DEVELOPMENT OF A TRAFFIC LIGHT CONTROL SYSTEM USING PROGRAMMABLE LOGIC CONTROLLER

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DEVELOPMENT OF TRAFFIC LIGHT CONTROL SYSTEM USING PROGRAMMABLE LOGIC CONTROLLER

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This thesis is submitted as partial in fulfillment of the requirements for the award of the Bachelor of Electrical Engineering (Electronics)

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NOVEMBER 2007

I declare that this thesis entitled "Development of a traffic light control system" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

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Date : 30 NOVEMBER 2007

To my beloved father, mother, brother and my sisters.

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ABSTRACT

Development of a traffic light control system using PLC (Programmable Logic Controller) is the title of this project. This project is divided into two parts which are hardware and software. The hardware part for this project is a model of four way junction of a traffic light. Each lane has two limits switch (input) function as a sensor. Three indicator lamps with different colours (Red, Yellow and Green) are installed at each lane for represents as traffic light signal. This limit switches and indicator lamps are connected to Omron PLC CQM1H-CPU51. The PLC controls every signal which is coming from the inputs (Limit switch) to software and display to the outputs (Indicator lamps). The software part operates with Omron PLC is CX-Programmer. With using this software, the ladder logic diagram is programmed to control the traffic light base on the flow chart. At the end of this project, the traffic light successfully control by PLC.

ABSTRAK

Pembangunan sistem kawalan lampu isyarat menggunakan PLC (Programmable Logic Controller) adalah tajuk projek ini. Projek ini terbahagi kepada dua bahagian software dan hardware. Hardware projek ini adalah model simpang empat berlampu isyarat. Setiap lorong menpunyai dua suis (masukkan) berfungsi sebagai penderia. Tiga lampu penanda yang berlainan warna (Merah, Kuning, Hijau) dipasang pada setiap lorong sebagai lampu isyarat. Suis dan lampu penanda bersambung pada PLC Omron CQM1H-CPU51. PLC mengawal setiap isyarat yang datang dari masukan (Suis) ke software dan dipaparkan ke keluaran (lampu penanda). Software yang beroperasi dengan PLC Omron ialah CX-Programmmer. Dengan menggunakan software ini, ladder logic diagram diprogramkan untuk mengawal lampu isyarat berpandukan carta aliran yang telah dipersetujui. Di akhir projek ini, lampu isyarat berjaya dikawal sepenuhnya menggunakan PLC.

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CHAPTER 1

INTRODUCTION

1.1 Overview of traffic light system

Ever since Roman times, society has tried to control traffic. Even the fabled Roman road system created a conflict between pedestrian and equine travelers. However, a practical solution was not developed until the mid-nineteenth century, when J. P. Knight, a railway signaling engineer, created the first traffic signal, which was installed near Westminster Abbey in London, England in 1868. Unfortunately, the device exploded, killing a police officer, and its use was discontinued after being in operation for only a short time.

The modern traffic light was invented in America. New York had a three-color system in 1918 that was operated manually from a tower in the middle of the street. Other cities soon adopted the idea of having someone on the scene to control the lights. Garrett Morgan, inventor of the gas mask, also developed traffic signaling devices. Having witnessed an accident between a car and a carriage, Morgan felt compelled to devise a system to prevent such collisions at street intersections. In 1923 he patented an electric traffic light system using a pole with a cross section on which the words STOP and GO were illuminated.

These basic designs were soon improved. In 1926 the first automatic signals were installed in London; they depended on a timer to activate them. In the 1930s vehicle-activated lights were created in which cars rolled over half-buried rubber tubes. Air in the tubes was displaced by the weight of the car rolling over them, and the increased pressure operated an electric contact, activating the lights. But these tubes wore out quickly. A better idea was the inductive-loop device: a loop of wire was imbedded in the road itself and connected to a box controlling the lights; a current of electricity passed through the loop, and when the steel body of a car passed overhead, it produced a signal that activated the light.

Today, traffic is automatically routed onto limited access highways courtesy of a computer activated guidance system that determines traffic volume on the highway. Global positioning satellite systems (GPS) are installed in many cars. These systems connect with a satellite and inform drivers where they are and possible routes to their destination. Such systems will eventually enable a drive to determine the best route to a destination given prevailing traffic conditions.

1.2 Overview of Programmable logic controller (PLC)

A programmable logic controller (PLC) is an industrial computer used to control and automate complex systems. Programmable logic controllers are a relatively recent development in process control technology. It is designed for use in an industrial environment, which uses a programmable memory for the integral storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control through digital or analog inputs and outputs, various types of machines or processes.

Programmable logic controllers are used throughout industry to control and monitor a wide range of machines and other movable components and systems. PLC is used to monitor input signals from a variety of input points (input sensors) which report events and conditions occurring in a controlled process. Programmable logic controllers are typically found in factory type settings. PLCs are used to control robots, assembly lines and various other applications that require a large amount of data monitoring and control.

A typical programmable logic controller employs a backplane to serve as the communications bus for interconnecting the PLC processor with the array of individual input/output devices with which the processor interacts in terms of receiving input data for use in executing the control program and transmitting control data for use in controlling the targeted objects. A PLC includes a rack into which a plurality of input/output cards may be placed. A rack includes several slots into which these input/output cards are installed.

Each input/output card has a plurality of I/O points. The I/O modules are typically pluggable into respective slots located on a backplane board in the PLC. An I/O bus couples the cards in the slots back to the processor of the programmable logic controller. The slots are coupled together by a main bus which couples any I/O modules plugged into the slots to a central processing unit (CPU).

The CPU itself can be located on a card which is pluggable into a dedicated slot on the backplane of the PLC. The particular processor employed in a PLC together with the particular choice of input and output cards installed in the PLC rack are often referred to as the hardware configuration of the programmable logic controller. The hardware configuration also includes the particular addresses which the I/O cards. Each option module typically has a plurality of input/output points.

The option modules are coupled through an interface bus, for example via a backplane, to a main controller having a microprocessor executing a user program. Option modules may also include a microprocessor and a memory containing separate user programs and data directed to a particular operation of the PLC system. During the execution of a stored control program, the PLC's read inputs from the controlled process and, per the logic of the control program, provide outputs to the controlled process. The outputs typically provide analog or binary voltages or "contacts" implemented by solid state switching devices.

PLC's are normally constructed in modular fashion to allow them to be easily reconfigured to meet the demands of the particular process being controlled. The processor and I/O circuitry are normally constructed as separate modules that may be inserted in a chassis and connected together through a common backplane using permanent or releasable electrical connectors.

1.3 Project objectives

This project is about develop a new practical traffic light control system which the system will solve the traffic congestion issue. To develop the project, there are two objectives that must be accomplished which are:-

i. Develop a new traffic light control system controlled by programmable logic controller (PLC).

ii. Implement the system on a model of a traffic light.

1.4 Project scope

i. Construct a model of four way junction of a traffic light model.

ii. Programmed a ladder logic diagram to control the traffic light.

iii. Combine the software part and the hardware part to simulate a traffic light system.

1.5 Problem statement

The monitoring and control of city traffic light is becoming a major problem in many countries. The increasing number of vehicles and the lower phase of highways developments have led to traffic congestion problem especially in major cities such as Kuala Lumpur, Georgetown, Johor Bahru, and Ipoh. Travel time, environment quality, life quality, and road safety are all adversely affected as a result of traffic congestions. In addition, delays due to traffic congestions also indirectly affect productivity, efficiency, and energy losses.

There are many factors that lead to traffic congestion such as the density of vehicles on the roads, human habits, social behavior, and traffic light system. One major factor is due to the traffic lights system that controls the traffic at junction. Traffic policeman are deployed at traffic intersection everyday in order to overcome these congestion during peak hour, thus one of the roots of the problem is due to ineffective traffic lights controllers. With effective control the intersection, it is believed that the overall capacity and performance of urban traffic network could be resolve.

There are several types of conventional methods of traffic light control; however they fail to deal effectively with complex and time varying traffic conditions. Currently, two types of traffic light control are commonly installed in Malaysia and many parts of the world: the preset cycle time (PCT) and vehicle-actuated (VA). Due the deployment of a large number of traffic police in the city during peak hours, it is evident that these types of traffic lights controllers are inadequate. There is a need to research on new types of highly effective practical traffic light controllers.

In this paper, the proposed of a new development of a traffic light control system controlled by PLC. This system will decreased the traffic congestion at traffic light by extend the time for the green signal if traffic density at that lane are high and give the priority to who first arrive at the junction to get a green signal.

1.6 Thesis outline

Chapter 1 is introduction to programmable logic controller and traffic light system. This chapter also explains about project objectives and scopes and discuss about problem statement.

Chapter 2 focuses on hardware development and configuration. This chapter explains every detail about PLC Omron CQM1H and traffic light model. The wiring diagram for this hardware also will be discussed in this chapter

Chapter 3 deals with the software development using software CX-Programmer. These chapters also discuss the flowchart and development program for traffic light system.

Chapter 4 presents all the results obtained and the configuration of doing simulation in the real world.

Chapter 5 discusses the conclusion of this project development traffic light control system using Programmable Logic Controller. This chapter also explains the problem and the recommendation for this project and for the future development or system modification.

CHAPTER 2

SYSTEM HARDWARE

2.1 Introduction

The hardware part of this project is Programmable logic controller (PLC) and a traffic light model. Omron CQM1H-CPU51 is the type of PLC used in this project as the processor to control the traffic light. This type of PLC was been chosen because the characteristic is fully necessary by the development of traffic light system.

The four ways traffic light model is constructed to display how this traffic light control system is running. This traffic light model has a complete set of traffic light signal which are red, yellow and green as a traffic signal for each lane. Each lane also has two limit switches represent as a sensor on the road. The first sensor placed in front of the lane to detect the presence of a car at the junction and the second sensor placed at certain length from first sensor to determine the volume of car at that lane. The right connection between PLC and traffic light model is very important because it can avoid the problem or conflict when the program is transferred to PLC.

2.2 Programmable Logic Controller

2.2.1 PLC configuration

i. Many PLC configurations are available, even from a single vendor. But each of these has common components and concepts. The most essential component is are:

ii. iPower supply – This can be built into the PLC or be an external unit. Common voltage levels required by the PLC are 24Vdc 120Vac 220Vac.

iii. CPU (central Processing Unit) – This is a computer where ladder logic is stored and processed.

iv. I/O (Input/output) – A number of input/output terminals must be provided so that the PLC can monitor the process and initiate actions. Inputs to, and outputs from, a PLC is necessary to monitor and control a process. Both inputs and outputs can be categorized into two basic types: logical or continuous. Consider the example of a light bulb. If it can only be turned on or off, it is logical control. If the light can be dimmed to different levels, it is continuous.

v. Indicator lights – These indicate the status of the PLC including power on, program running, and a fault. These are essential when diagnosing problems.

vi. Rack Type : A rack can often be as large as 18” by 30” by 10”

vii. Mini: These are similar in function to PLC racks, but about the half size. Dedicated Backplanes can be used to support the cards OR DIN rail mountable with incorporated I/O bus in module.

viii. Shoebox: A compact, all-in-one unit that has limited expansion capabilities. Lower cost and compactness make these ideal for small applications. DIN rail mountable.

ix. Micro: These units can be as small as a deck of cards. They tend to have fixed quantities of I/O and limited abilities, but costs will be lowest. DIN rail mountable

2.2.2 Basic PLC schema

The basic PLC schema include CPU, power supply, memory, Input block, output block, communication and expansion connections. Figure 2.1 shows the PLC system overview.

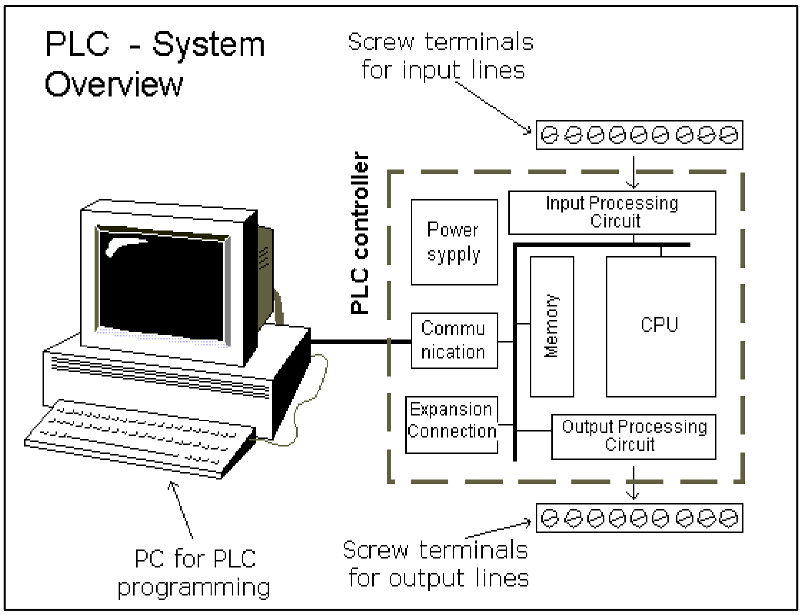

Figure 2.1 PLC system overview

CPU modules - The Central Processing Unit (CPU) Module is the brain of the PLC.Primary role to read inputs, execute the control program, update outputs. The CPU consists of the arithmetic logic unit (ALU), timing/control circuitry, accumulator, scratch pad memory, program counter, address stack and instruction register. A PLC works by continually scanning a program.

Memory - The memory includes pre-programmed ROM memory containing the PLC's operating system, driver programs and application programs and the RAM memory. PLC manufacturer offer various types of retentive memory to save user programs and data while power is removed, so that the PLC can resume execution of the user-written control program as soon as power is restored. Some types of memory used in a PLC include:

i. ROM (Read-Only Memory)

ii. RAM (Random Access Memory)

iii. PROM (Programmable Read-Only Memory)

iv. EPROM (Erasable Programmable Read-Only Memory)

v. EEPROM (Electronically Erasable Programmable Read-Only Memory)

vi. FLASH Memory

vii. Compact Flash – Can store complete program information, read & write text files

viii. I/O Modules - Input and output (I/O) modules connect the PLC to sensors and actuators. Provide isolation for the low-voltage, low-current signals that the PLC uses internally from the higher-power electrical circuits required by most sensors and actuators. Wide range of I/O modules available including: digital (logical) I/O modules and analogue (continuous) I/O modules.

2.2.3 PLC Operation

CHECK INPUT STATUS-First the PLC takes a look at each input to determine whether it is on or off condition.

EXECUTE PROGRAM-Next the PLC executes a program by one instruction at a time. If the first input is on then it should turn on the first output. Since it already knows then it will be able to decide whether the first output should be turned on based on the state of the first input. It will store the execution results for use later during the next step.

UPDATE OUTPUT STATUS-Finally the PLC updates the status of the outputs. It updates the outputs based on which inputs are on during the first step and the results of executing your program during the second step. Based on the example in step 2 it would now turn "ON" the first output because the first input is "ON" and your program said to turn "ON" the first output when this condition is true.

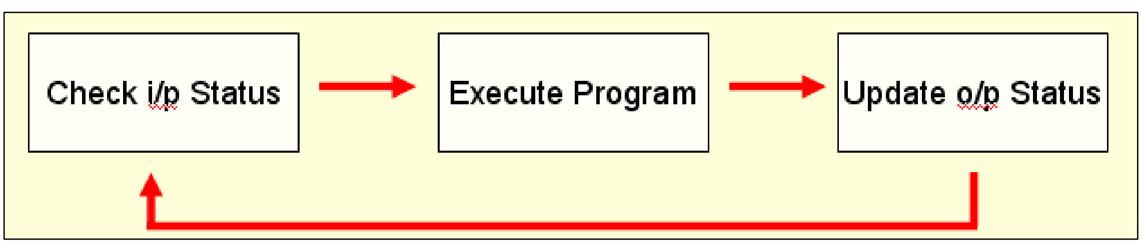

Figure 2.2 PLC operation block diagram

2.2.4 Internal PLC

INPUT RELAYS-(contacts) These are connected to the outside world. They physically exist and receive signals from switches, sensors, etc.

INTERNAL UTILITY RELAYS-(contacts) These do not receive signals from the outside world nor do they physically exist. They are simulated relays and are what enables a PLC to eliminate external relays.

