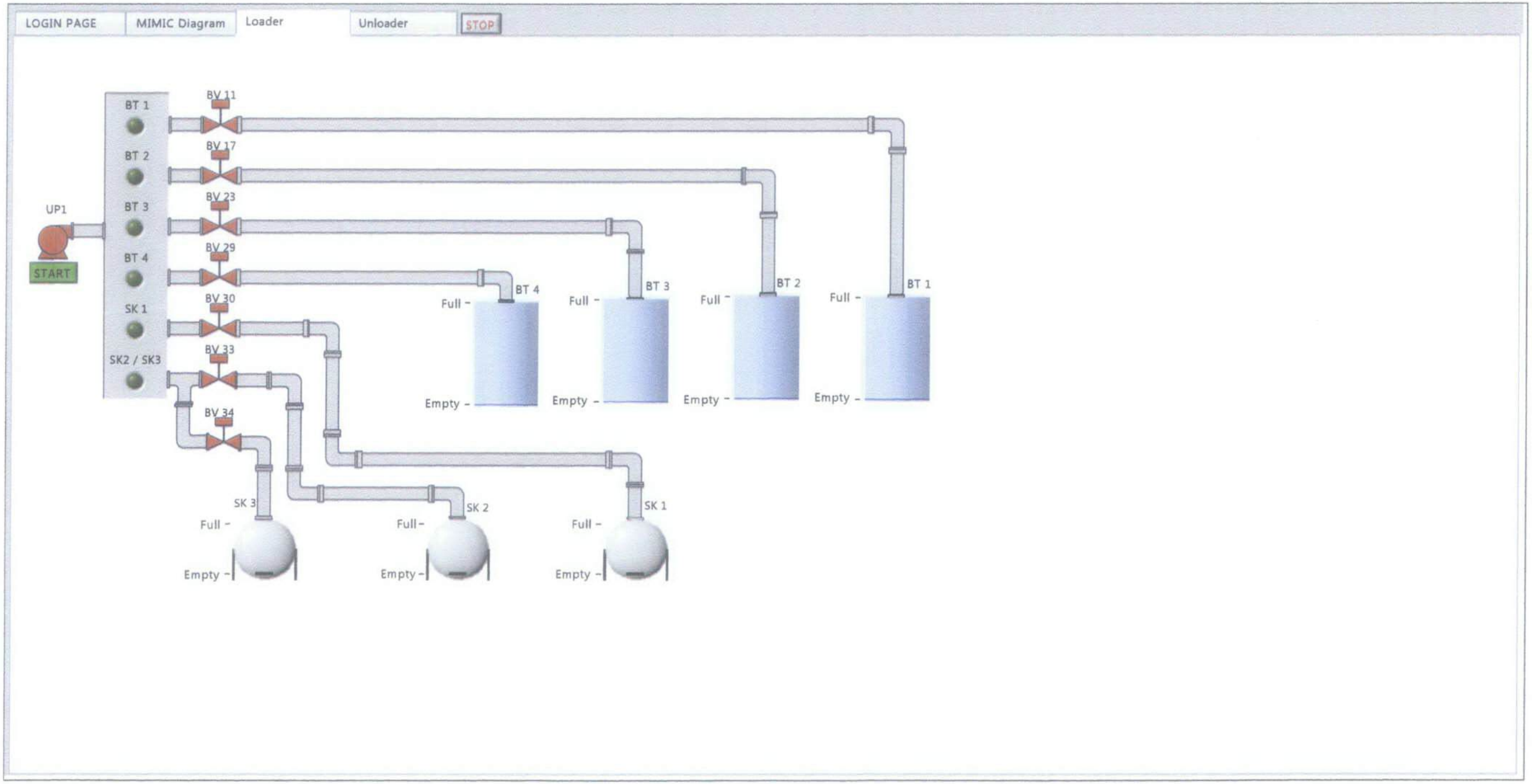
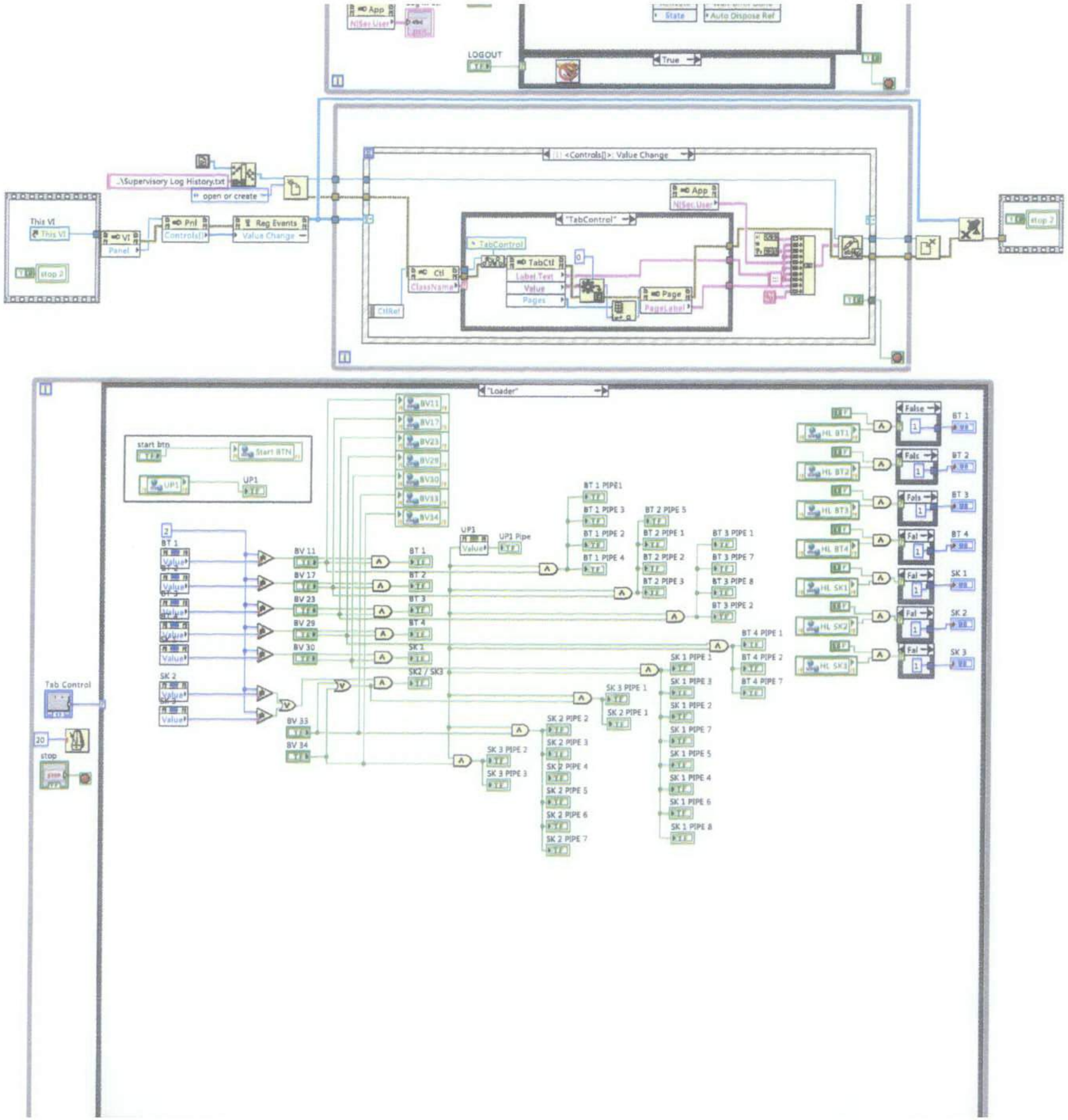
True
State
Auto Dispose Ref
App
NISec User
..\Supervisory Log History.txt
open or create
This VI
stop 2
VI
Panel
Pnl
Controls[]
Reg Events
Value Change
[1] <Controls[]>: Value Change
"TabControl"
TabControl
Ctl
ClassName
CtlRef
TabCtl
Label.Text
Value
Pages
Page
PageLabel
"MIMIC Diagram", Default
Tab Control
stop

Front Panel



LOGIN PAGE
MIMIC Diagram
Loader
Unloader
STOP
UP1
START
BT 1
BT 2
BT 3
BT 4
SK 1
SK2 / SK3
BV 11
BV 17
BV 23
BV 29
BV 30
BV 33
BV 34
BT 4
BT 3
BT 2
BT 1
Full
Empty
SK 3
SK 2
SK 1



LOGOUT
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open or create