OUTPUT RELAYS-(coils) These are connected to the outside world. They physically exist and send on/off signals to solenoids, lights, etc.

DATA STORAGE -Typically there are registers assigned to simply store data. They are usually used as temporary storage for math or data manipulation. They can also typically be used to store data when power is removed from the PLC.

2.3 CQM1H configuration

Figure 2.3 shows the Omron PLC CQM1H configuration. The main body of this PLC is power supply unit, Central processor unit and input/output slot. The power supply unit receive the required PLC voltage is 240Vac. For safety the voltage to PLC must connect to automatic circuit breaker before connect to the PLC because to protect the PLC from overload. The CPU covered by Analog input/output slot, RS232 port, and processor. The inputs/outputs slot uses for system are using digital input and digital output. There are not limited slot for input and output port and can use for multiple inputs/outputs card.

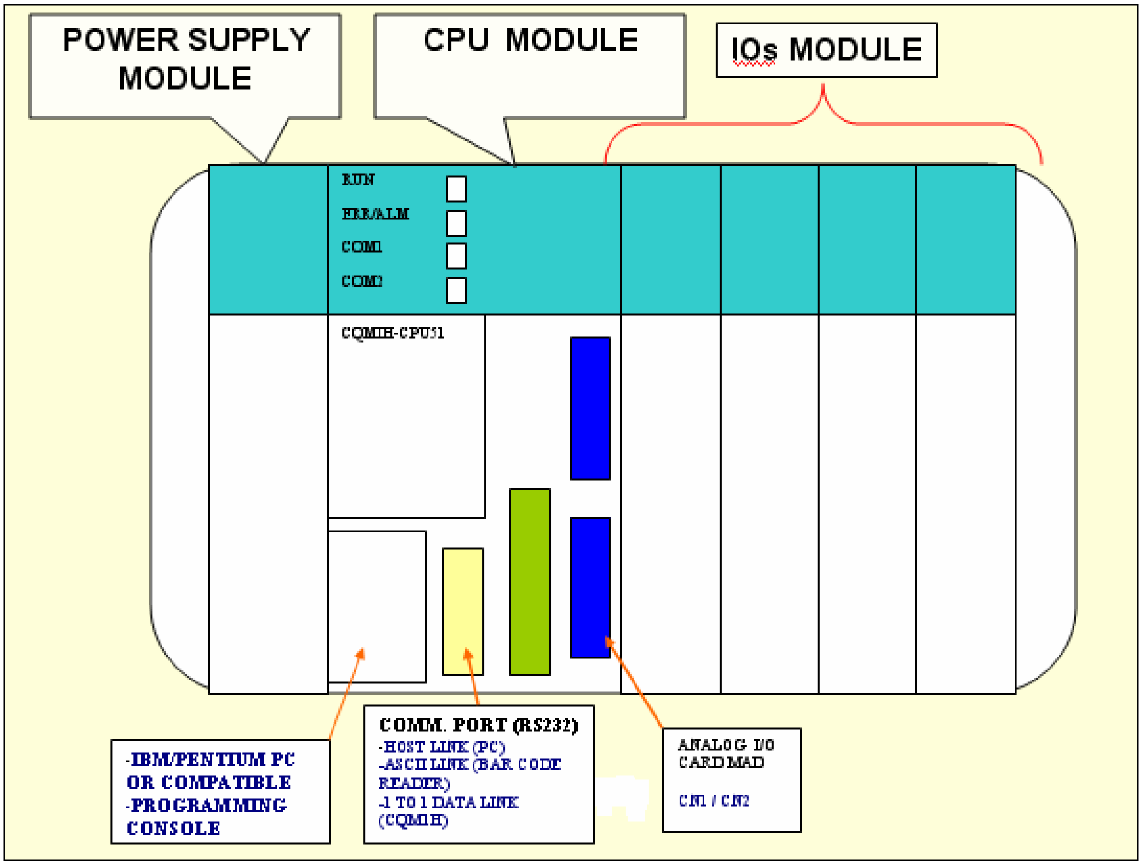

Figure 2.3 CQM1H configuration

2.4 Traffic light model

The four ways junction is developed to display the simulation the development of the new traffic light control system. Figure 2.4 and 2.5 show the design of traffic light model. Every lane and traffic light signals have been labeled with alphabet A, B, C and D to separate each lane and traffic light. Each traffic light lane has their set of traffic light signal "Red, Yellow, and Green". This traffic light signal operates similar like common traffic light signal. It changes from red to green and then yellow and after that back to red signal.

Each lane also has two limit switches represent as a sensor on the road. The suitable sensor for design a real traffic light system is type of linear sensor or electromagnetic sensor. The first sensor placed in front of lane to detect the presence car at the junction and the second sensor placed at certain length from first sensor to determine the volume of the car at that lane. From this combination of sensor, we will know the expected time for green signal on when each lane change to the green signal.

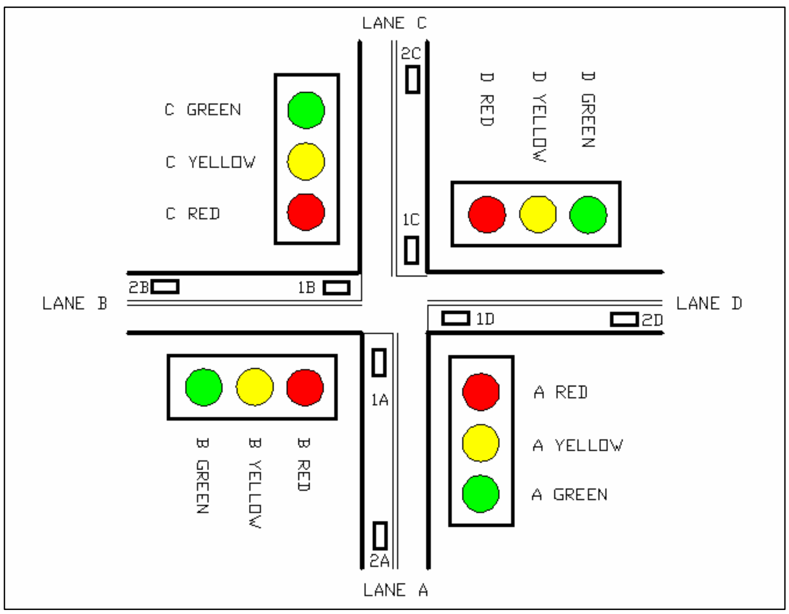

Figure 2.4 Traffic light model

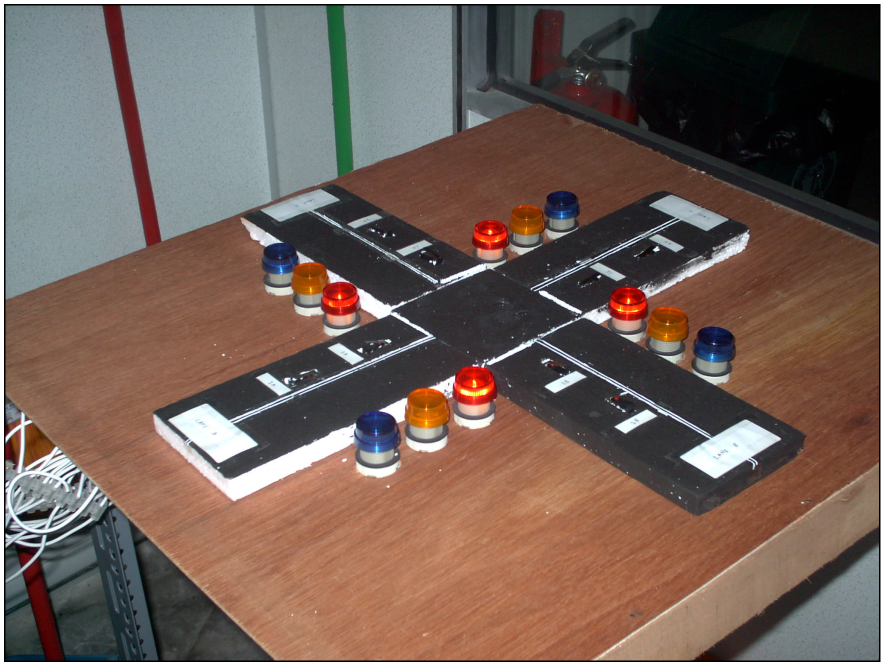

Figure 2.5 Traffic light hardware

2.5 Hardware wiring diagram

Once hardware is designed ladder diagrams are constructed to document the wiring. For this project, existed PLC cabinet box are use and connect with the traffic light model. A basic wiring diagram is as shown in figure 2.6. The PLC would be supplied with AC power 240V and then I/O card supplied with DC power 12V to 24V. The common for input card is 24Vdc and for output card is 0Vdc. A fuse is used after disconnect to limit the maximum current drawn by the system.

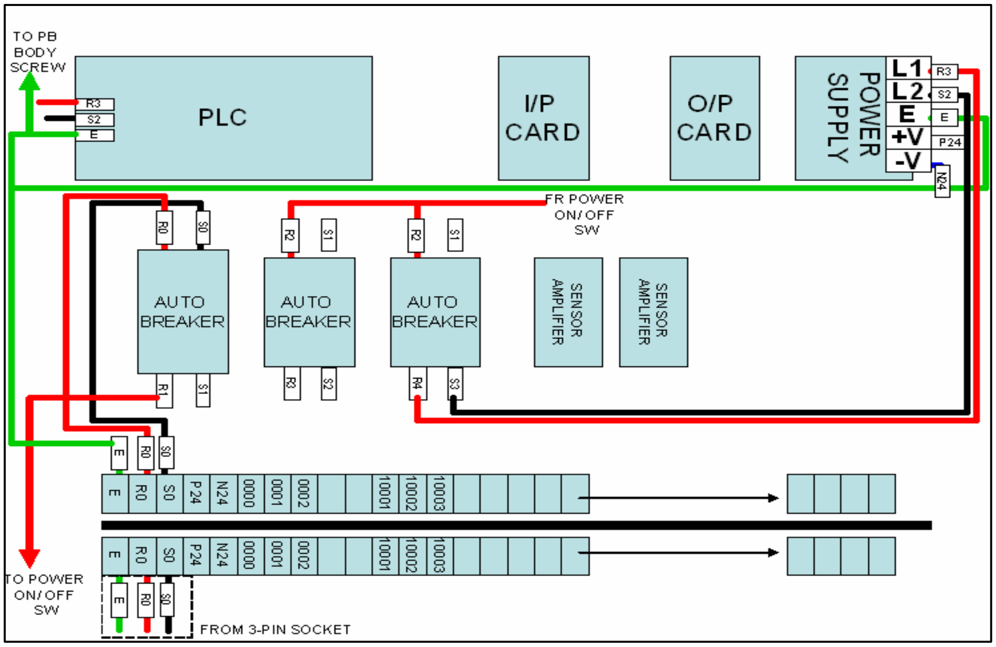

Figure 2.6 PLC cabinet box wiring diagram

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The PLC input wiring address start with number 0.00 to 0.15 for every input card. When the other input card is install to the PLC socket the address for this input card will start with number 1.00 to 1.15 and so on. Figure 2.7 shows the wiring diagram for input card which this input card connects to sensor (limit switch) at traffic light model.

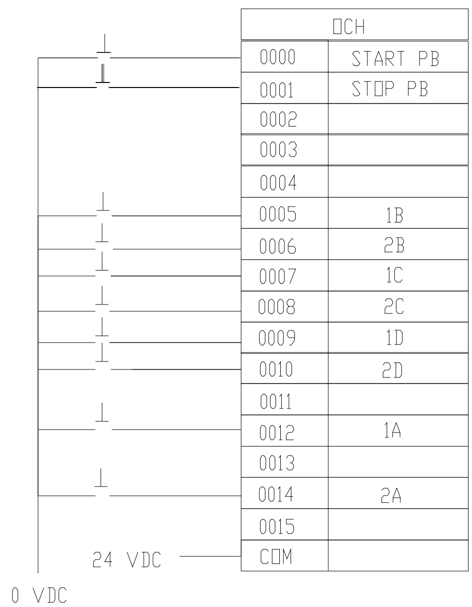

Figure 2.7 Input wiring diagram

The PLC outputs wiring address start with number 100.00 to 100.07 for every output card. When the other output card is install to the PLC socket the address for this output card will start with number 101.00 to 101.07 and so on. The figure 2.8 show the wiring diagram for output card which output card connect to sensor (limit switch) at traffic light model.

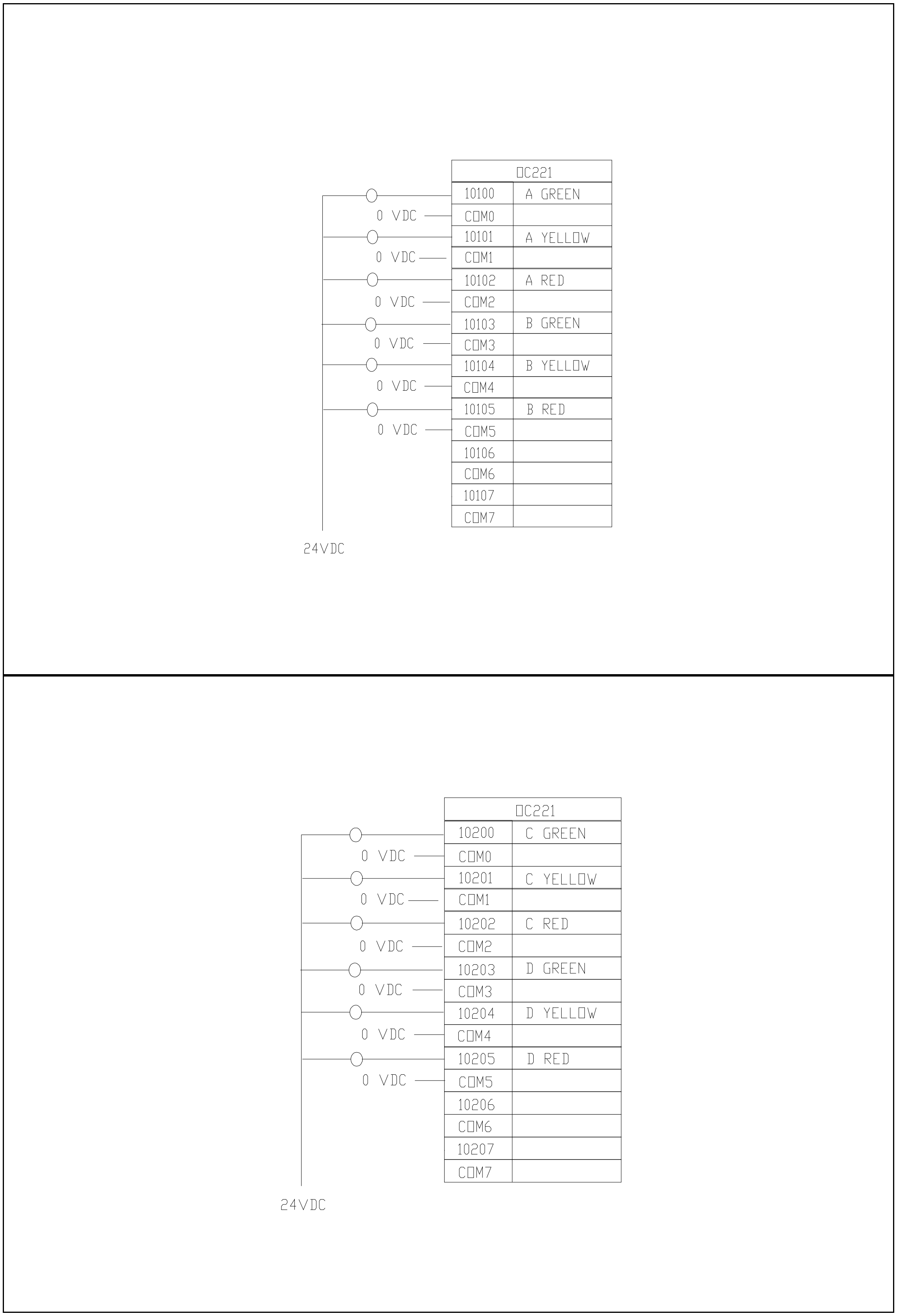

Figure 2.8 Output wiring diagram

CHAPTER 3

SYSTEM SOFTWARE

3.1 Introduction to CX-Programmer software

CX-Programmer is a PLC programming tool for the creation, testing and maintenance of programs associated with Omron CSI-series PLCs, CV-series PLCs and C-series PLCs. It provides facilities for support of PLC device and address information and for communications with OMRON PLCs and their supported network

CX-Programmer operates on IBM compatible personal computers with Pentium or better central processors, including Pentium II. It run in a Microsoft windows environment. The information within a CX-Programmer project consists of ladder programs, operands, required PLC memory content, I/O table, expansion instructions (if applicable) and symbols. Each CX-Programmer project file is separate and is a single document.

CX-Programmer can only open a single project at a time. However, it is possible to deal with many project files by using CX-Programmer at once. A CX-Programmer project has a CXP or CXT file extension (normally the CXP file is used and is a compressed version of the CXT file).

3.2 Diagram workspace

The diagram workspace can display a ladder program, the symbol table of that program or the Mnemonic view. The details displayed depend upon the selection made in the project workspace.

When a new project is created or a new PLC added to a project, an empty ladder is automatically displayed on the right-hand side to the project workspace. The symbol table and Mnemonics view must be explicitly selected to be displayed. All views can be opened at the same time and can selected via option associated with the window menu.

PLC program instruction can be entered as a graphical representation in ladder form. Programs can be created, edited, and monitored in this view. The 3.1 shows the diagram workspace appearance.

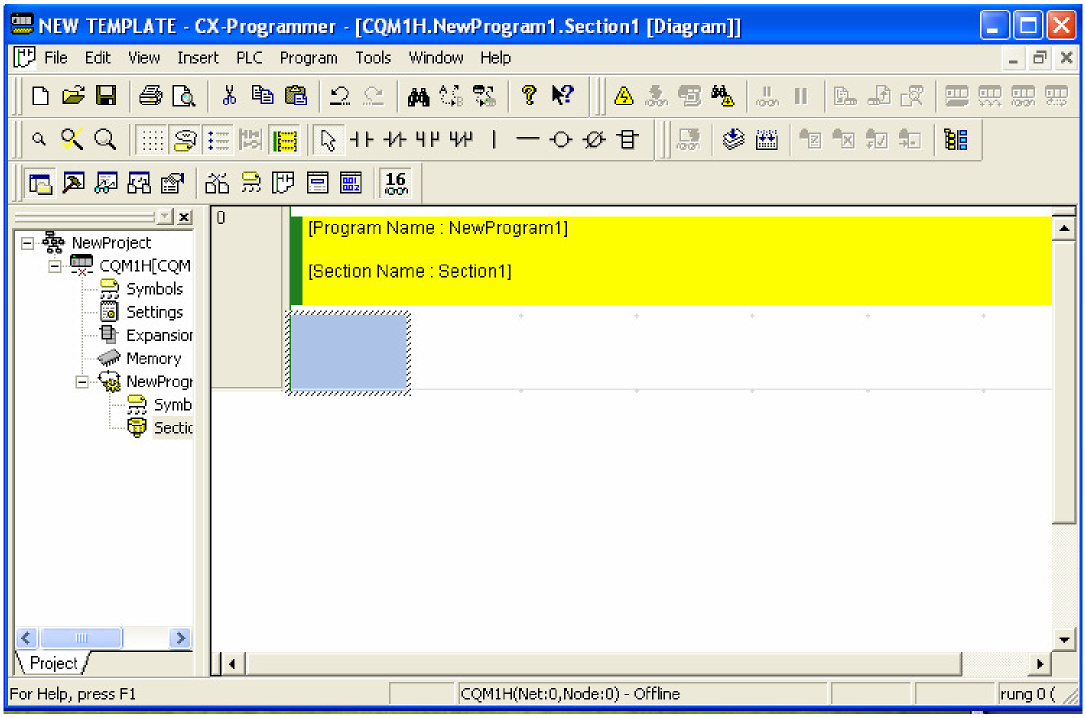

Figure 3.1 Programming section

3.3 Program development.

Before construct a ladder logic diagram, program flowchart is ideal for a process that has sequential process steps. The steps will be executed in a simple order that may change as the result of some simple decisions. The block symbol is connected using arrow to indicate the sequence of the steps and different types of program actions. The other functions may be used but are not necessary for most PLC applications.

A flowchart in figure 3.2 shows about how the lane changes to the other lane for a green signal. This traffic light system is working independently to change from one lane to the other lane based on which lane can activate sensor 1 fast. This traffic light system give the priority to the lane which have a car and followed by the other..

This traffic light control system operate similar to intelligent traffic light system which it only give a green signal to the lane which have a vehicles and not like a common traffic light control system which have a fix rotation for each lane.

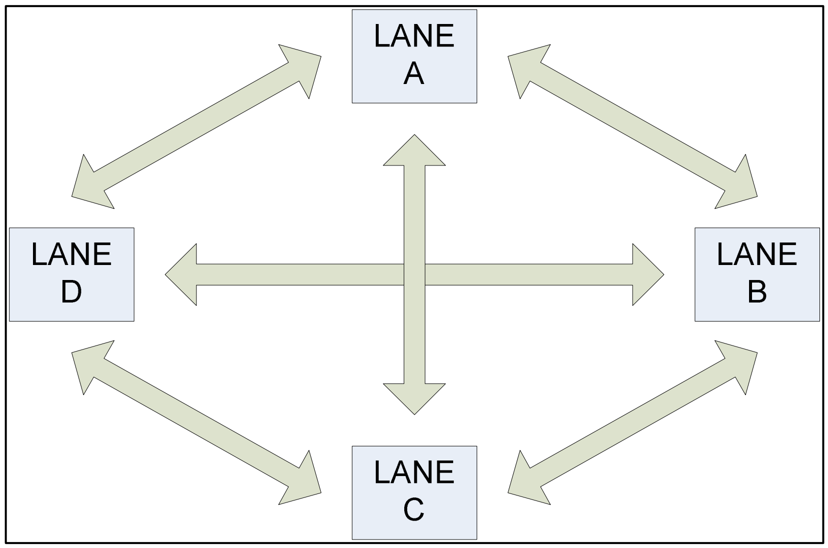

Figure 3.2 Traffic phase flowchart

Figure 3.3 shows a sample ladder logic diagram that has been constructed for the flowchart is shown in figure for the lane A. The ladder diagram for the other lanes is similar with this ladder diagram but the memories for the contacts are different.

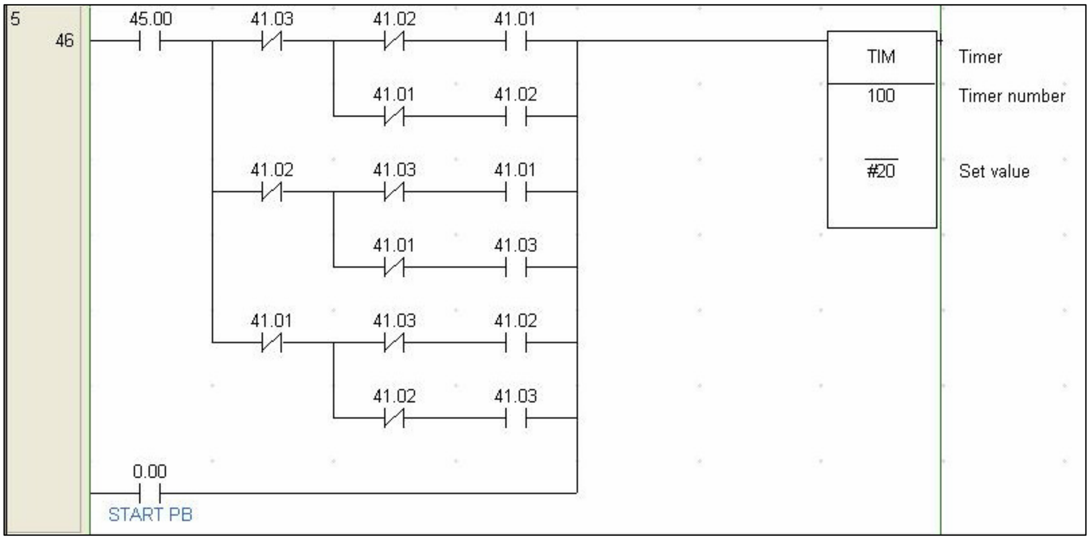

Figure 3.3 Lane phase ladder diagram

Figure 3.4 shows a program flowchart for changing traffic light signal at the specific lane. A red signal will turn to green signal if a sensor 1 is activated. If the sensor 2 is activated before a red signal turn to a green signal, a green signal will hold for a 20s and if not a green signal only hold for a 10s. A green signal will hold the that time or extend more than time if sensor 1 from other lanes are not activated. When the sensor 1 from the other lanes activate, a green signal will turn into a yellow signal for 2s and then back to red signal. For safety, the other lanes will change to a green signal after 2s.

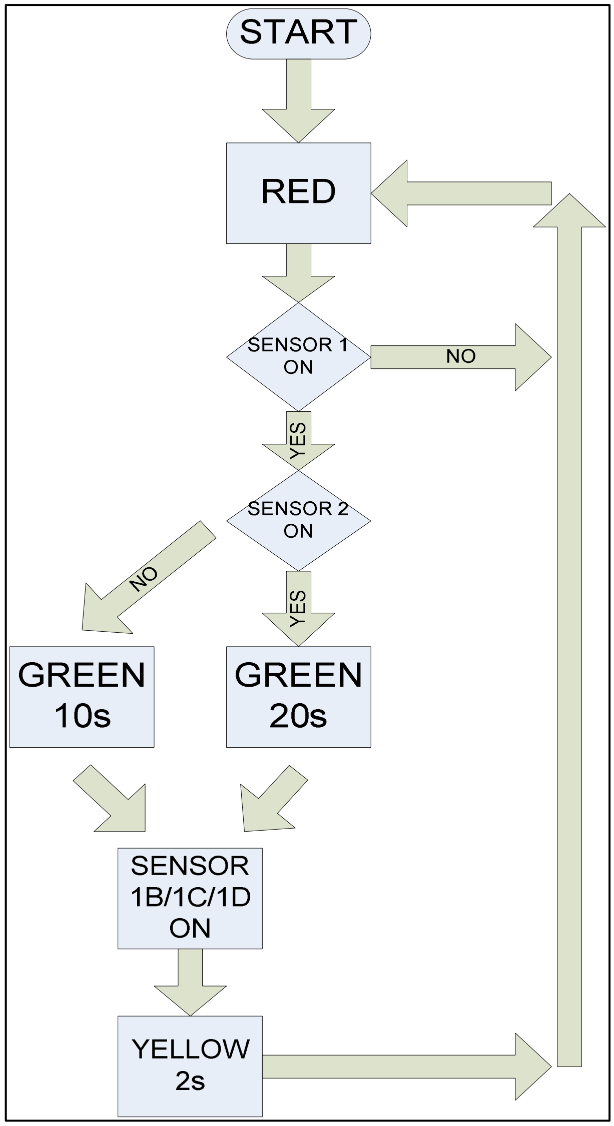

Figure 3.4 Program flowchart

Figure 3.5 shows a sample ladder logic diagram has been constructed for the lane A. The ladder diagram for the other lanes is similar with this ladder diagram but the memory for the contacts is different. The address for every traffic signal are different based on hardware design when wiring the indicator lamp from traffic light model to output card at PLC cabinet box. The set value of the timer can change for a desired value based on distance between sensor 1 and sensor 2.

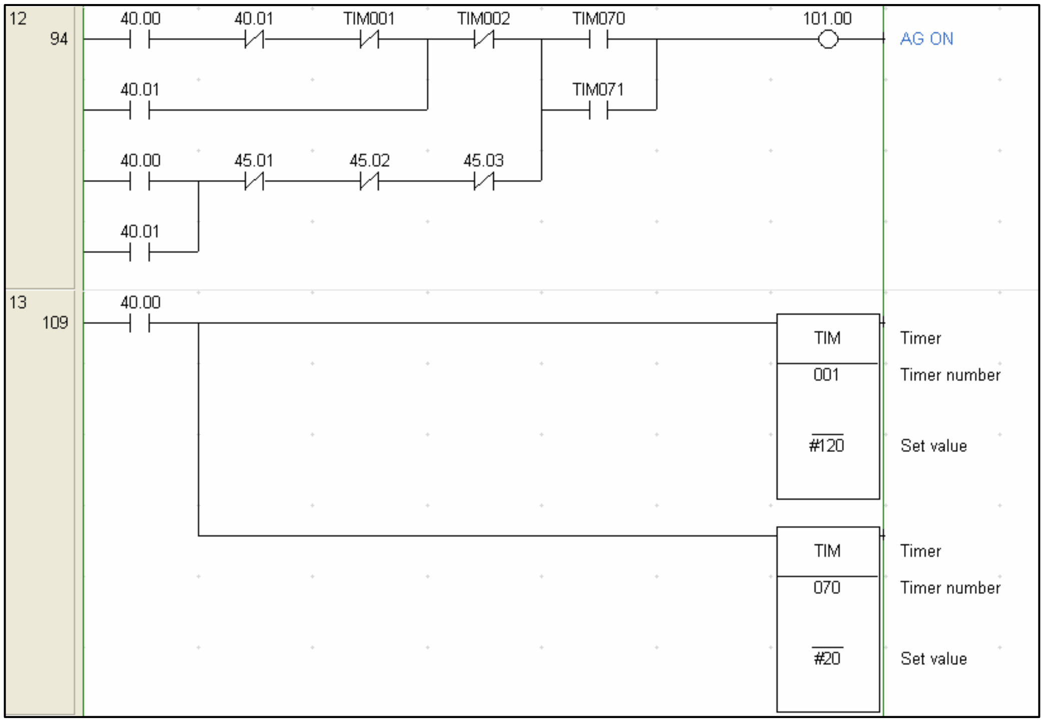

Figure 3.5 Program ladder diagram

CHAPTER 4

RESULT & ANALYSIS

4.1 Introduction

This chapter will discusses all the finding results after hardware and software development. This chapter also includes the analysis from the simulation of this project and setup configuration for simulation in the real world.

4.2 Input and Output testing

Input and Output of the traffic light could be tested to know either the address from PLC is similar with the sensor and indicator lamp from hardware or not. To check the address between PLC and traffic light model is similar with the wiring diagram made before, a ladder logic diagram from software may testify either the connection between PLC and sensor and traffic signal are correct. The table 4.1 and 4.2 show the address connection between PLC and input/output on traffic light model.

Table 4.1 Input addresses

INPUT	ADDRESS
SENSOR 1A	0.12
SENSOR 2A	0.14
SENSOR 1B	0.05
SENSOR 2B	0.06
SENSOR 1C	0.07
SENSOR 2C	0.08
SENSOR 1D	0.09
SENSOR 2D	0.1

Table 4.2 Output addresses

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OUTPUT	ADDRESS
A RED	101.02
A YELLOW	101.01
A GREEN	101
B RED	101.05
B YELLOW	101.04
B GREEN	101.03
C RED	102.02
C YELLOW	102.01
C GREEN	102
D RED	102.05
D YELLOW	102.04
D GREEN	102.03

Figure 4.1 shows the ladder diagram for testing the every input and output of the system. This figure shows the example to testify input sensor 1A and output A Red. The indicator lamp A Red will on. By using this ladder diagram all input and output will be tested.

Figure 4.1 Testing input/output ladder diagram

4.3 Traffic light control system analysis

Since in the beginning, this project objective is to develop a new traffic light control system and reduce traffic congestion at the junction. At the end, a new traffic light system is well developed by using two sensors. This sensors is to determine the traffic volume at the lane when waiting a green signal to go through the junction. With this sensors the volume of traffic can be determined and the system can choose a suitable time for green signal once get their turn.

The common traffic light system have fix their time for every signal of traffic light, it cause the traffic congestion when each lane have a high volume of vehicles. It also wastes time for waiting at traffic light when the lower volume of traffic at certain time. The tables 4.3 show the comparison about time between this project traffic light control system and preset cycle time system.

Table 4.3 Preset Cycle Time lane and phase duration

LANE	RED	YELLOW	GREEN
A	66s	2s	20s
B	66s	2s	20s
C	66s	2s	20s
D	66s	2s	20s

Table 4.3 shows time duration for preset cycle time traffic control system. This type of traffic light system has fix duration for traffic signal and rotation lane. So the time for waiting for the next lane to turn green signal is about 22 second to 66 second. If now the lane A get a green signal and then only lane D have a vehicle waiting at the junction, it must wait for 66 second before the lane D change to a green signal. This type of traffic light control system is not effective and cost wasted time and energy. It also causes the traffic congestion when waiting too long at traffic light junction.