This VI
stop 2
Panel
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Reg Events
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TabCtl
Label.Text
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Pages
Ctl
ClassName
CtlRef
Page
PageLabel
App
NISec.User
"Loader"
start btn
Start BTN
UP1
UP1 Pipe
BV11
BV17
BV23
BV29
BV30
BV33
BV34
BT 1
BT 2
BT 3
BT 4
SK 1
SK 2
SK 3
SK2 / SK3
BV 11
BV 17
BV 23
BV 29
BV 30
BV 33
BV 34
BT 1 PIPE1
BT 1 PIPE 3
BT 1 PIPE 2
BT 1 PIPE 4
BT 2 PIPE 5
BT 2 PIPE 1
BT 2 PIPE 2
BT 2 PIPE 3
BT 3 PIPE 1
BT 3 PIPE 7
BT 3 PIPE 8
BT 3 PIPE 2
BT 4 PIPE 1
BT 4 PIPE 2
BT 4 PIPE 7
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SK 1 PIPE 3
SK 1 PIPE 2
SK 1 PIPE 7
SK 1 PIPE 5
SK 1 PIPE 4
SK 1 PIPE 6
SK 1 PIPE 8
SK 2 PIPE 1
SK 2 PIPE 2
SK 2 PIPE 3
SK 2 PIPE 4
SK 2 PIPE 5
SK 2 PIPE 6
SK 2 PIPE 7
SK 3 PIPE 1
SK 3 PIPE 2
SK 3 PIPE 3
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HL BT2
HL BT3
HL BT4
HL SK1
HL SK2
HL SK3
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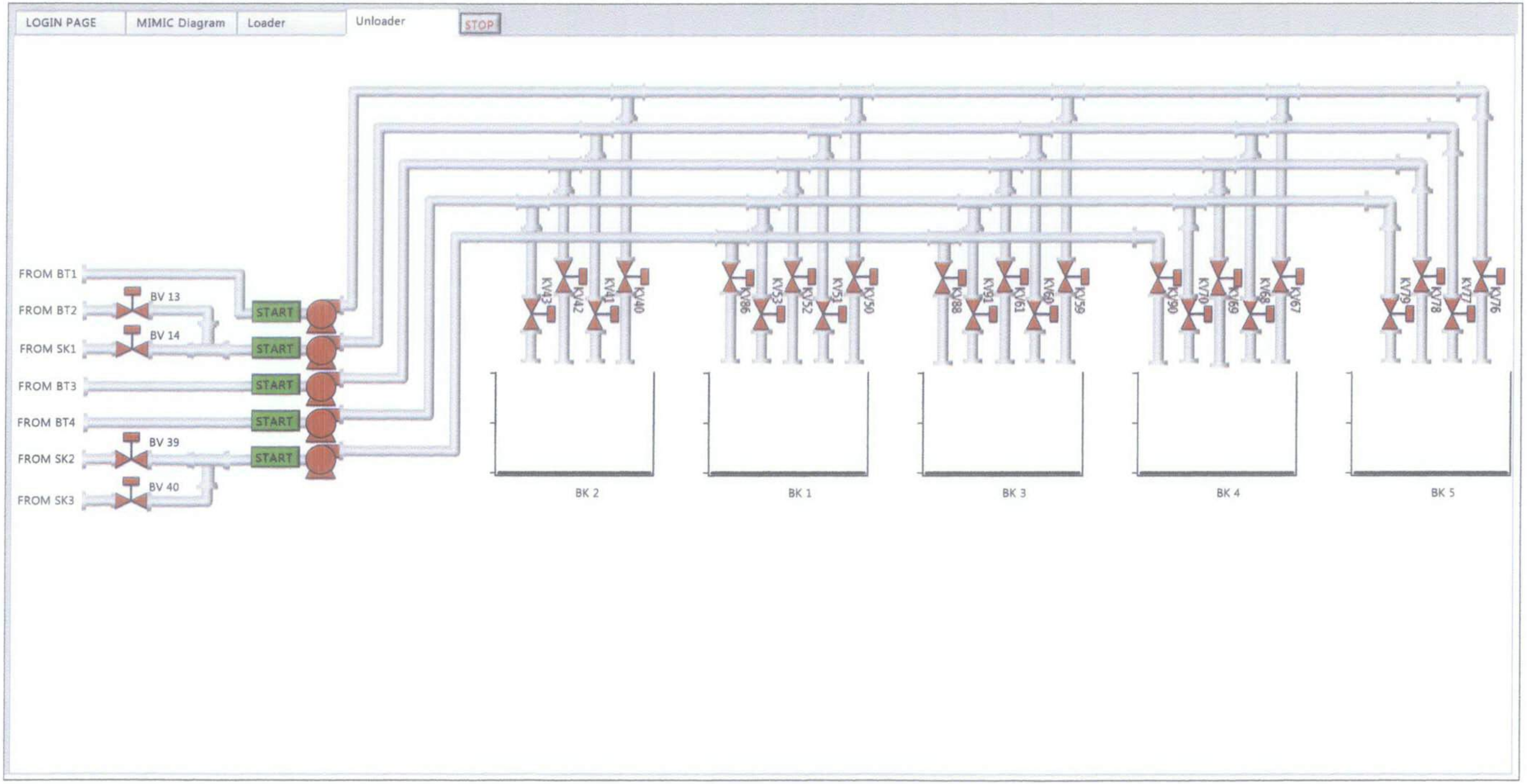
Tab Control
stop
20

Front Panel



LOGIN PAGE
MIMIC Diagram
Loader
Unloader
STOP
FROM BT1
FROM BT2
FROM SK1
FROM BT3
FROM BT4
FROM SK2
FROM SK3
BV 13
BV 14
BV 39
BV 40
START
START
START
START
START
KV43
KV42
KV41
KV40
KV86
KV53
KV52