Table 4.4 New traffic light control system phase and lane duration

LANE	RED	YELLOW	GREEN	
			SENSOR 1	SENSOR 2
A	-	2s	10s	20s
B	-	2s	10s	20s
C	-	2s	10s	20s
D	-	2s	10s	20s

Table 4.4 shows time duration for this project development a traffic light control system. This type of traffic light system is freely changing the lane to the other lane based on the priority if any of 1st vehicles presence at traffic light junction. This traffic light system not depends on lane rotation and effective and reduces time and energy. It effective when the volume of traffic is low at certain time because the time for a green signal is different depends on volume of traffic at lane.

4.4 Simulation in the real world.

In order to apply this project traffic light control system, there had some criterion that had to be determined. Firstly, the situation of traffic condition at junction. The average volume of traffic at junction must be verified because from this data we know where sensor 2 will place at that lane. This criterion is very important because the efficient and effective of this traffic light system depend with these sensors. The other criterion is time for a green signal on when only sensor 1 activates or sensor 2 also activate. The table 4.5 is the suggestion times for a green signal depend on distance from sensor 1 to sensor 2.

Table 4.5 Sensor distance

DISTANCE	SENSOR 1	SENSOR 2
50M	10s	20s
100M	25s	50s
150M	55s	110s
200M	120s	250s

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

At the end of this project, the traffic light successfully controlled by PLC. The software and hardware part can operate together without any problem. The design of ladder logic diagram is based on program flow chart. This intelligent traffic light control system operate smoothly without any conflict or error coming from input or output in many condition when running the simulation. It is better running a simulation of this traffic light control system in the real world to discover any weakness of this system.

5.2 Recommendation

For the future development, this traffic light controller can be upgrade by replace the sensor with using any suitable type of vision sensor. It can reduce applied more sensor because only one sensor enough to detect any distance vehicles at the lane. It is more accurate to determine a volume of traffics than any type of sensors use for this project. By using this vision sensor, it easier to apply a fuzzy logic method on this traffic light control system.

5.2.1 Costing and commercialization

Table 5.1 shows the cost that use for this project.

Table 5.1 Cost of project

No	Component	Cost per unit	Quantity	Total cost
1	Limit switch	RM 1.20	8	RM 9.60

This project is very valuable to commercial because the traffic congestion problem have an effect on our life everyday. In addition, delays due to traffic congestions also indirectly affect productivity, efficiency and energy losses. This traffic light controller is new types of highly effective practical traffic light controllers because this system will decrease the traffic congestion at traffic light. By applied this traffic light controller the traffic congestion issue can be solved.

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Traffic light summary

[2] www.answer.com/trafficlight
Traffic light: definition

[3] http://en.wikipedia.org/wiki/trafficlight

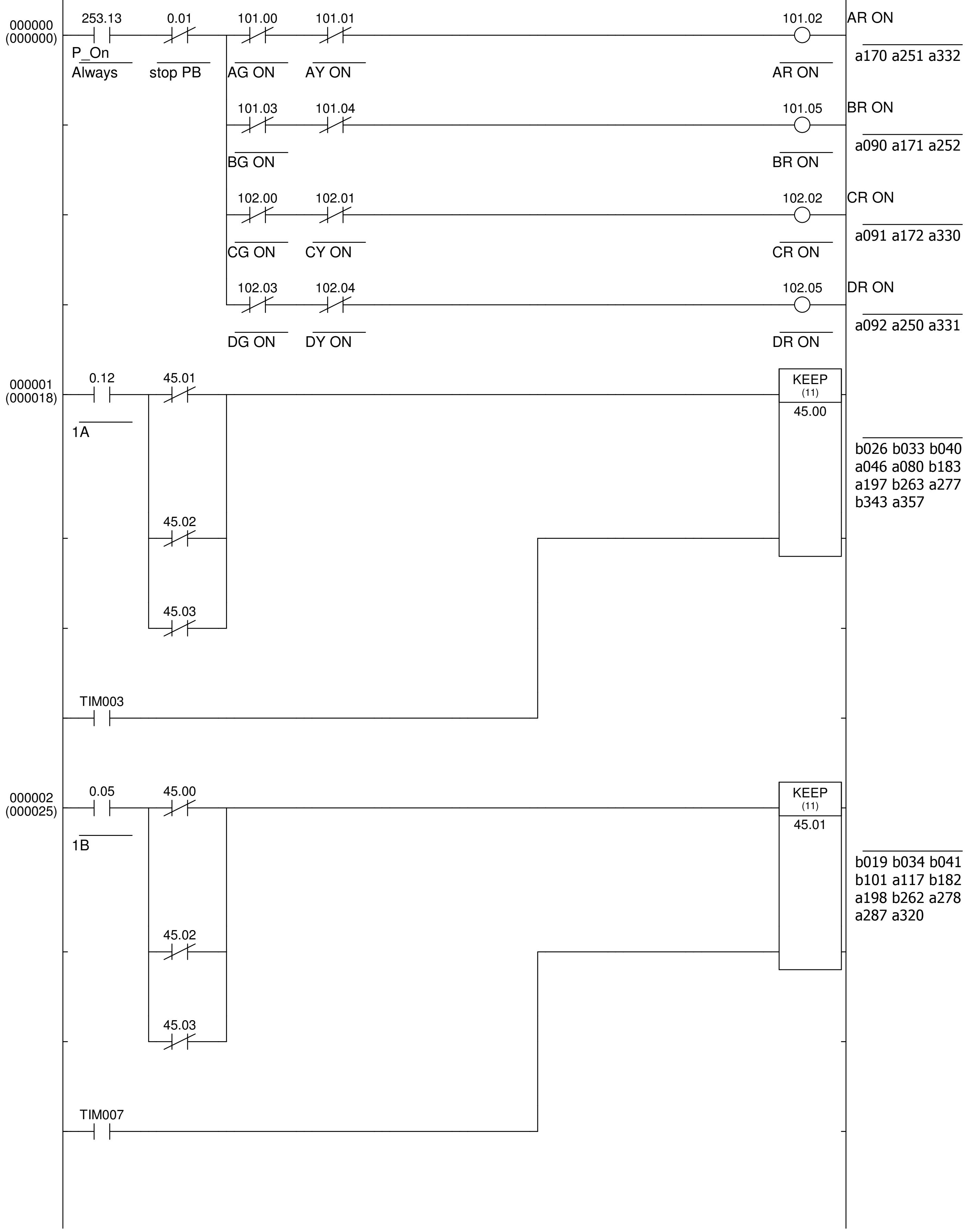
[4] John K. Hackworth and Federick D. Hackworth "Programmable logic controllers: Programming methods & applications

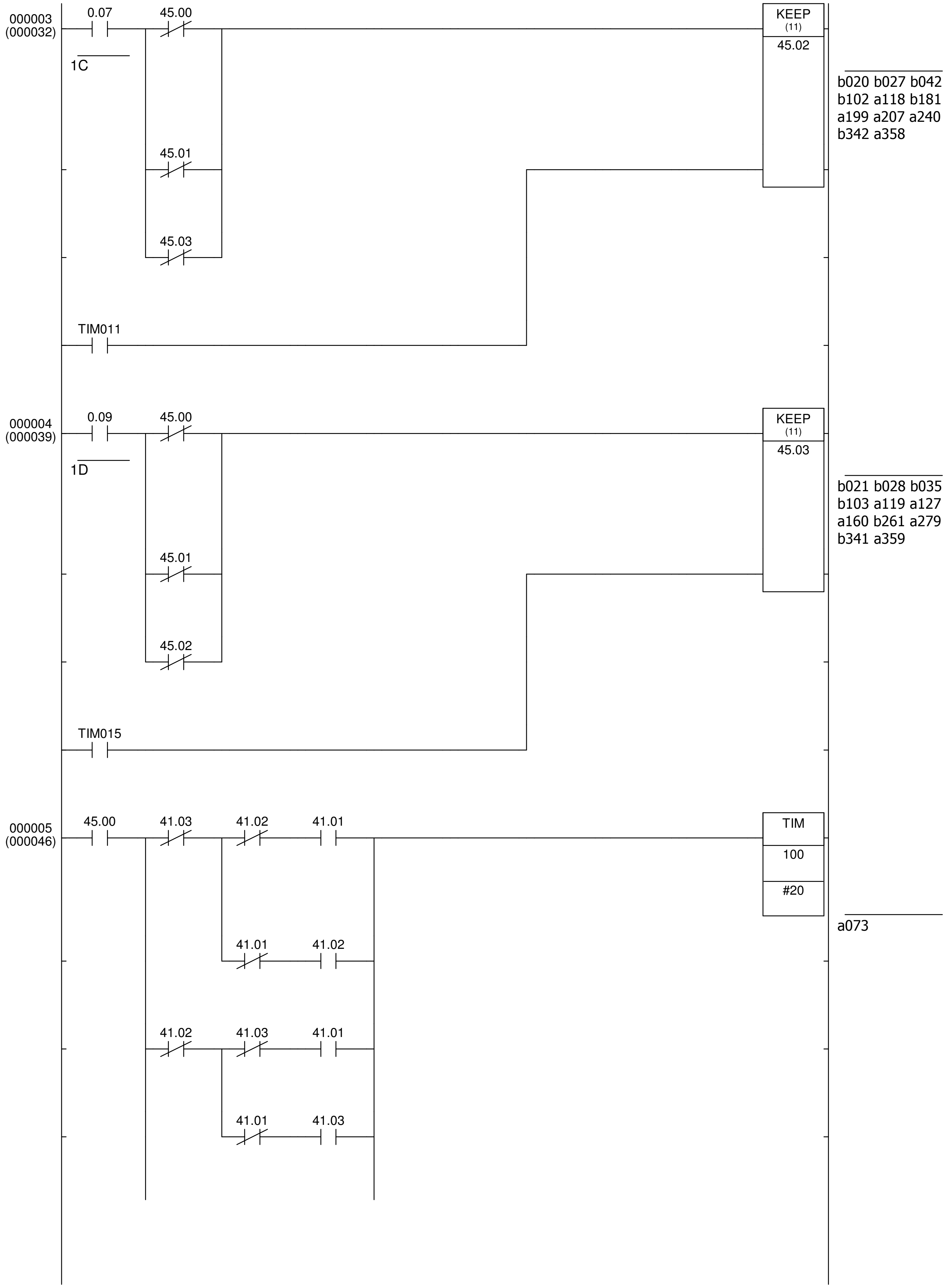
[5] Hugh Jack "Automating manufacturing system with PLC"

[6] FKEE PLC notes

[Program Name : Section1]

[Section Name : Section1]

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(000032)
0.07
1C
45.00
45.01
45.03
TIM011
KEEP
(11)
45.02
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b102 a118 b181
a199 a207 a240
b342 a358
000004
(000039)
0.09
1D
45.00
45.01
45.02
TIM015
KEEP
(11)
45.03
b021 b028 b035
b103 a119 a127
a160 b261 a279
b341 a359
000005
(000046)
45.00
41.03
41.02
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41.02
41.03
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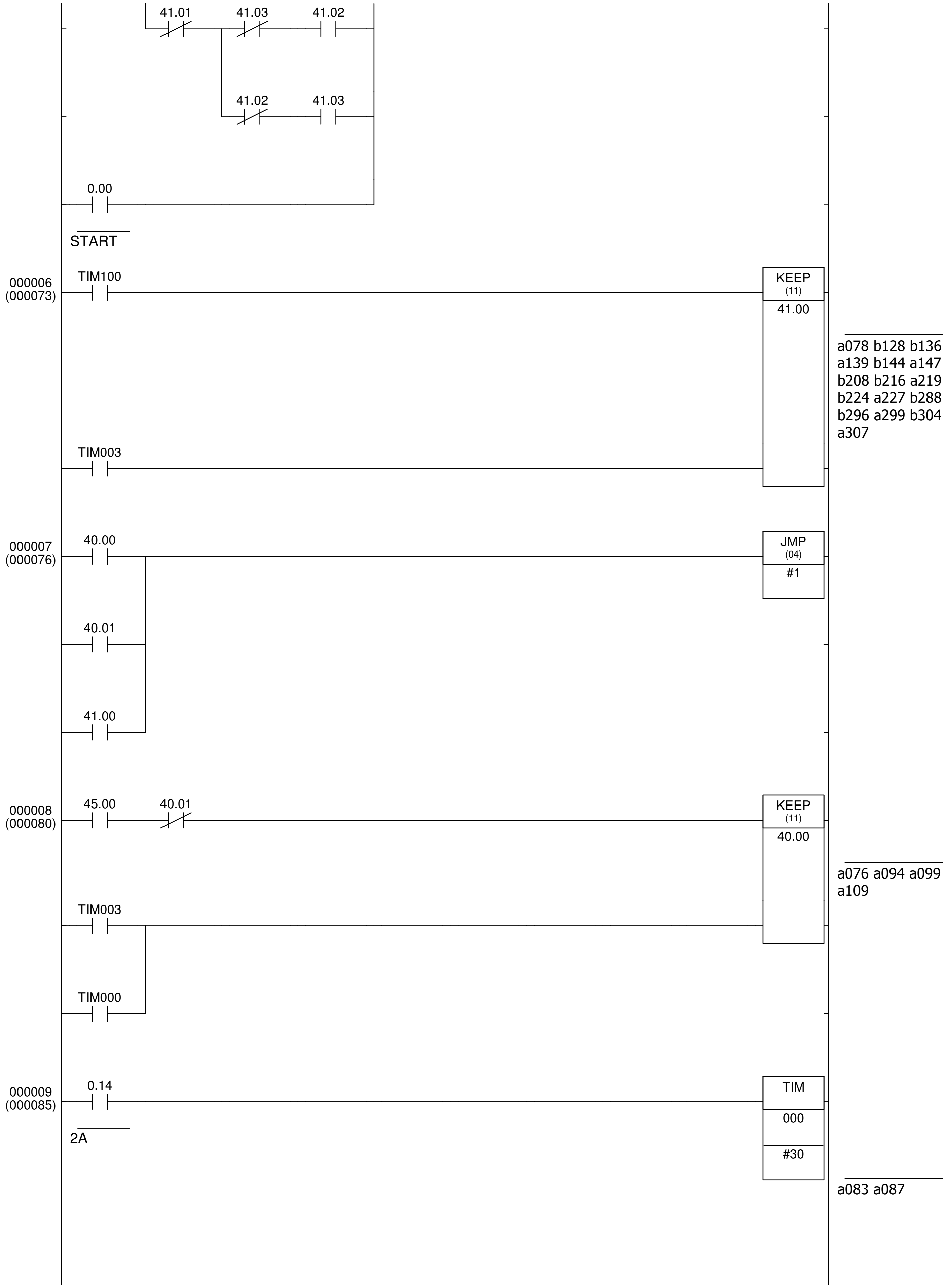
41.03
TIM
100
#20
a073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41.02
41.02
41.03
0.00
START
000006
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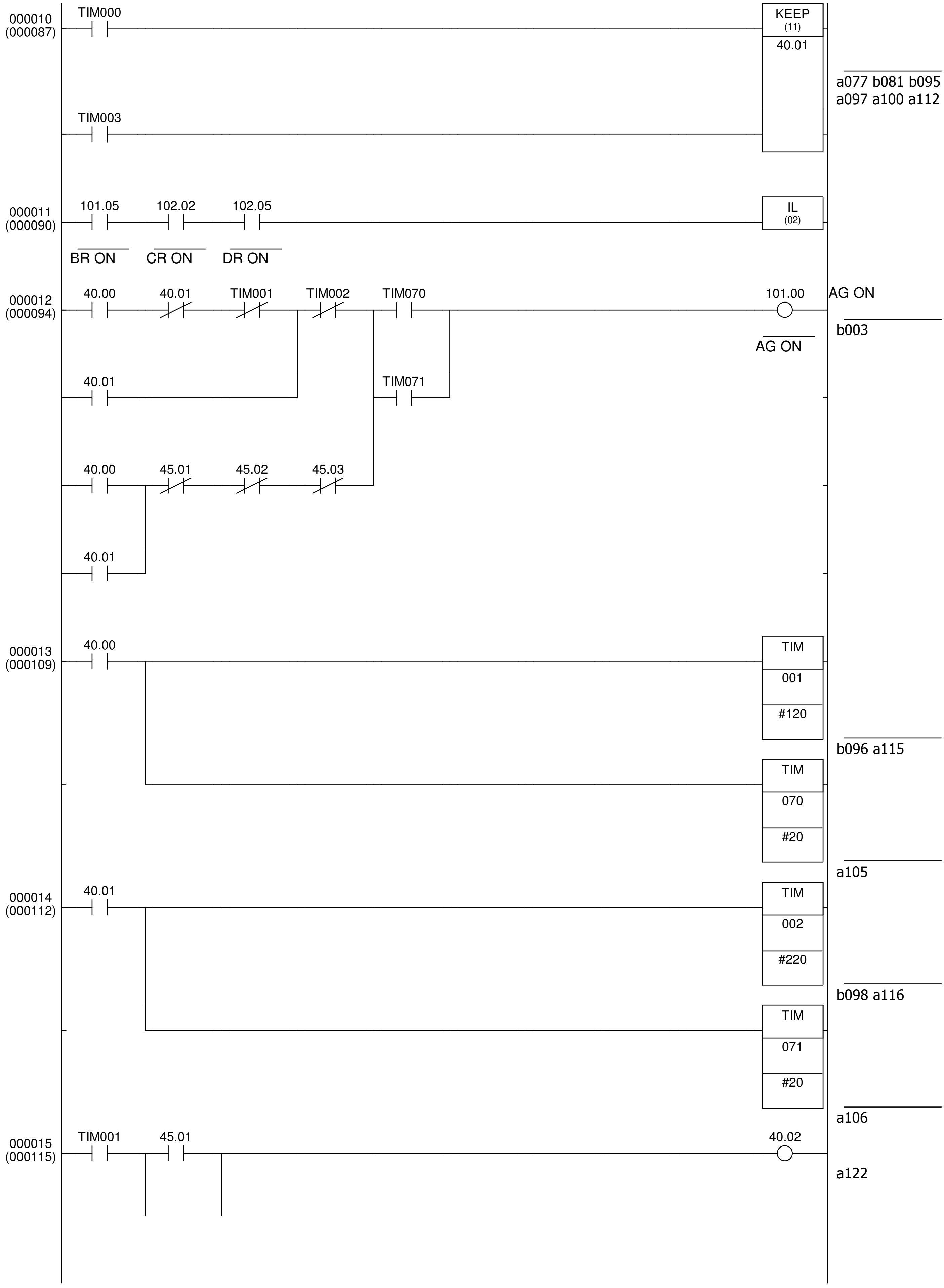
TIM100
KEEP
(11)
41.00
a078 b128 b136
a139 b144 a147
b208 b216 a219
b224 a227 b288
b296 a299 b304
a307
TIM003
000007
(000076)
40.00
JMP
(04)
#1
40.01
41.00
000008
(000080)
45.00
40.01
KEEP
(11)
40.00
a076 a094 a099
a109
TIM003
TIM000
000009
(000085)
0.14
2A
TIM
000
#30
a083 a087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TIM000
TIM003
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(11)
40.01
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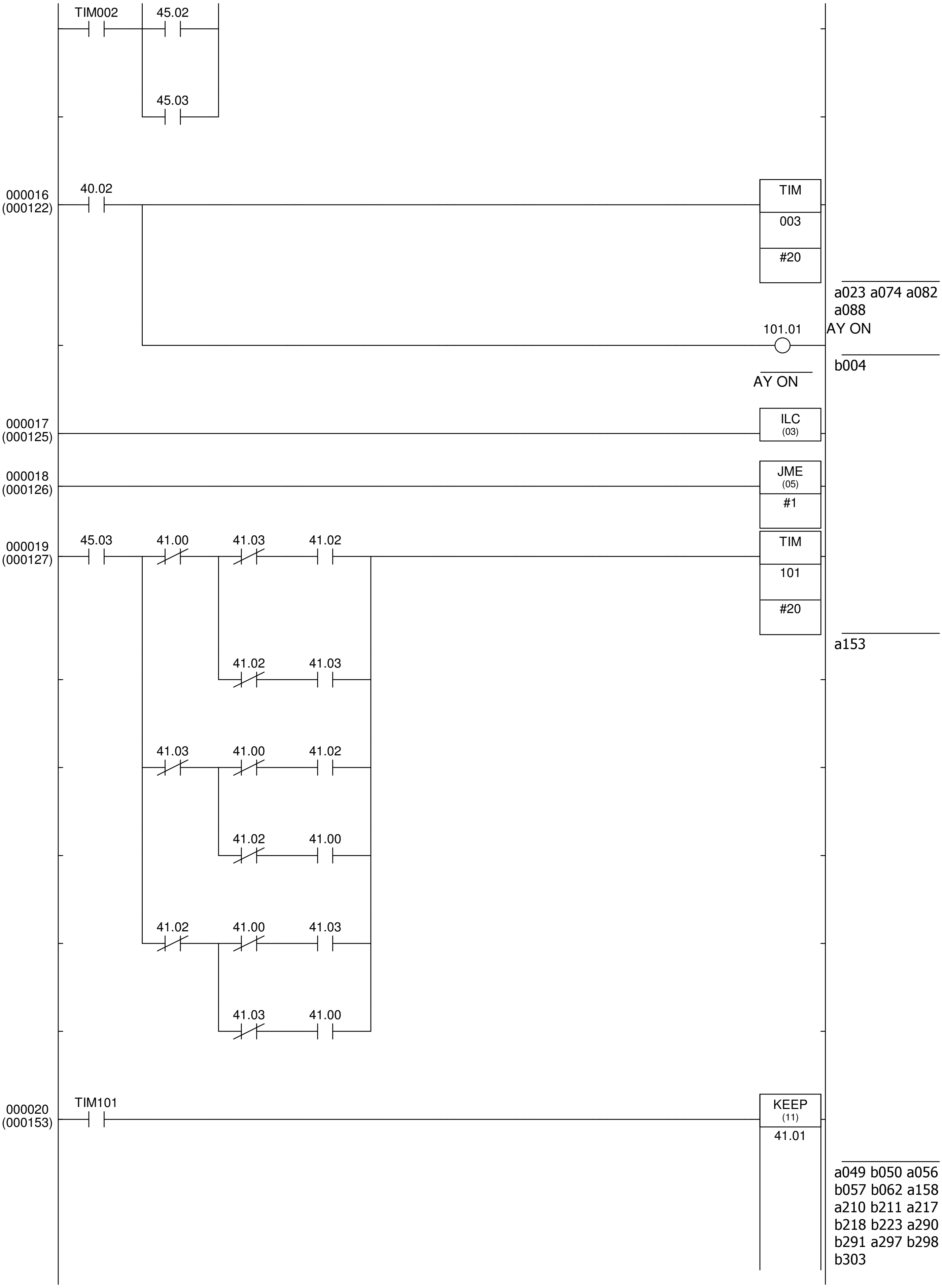
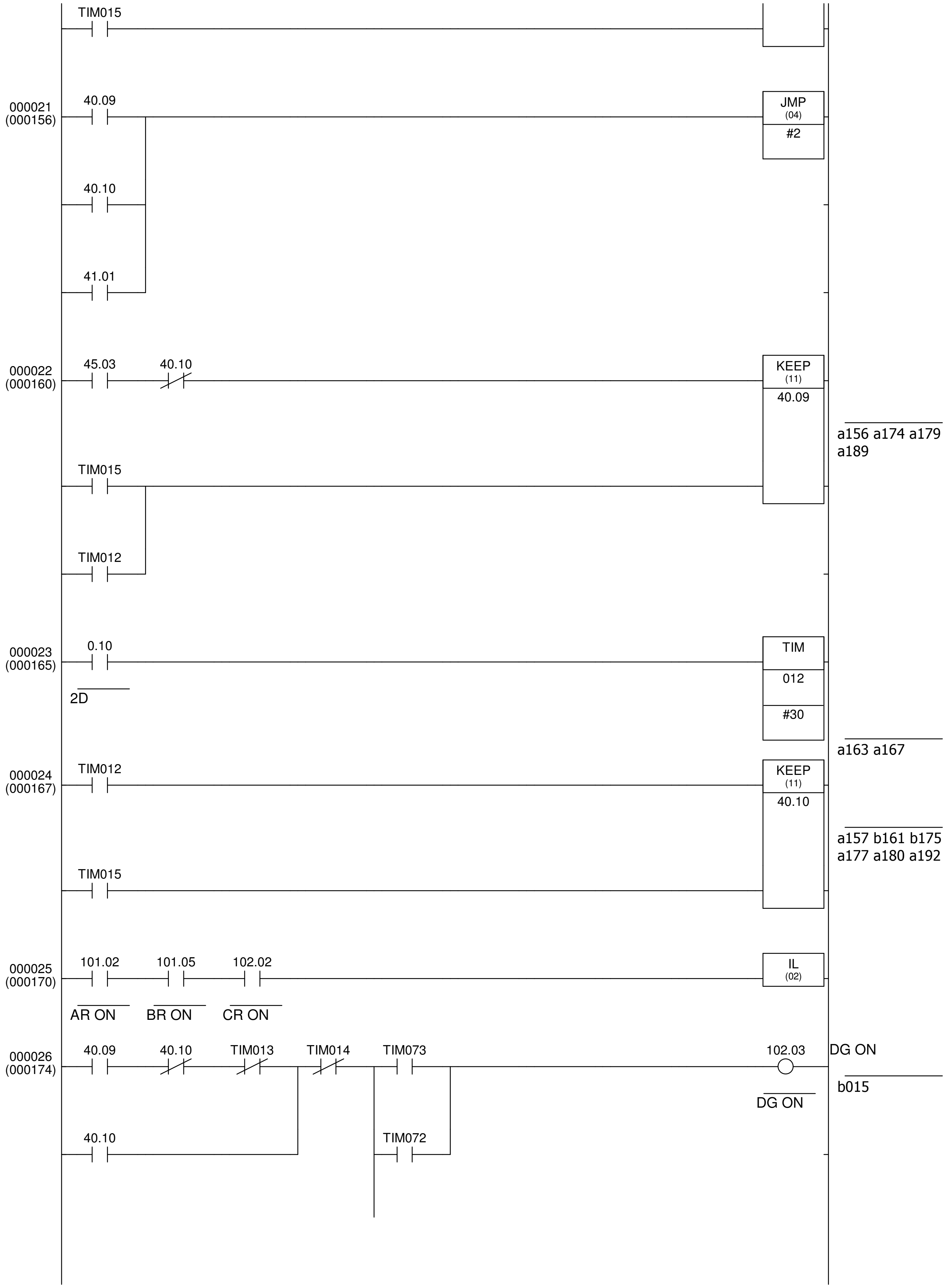
101.05
102.02
102.05
BR ON
CR ON
DR ON
IL
(02)
000012
(000094)
40.00
40.01
TIM001
TIM002
TIM070
101.00
AG ON
AG ON
b003
40.01
TIM071
40.00
45.01
45.02
45.03
40.01
000013
(000109)
40.00
TIM
001
#120
b096 a115
TIM
070
#20
a105
000014
(000112)
40.01
TIM
002
#220
b098 a116
TIM
071
#20
a106
000015
(000115)
TIM001
45.01
40.02
a122


TIM002
45.02
45.03
000016
(000122)
40.02
TIM
003
#20
a023 a074 a082
a088
101.01
AY ON
b004
AY ON
000017
(000125)
ILC
(03)
000018
(000126)
JME
(05)
#1
000019
(000127)
45.03
41.00
41.03
41.02
TIM
101
#20
a153
41.02
41.03
41.03
41.00
41.02
41.02
41.00
41.02
41.00
41.03
41.03
41.00
000020
(000153)
TIM101
KEEP
(11)
41.01
a049 b050 a056
b057 b062 a158
a210 b211 a217
b218 b223 a290
b291 a297 b298
b303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000021
(000156)
40.09
40.10
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JMP
(04)
#2
000022
(000160)
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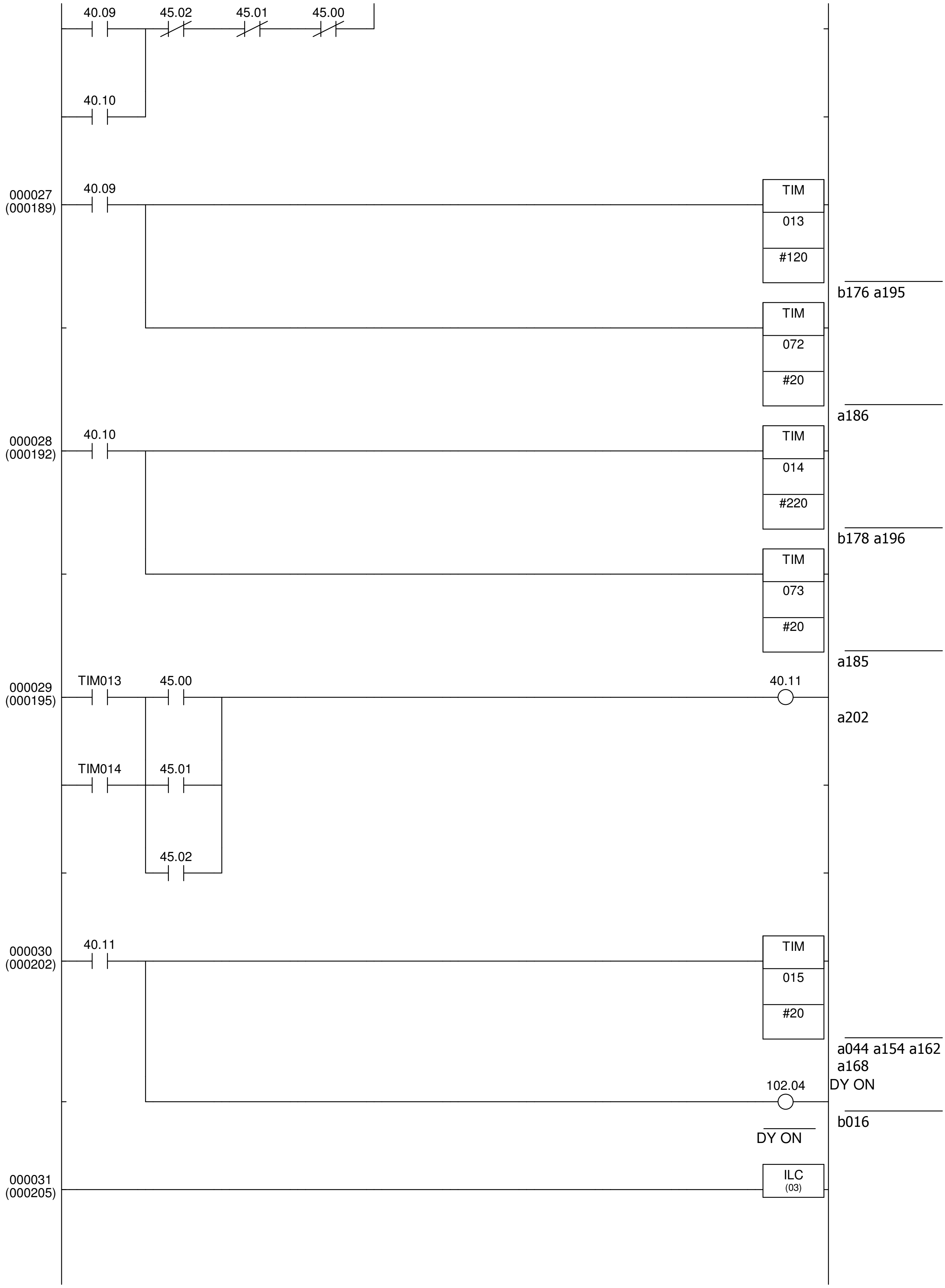
40.10
TIM015
TIM012
KEEP
(11)
40.09
a156 a174 a179
a189
000023
(000165)
0.10
2D
TIM
012
#30
a163 a167
000024
(000167)
TIM012
TIM015
KEEP
(11)
40.10
a157 b161 b175
a177 a180 a192
000025
(000170)
101.02
101.05
102.02
AR ON
BR ON
CR ON
IL
(02)
000026
(000174)
40.09
40.10
TIM013
TIM014
TIM073
40.10
TIM072
102.03
DG ON
DG ON
b015