KV51
KV50
KV88
KV91
KV61
KV60
KV59
KV90
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KV67
KV79
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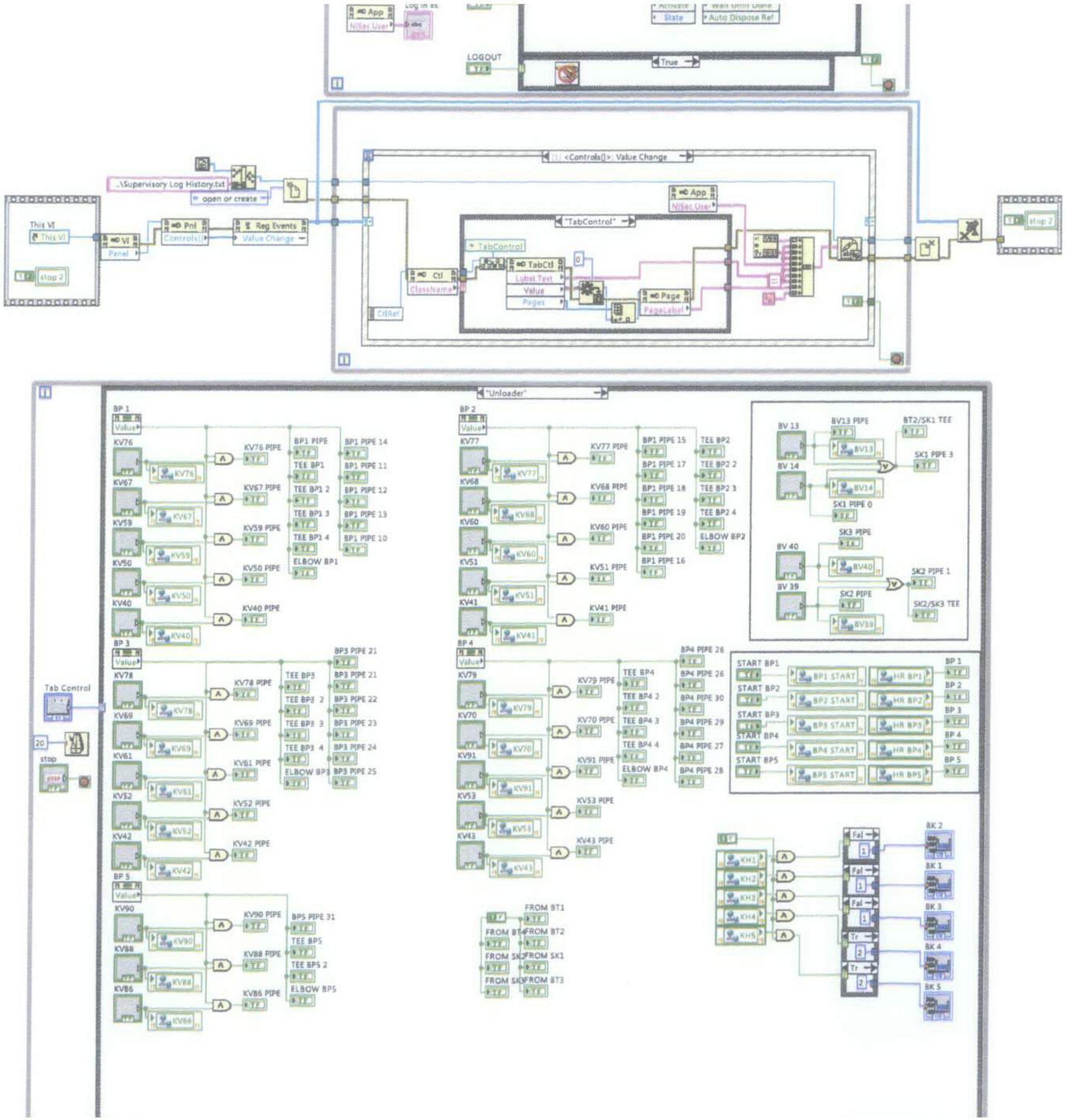
KV77
KV76
BK 2
BK 1
BK 3
BK 4
BK 5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open or create
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Reg Events
Value Change
stop 2
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TabControl
TabCtl
Label Text
Value
Pages
Page
PageLabel
ClassName
CtlRef
App
NISec User
"Unloader"
Tab Control
stop
BP 1
BP 2
BP 3
BP 4
BP 5
KV76 PIPE
KV67 PIPE
KV59 PIPE
KV50 PIPE
KV40 PIPE
KV77 PIPE
KV68 PIPE
KV60 PIPE
KV51 PIPE
KV41 PIPE
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KV69 PIPE
KV61 PIPE
KV52 PIPE
KV42 PIPE
KV79 PIPE
KV70 PIPE
KV91 PIPE
KV53 PIPE
KV43 PIPE
KV90 PIPE
KV88 PIPE
KV86 PIPE
BP1 PIPE
TEE BP1
ELBOW BP1
TEE BP2
ELBOW BP2
TEE BP3
ELBOW BP3
TEE BP4
ELBOW BP4
BP5 PIPE 31
TEE BP5
TEE BP5 2
ELBOW BP5
BV13 PIPE
BT2/SK1 TEE
SK1 PIPE 3
SK1 PIPE 0
SK3 PIPE
SK2 PIPE 1
SK2 PIPE
SK2/SK3 TEE
START BP1
START BP2
START BP3
START BP4
START BP5
FROM BT1
FROM BT2
FROM SK1
FROM BT3
BK 2
BK 1
BK 3
BK 4
BK 5

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Jsing Events

—— Cancelled?

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