40.09
45.02
45.01
45.00
40.10
000027
(000189)
40.09
TIM
013
#120
b176 a195
TIM
072
#20
a186
000028
(000192)
40.10
TIM
014
#220
b178 a196
TIM
073
#20
a185
000029
(000195)
TIM013
45.00
40.11
a202
TIM014
45.01
45.02
000030
(000202)
40.11
TIM
015
#20
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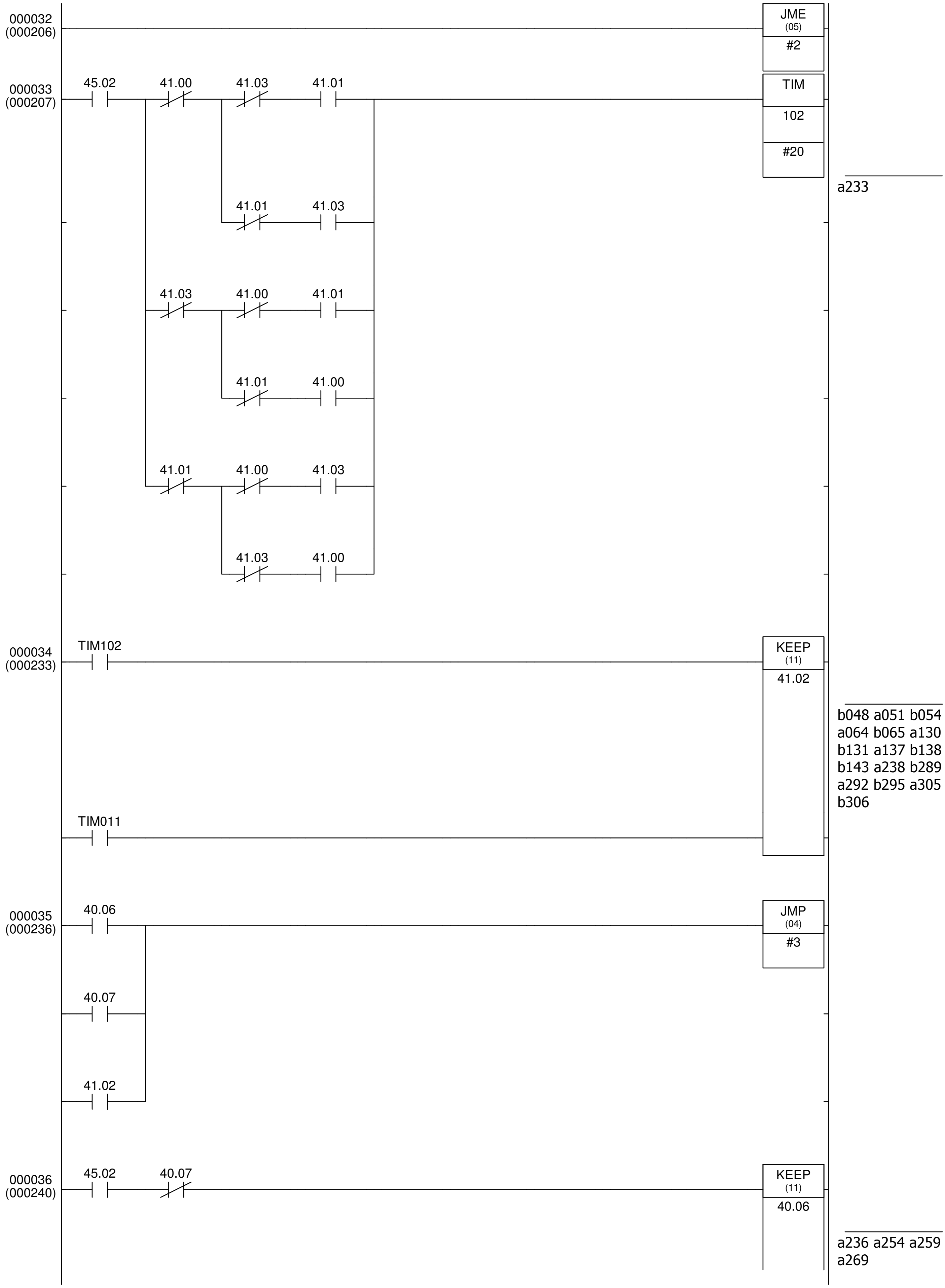
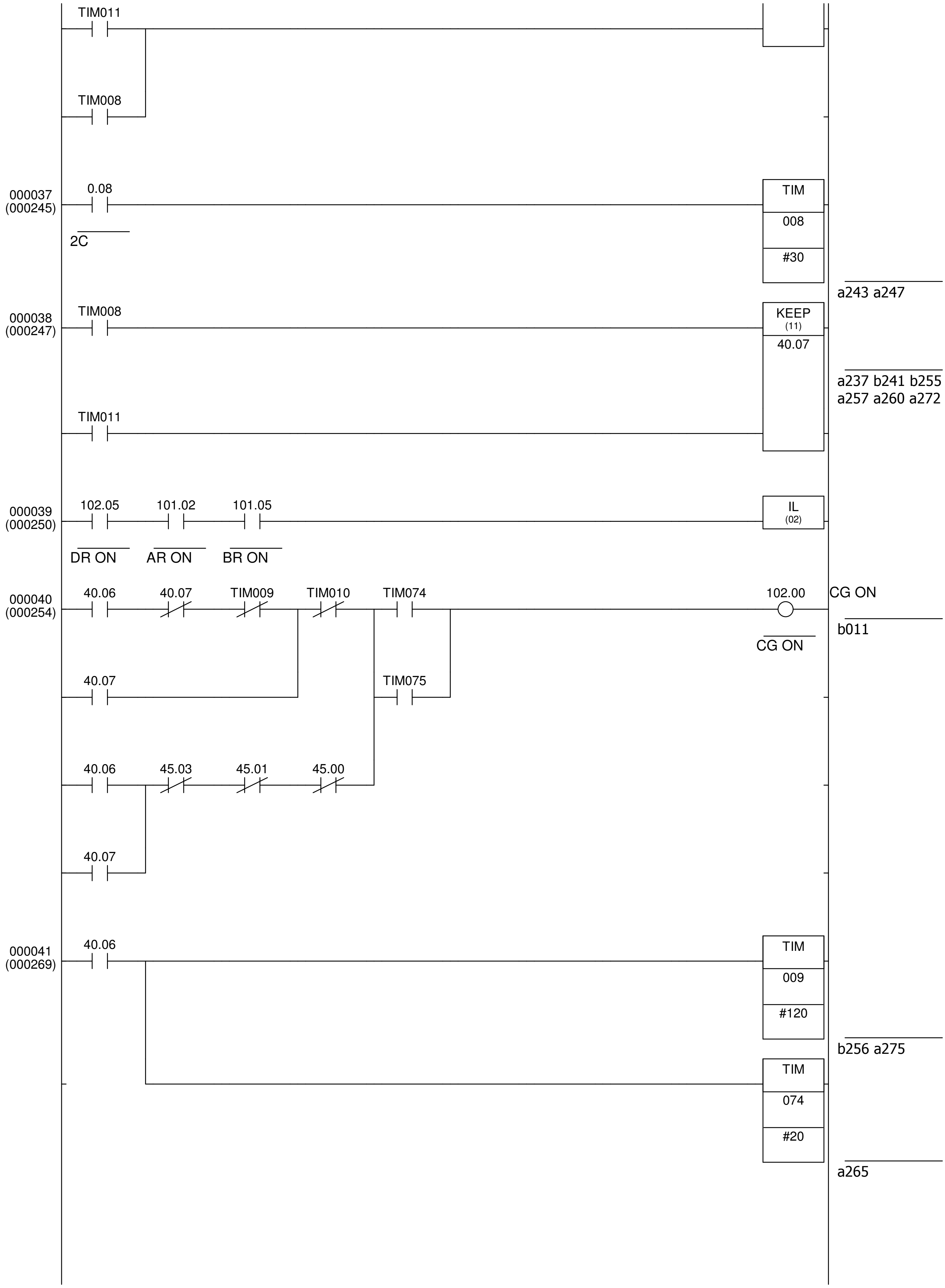
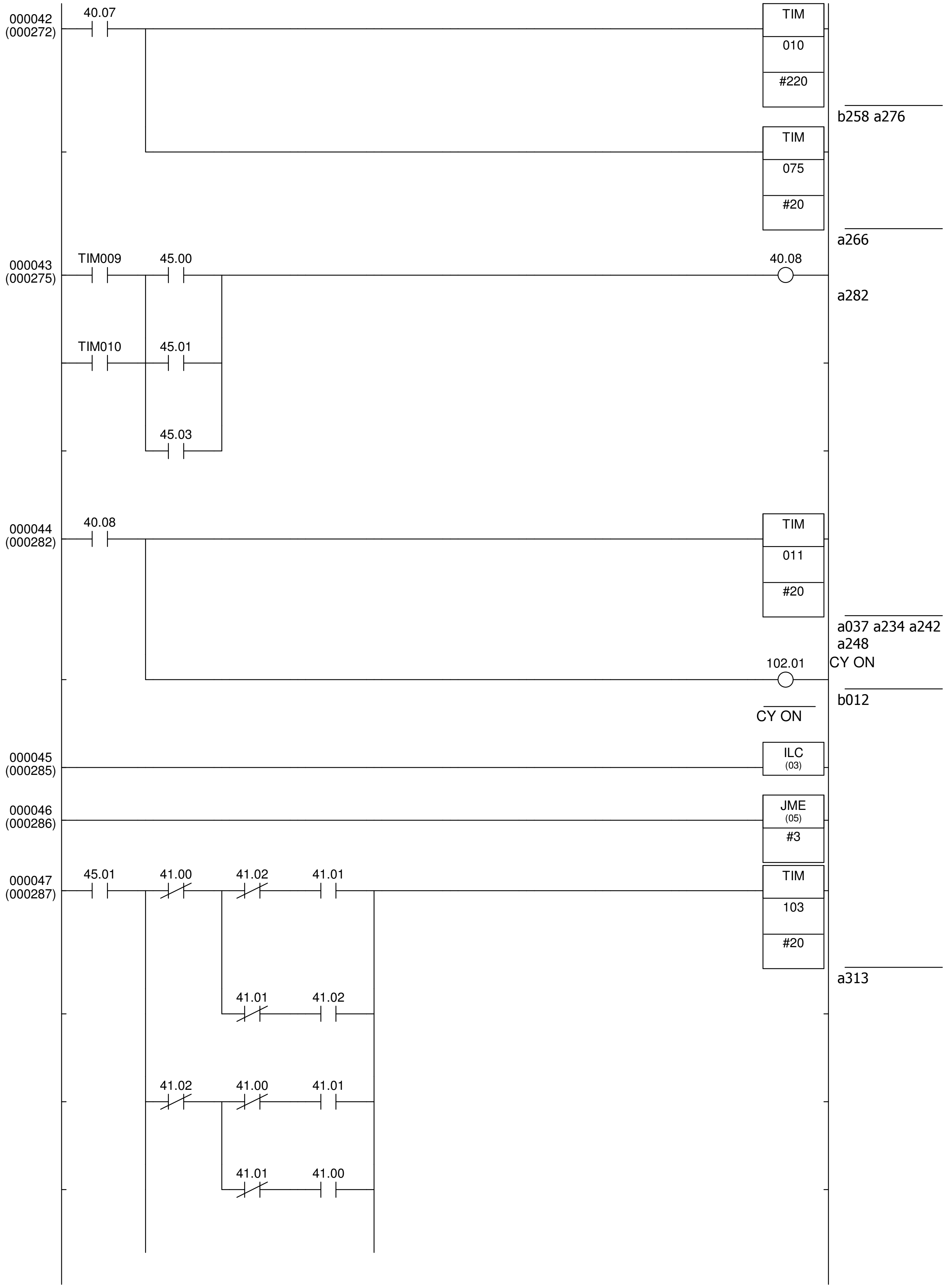
a168
DY ON
102.04
b016
DY ON
000031
(000205)
ILC
(03)


000032
(000206)
JME
(05)
#2
000033
(000207)
45.02
41.00
41.03
41.01
TIM
102
#20
a233
41.01
41.03
41.03
41.00
41.01
41.01
41.00
41.01
41.00
41.03
41.03
41.00
000034
(000233)
TIM102
KEEP
(11)
41.02
b048 a051 b054
a064 b065 a130
b131 a137 b138
b143 a238 b289
a292 b295 a305
b306
TIM011
000035
(000236)
40.06
JMP
(04)
#3
40.07
41.02
000036
(000240)
45.02
40.07
KEEP
(11)
40.06
a236 a254 a259
a269



TIM011
TIM008
000037
(000245)
0.08
2C
TIM
008
#30
a243 a247
000038
(000247)
TIM008
KEEP
(11)
40.07
a237 b241 b255
a257 a260 a272
TIM011
000039
(000250)
102.05
101.02
101.05
IL
(02)
DR ON
AR ON
BR ON
000040
(000254)
40.06
40.07
TIM009
TIM010
TIM074
102.00
CG ON
b011
CG ON
40.07
TIM075
40.06
45.03
45.01
45.00
40.07
000041
(000269)
40.06
TIM
009
#120
b256 a275
TIM
074
#20
a265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TIM
010
#220
b258 a276
TIM
075
#20
a266
000043
(000275)
TIM009
45.00
40.08
a282
TIM010
45.01
45.03
000044
(000282)
40.08
TIM
011
#20
a037 a234 a242
a248
CY ON
102.01
b012
CY ON
000045
(000285)
ILC
(03)
000046
(000286)
JME
(05)
#3
000047
(000287)
45.01
41.00
41.02
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TIM
103
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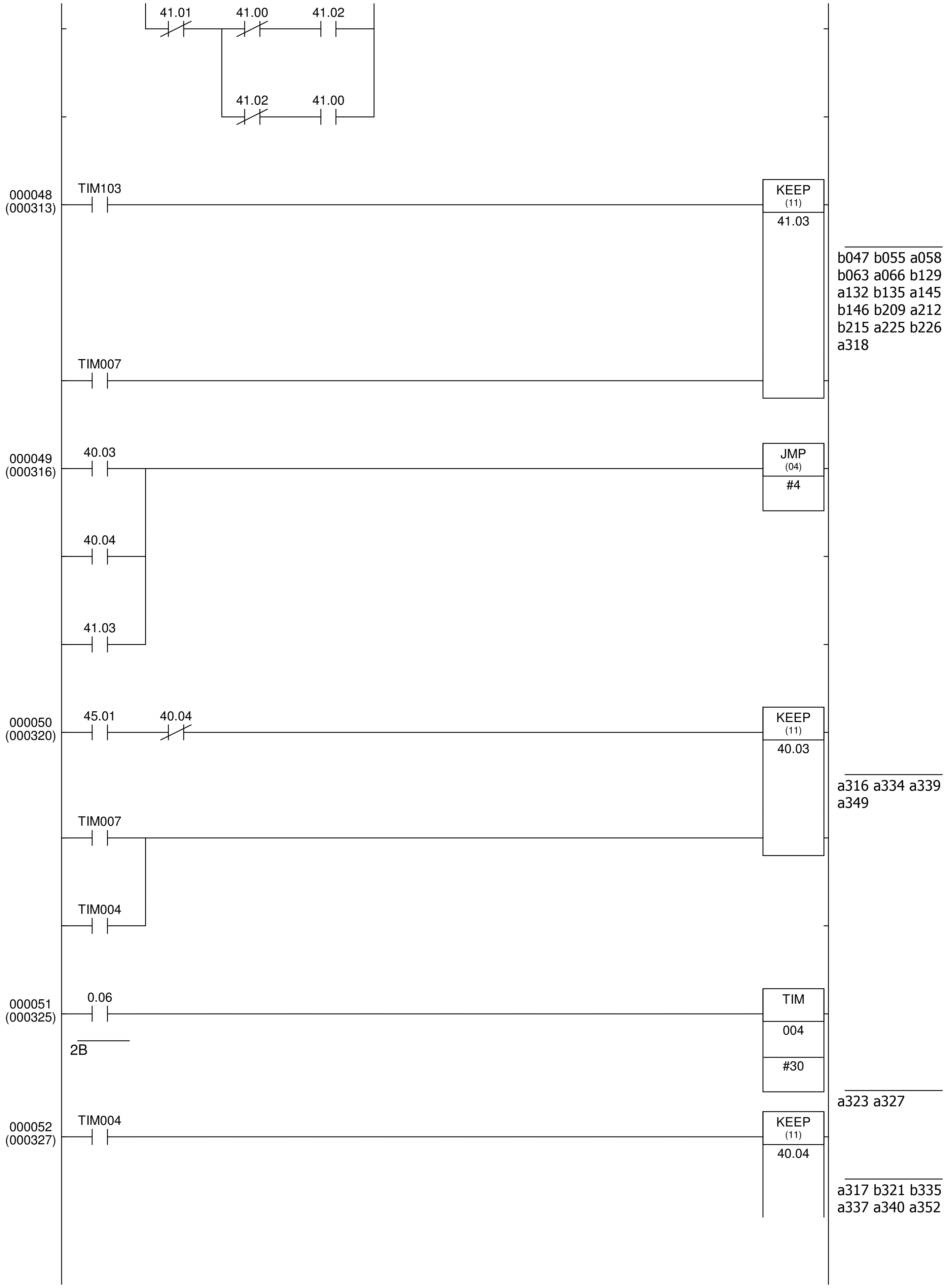
41.02
41.02
41.00
41.01
41.01
41.00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41.02
41.02
41.00
000048
(000313)
TIM103
KEEP
(11)
41.03
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b063 a066 b129
a132 b135 a145
b146 b209 a212
b215 a225 b226
a318
TIM007
000049
(000316)
40.03
JMP
(04)
#4
40.04
41.03
000050
(000320)
45.01
40.04
KEEP
(11)
40.03
a316 a334 a339
a349
TIM007
TIM004
000051
(000325)
0.06
2B
TIM
004
#30
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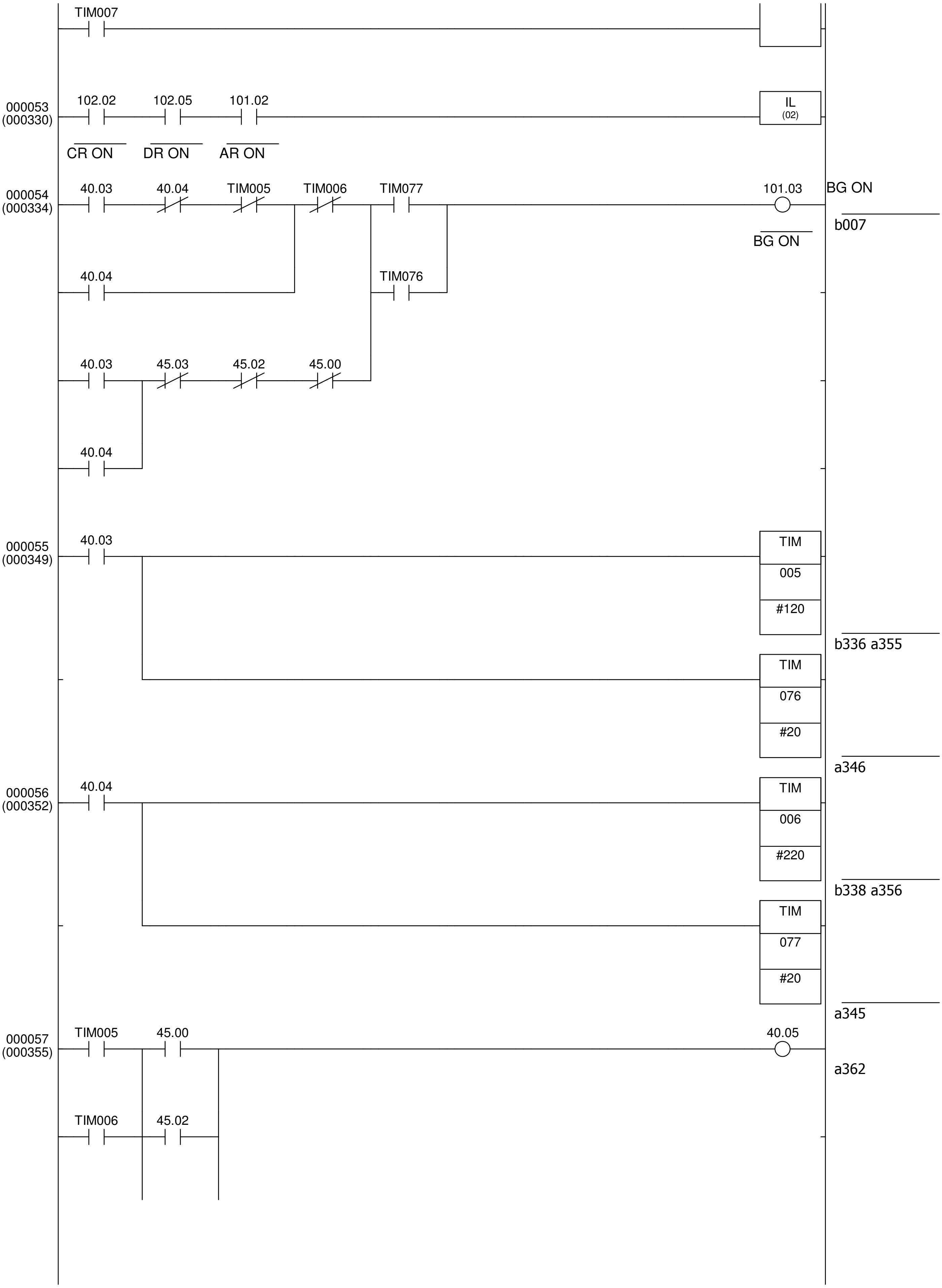
000052
(000327)
TIM004
KEEP
(11)
40.04
a317 b321 b335
a337 a340 a352



TIM007
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(000330)
102.02
102.05
101.02
IL
(02)
CR ON
DR ON
AR ON
000054
(000334)
40.03
40.04
TIM005
TIM006
TIM077
101.03
BG ON
b007
BG ON
40.04
TIM076
40.03
45.03
45.02
45.00
40.04
000055
(000349)
40.03
TIM
005
#120
b336 a355
TIM
076
#20
a346
000056
(000352)
40.04
TIM
006
#220
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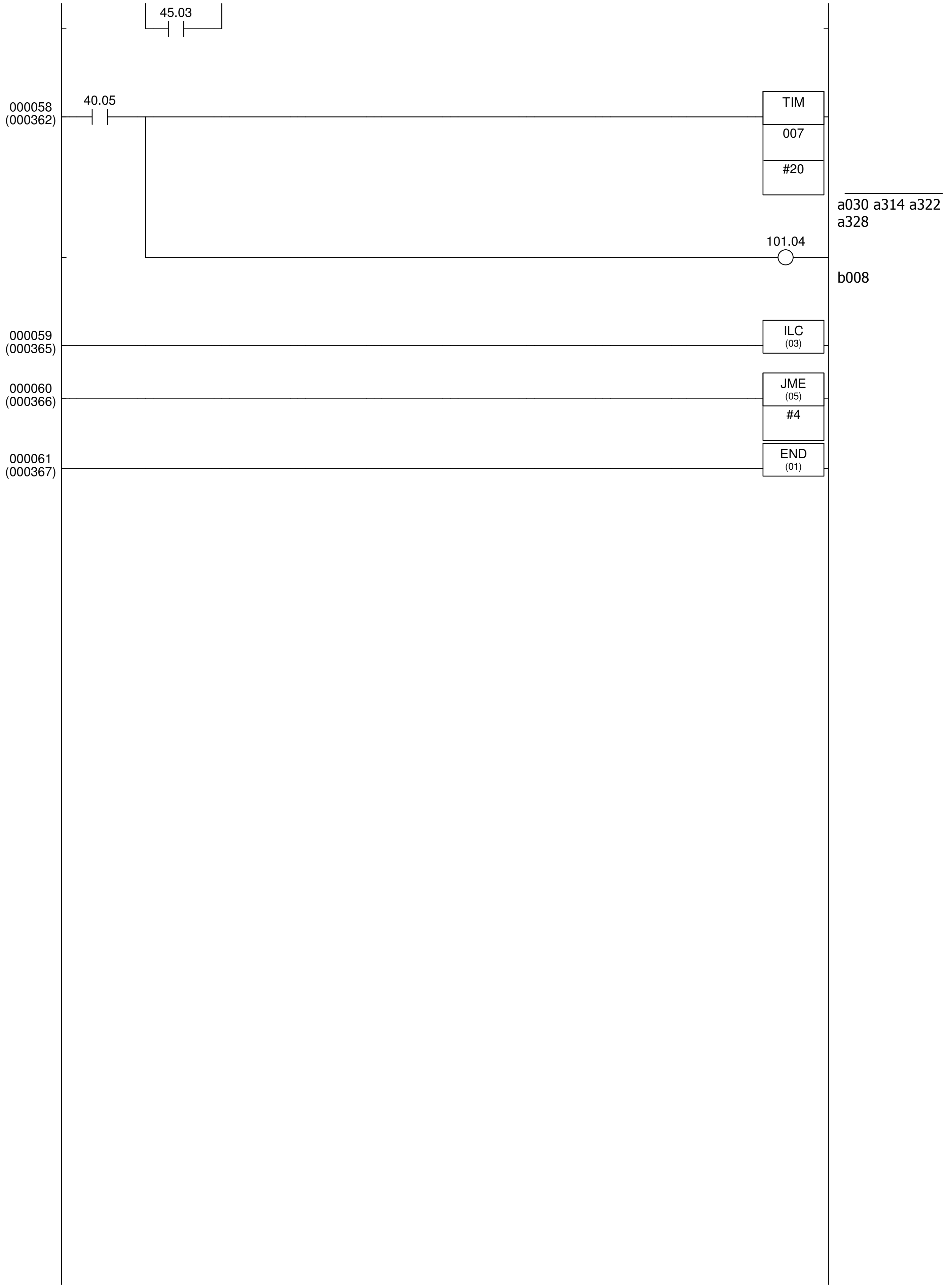
TIM006
45.02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TIM
007
#20
a030 a314 a322
a328
101.04
b008
000059
(000365)
ILC
(03)
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(000366)
JME
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#4
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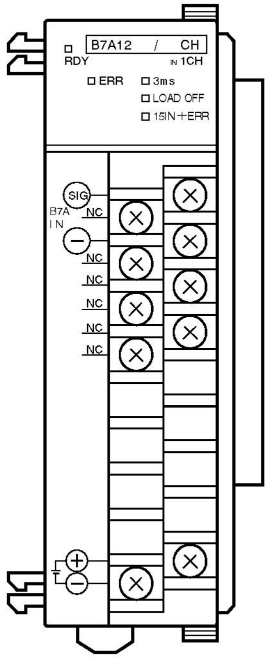
END
(01)

CQM1-B7A12

Front View



Indicators (see following table)

B7A Link Terminal connection terminals 1
For connection of a 16-point Input B7A Link Terminal.

External power terminals
Required for transmission with the B7A Link Terminal. Connect a 12- to-24 VDC power supply.

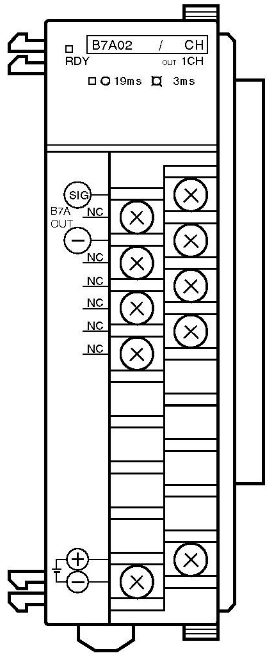
Terminal screws: M3
(Optimum tightening torque: 0.5 N S m)

Indicators

Name		Color	Function
RDY	Unit ready	Green	Lit while the CQM1H/CQM1 is supplied with power.
ERR	Input transmission error	Red	Lit if the B7A Link Terminal for input is malfunctioning or the B7A Link Terminal for input is disconnected.
3ms	Transmission delay time	Orange	Lit while transmission delay time is set to RAPID (3 ms). Not lit when set to STANDARD (19.2 ms).
LOAD OFF	Transmission error processing	Orange	Lit while transmission error processing is set to LOAD OFF. Not lit when set to HOLD.
15IN+ERR	Input mode	Orange	Lit while input mode is set to 15IN+ERR. Not lit when set to 16IN.

CQM1-B7A02

Front View



Indicators (see following table)

B7A Link Terminal connection terminals 1
For connection of a 16-point output B7A Link Terminal.

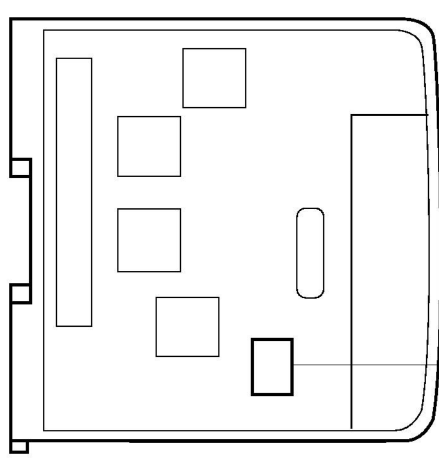
External power terminals
Required for transmission with the B7A Link Terminal. Connect a 12- to 24-VDC power supply.

Terminal screws: M3
(Optimum tightening torque: 0.5 N S m)

Name		Color	Function
RDY	Unit ready	Green	Lit while the CQM1H/CQM1 is supplied with power.
19ms/3ms	Transmission delay time	Orange	Lit while transmission delay time is set to RAPID (3 ms). Not lit when set to STANDARD (19.2 ms).

Left-side View

Common to all models.

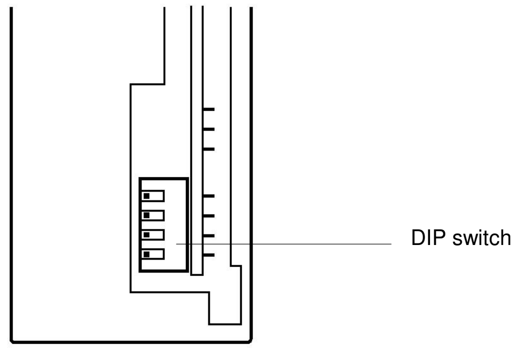


Operation setting DIP Switch
Sets to the operation of the B7A Interface Unit (*see page 15*). Set the switches before mounting the B7A Interface Unit in CQM1H/CQM1. To set after mounting, remove the terminal block and make the setting from the front face.

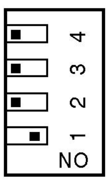
2-2 Switch Settings

Remove the terminal block to expose the DIP switch underneath. Refer to the *CQM1H Operation Manual (W363) or the CQM1 Operation Manual (W226)* for the method of removing the terminal block.

Use a thin-tipped object, such as a small screwdriver, to set the pins.



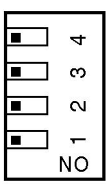
CQM1-B7A21/CQM1-B7A12



Pin no.	Setting	OFF	ON
4	Transmission delay time	STANDARD (19.2 ms)	RAPID (3 ms)
3	Transmission error processing	HOLD	LOAD OFF
2	Input mode	16IN	15IN+ERR
1	ERR indicator	Not lit	Lit

Note On delivery from the factory, pin 1 is set ON and all others OFF.

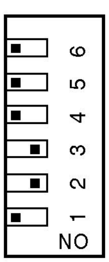
CQM1-B7A03/CQM1-B7A02



Pin no.	Setting	OFF	ON
4	Transmission delay time	STANDARD (19.2 ms)	RAPID (3 ms)
3	Not used (set OFF)	——	——
2	Not used (set OFF)	——	——
1	Not used (set OFF)	——	——

Note On delivery from the factory, all pins set OFF.

CQM1-B7A13



Pin no.	Setting	OFF	ON
6	Transmission delay time	STANDARD (19.2 ms)	RAPID (3 ms)
5	Transmission error processing	HOLD	LOAD OFF
4	Input mode	16IN	15IN+ERR
3	ERR1 indicator	Not lit	Lit
2	ERR2 indicator	Not lit	Lit
1	Not used (set OFF)	——	——

Note On delivery from the factory, pins 2 and 3 are set ON and all others OFF.

⚠ **Caution** Turn off the CQM1H/CQM1 power before setting the pins.

Transmission Delay Time Setting

Sets the transmission delay time for the B7A Interface Unit.

Setting	Transmission Delay Time
ON	RAPID (3 ms)
OFF	STANDARD (19.2 ms) (factory setting)

Set the transmission delay time to RAPID to enable transmission with high-speed B7A Link Terminals with a transmission delay time of 3 ms. Set the transmission delay time to STANDARD to enable transmission with standard B7A Link Terminals with a transmission delay time of 19.2 ms.

Set the pin to match the transmission delay time of the type of B7A Link Terminal connected. A transmission error will occur if the setting does not match the transmission delay time of the B7A Link Terminal.

The transmission delay time setting is made for the entire Unit. It is not possible to make separate settings for each word if multiple words are used.

Transmission Error Processing Setting

This setting determines whether the input bit status immediately prior to the error is held when a transmission error occurs (HOLD) or whether all input bits turn off (LOAD OFF).

Setting	Transmission error processing
ON	LOAD OFF
OFF	HOLD (factory setting)

Input Mode Setting

Set the input mode (the use of bit 15) from the Input B7A Link Terminal to one of the modes shown in the table below. Match the pin setting to the Input B7A Link Terminal.

Setting	Input mode	Description
ON	15-point input + 1 error (15IN+ERR)	Bit 15 used as transmission error bit. The bits available for input are the 15 bits from 00 to 14.
OFF	16-point input (16IN)	Bit 15 also used as a normal input bit. The bits available for input are the 16 bits from 00 to 15. (factory setting)

ERR Indicator Lighting Setting

Sets whether the ERR indicator lights when an input transmission error occurs.

Setting	Description
ON	ERR indicator lights (factory setting)
OFF	ERR indicator does not light

To avoid indicator lighting unnecessarily, set pin OFF if the input side of the B7A Interface Unit is not used.

SECTION 3
Connections

This section describes the connections between the CQM1-B7Ajj Interface Units and B7A Link Terminals.

3-1 Connections to B7A Link Terminals

3-1-1 Recommended Cables

The B7A Interface Unit can be connected to the input and output B7A Link Terminals using the following cables.

Standard Transmission Delay-time Type

Cabtire Cable

Use a VCTF 0.75 x 3 C cabtire cable (100 m max.) if a power supply is shared and a VCTF 0.75 x 2 C cabtire cable (500 m max.) if power is supplied independently.

Rapid Transmission Delay-time Type

Shielded Cable

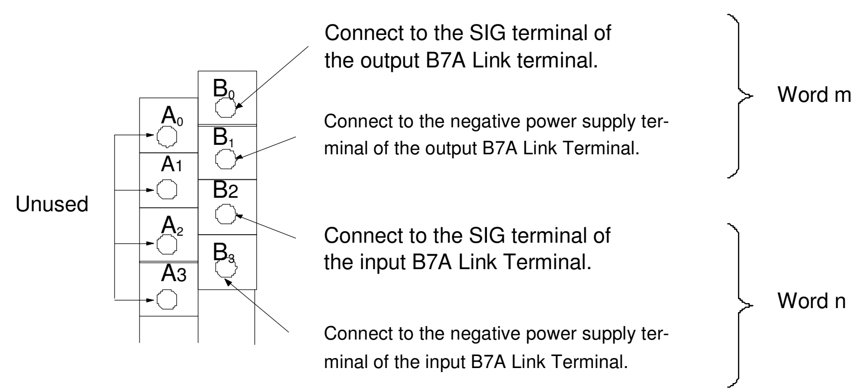
Use a 0.75 x 3 C shielded cable (50 m max.) if a power supply is shared and a 0.75 x 2 C shielded cable (100 m max.) if power is supplied independently.

⚠ Caution If shielded cable is not used for the high-speed transmission delay-time Link Terminal, the transmission distance is not to exceed 10 m regardless of whether power supply is shared or wired separately.

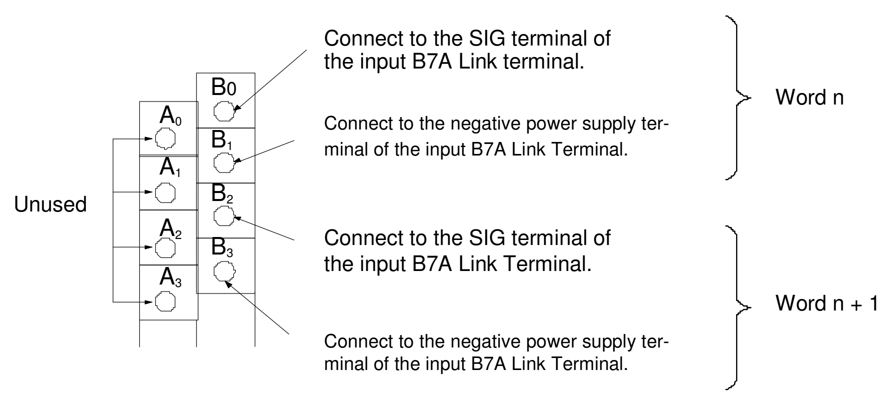
3-1-2 Connecting Terminals

Connect the input and output B7A Link Terminals to the B7A Interface Unit via the following terminals using crimp-style terminals used for CQM1H/CQM1 I/O Units.

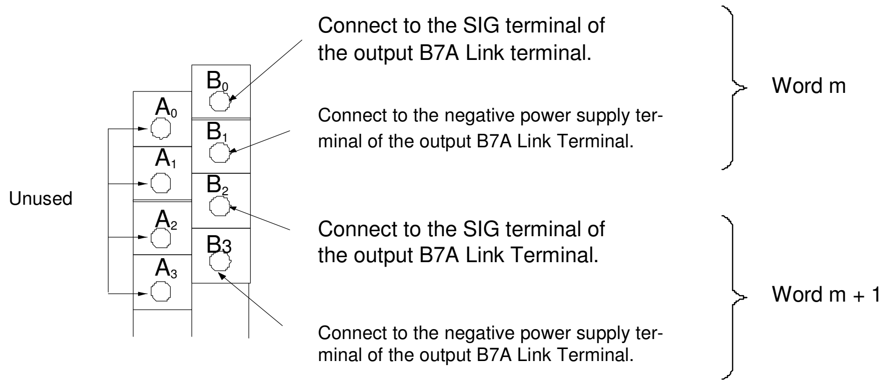
CQM1-B7A21



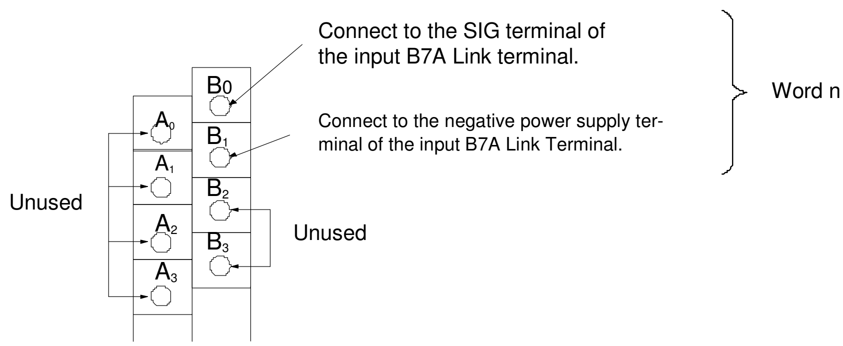
CQM1-B7A13



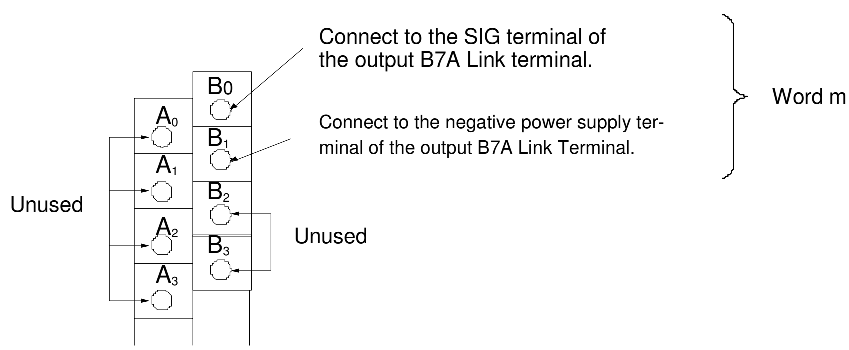
CQM1-B7A03



CQM1-B7A12



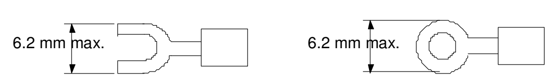
CQM1-B7A02



Connectors

Crimp connectors for I/O Unit wiring should be less than 6.2 mm wide (M3), and the wire should be AWG22 to 18 (0.3 to 0.75 mm^2).

Terminal screws should be tightened with a torque of 0.5 N S m.



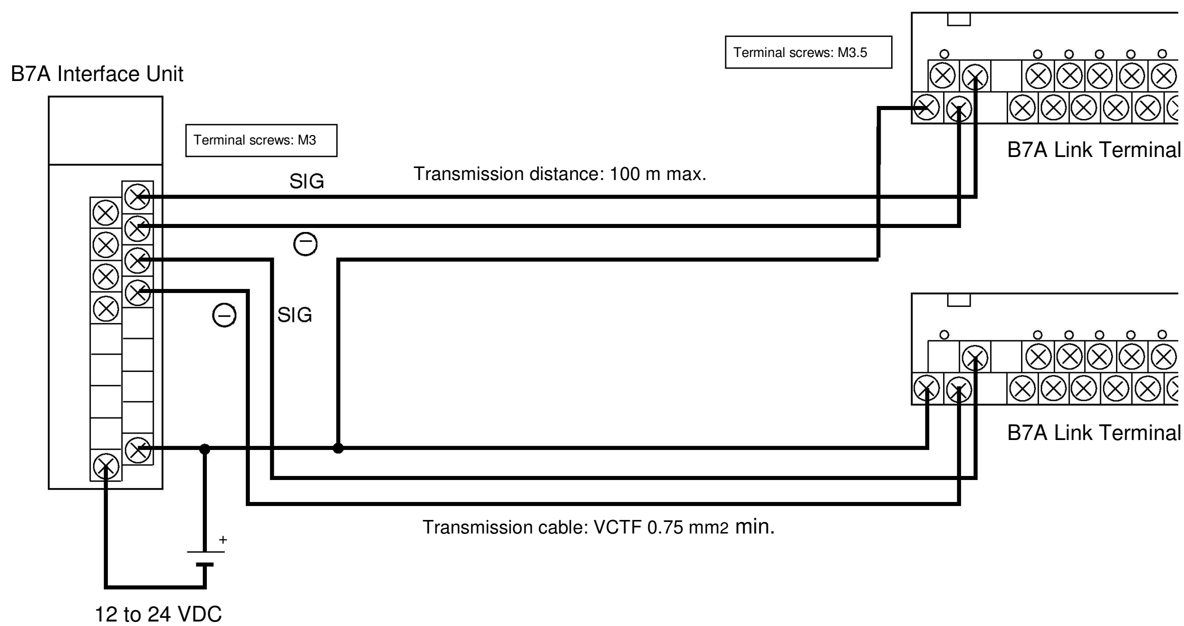
⚠ **Caution** Forked crimp connectors are required by UL and CSA standards.

3-2 Wiring

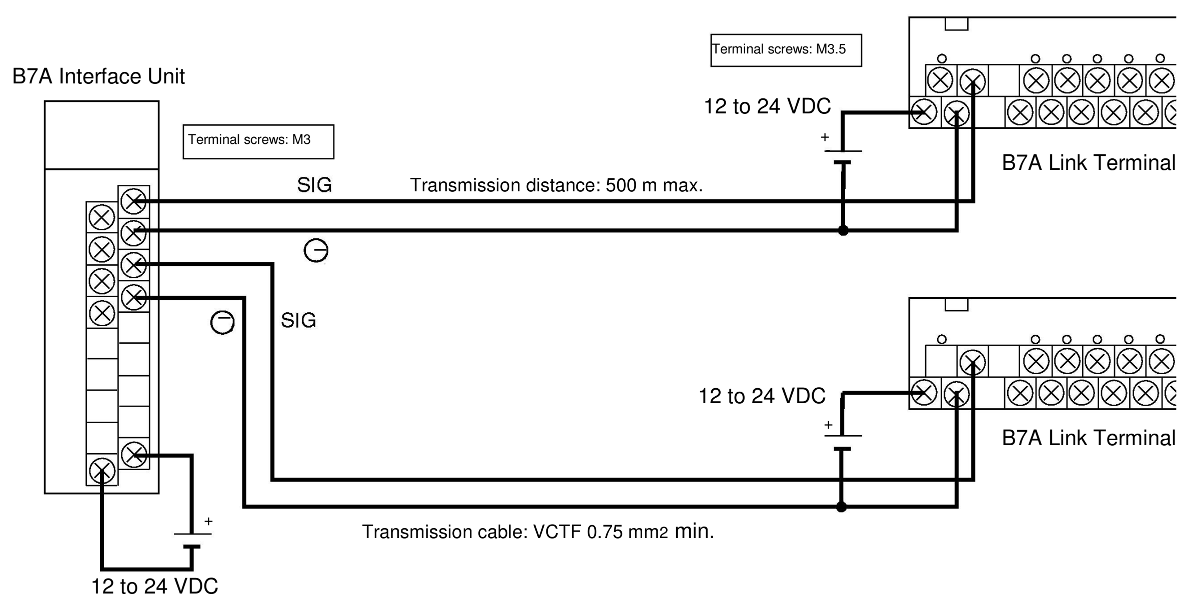
Wiring between the B7A Interface Unit, input B7A Link Terminal, and output B7A Link Terminal sharing a single power supply differs from wiring between Units using independent power supplies as shown in the following diagrams.

Standard Transmission Delay-time Link Terminal

Single Power Supply



Independent Power Supplies



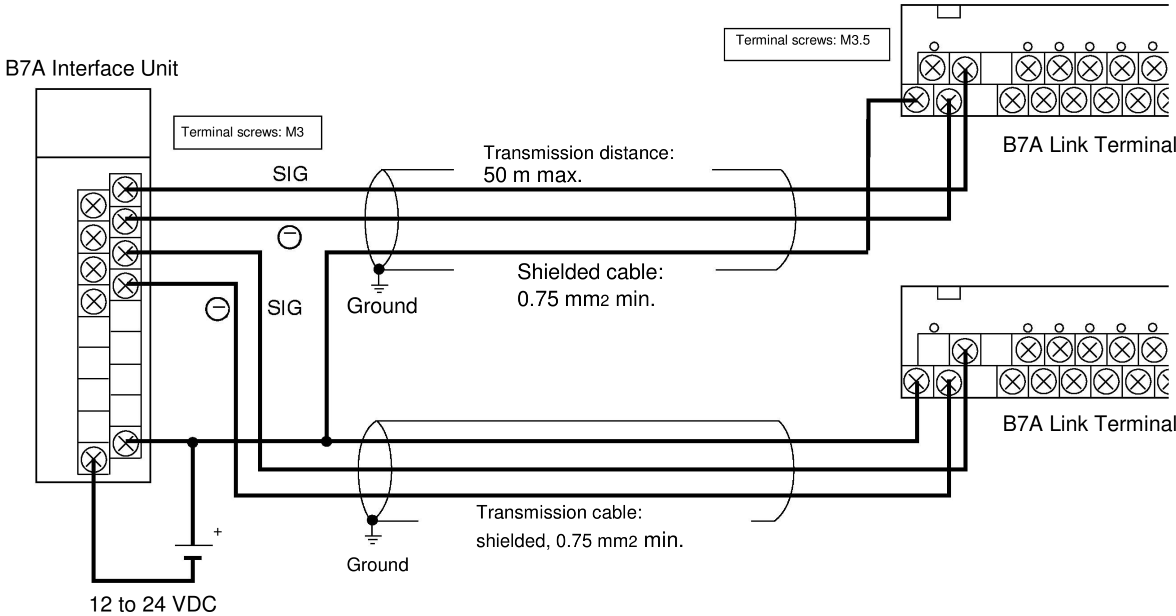
Note 1. The transmission distance depends on the type of wiring used.

2. The size of terminal screw differs for the B7A Interface Unit and B7A Link Terminal. Consider the size of the terminal screws when using crimped terminals.

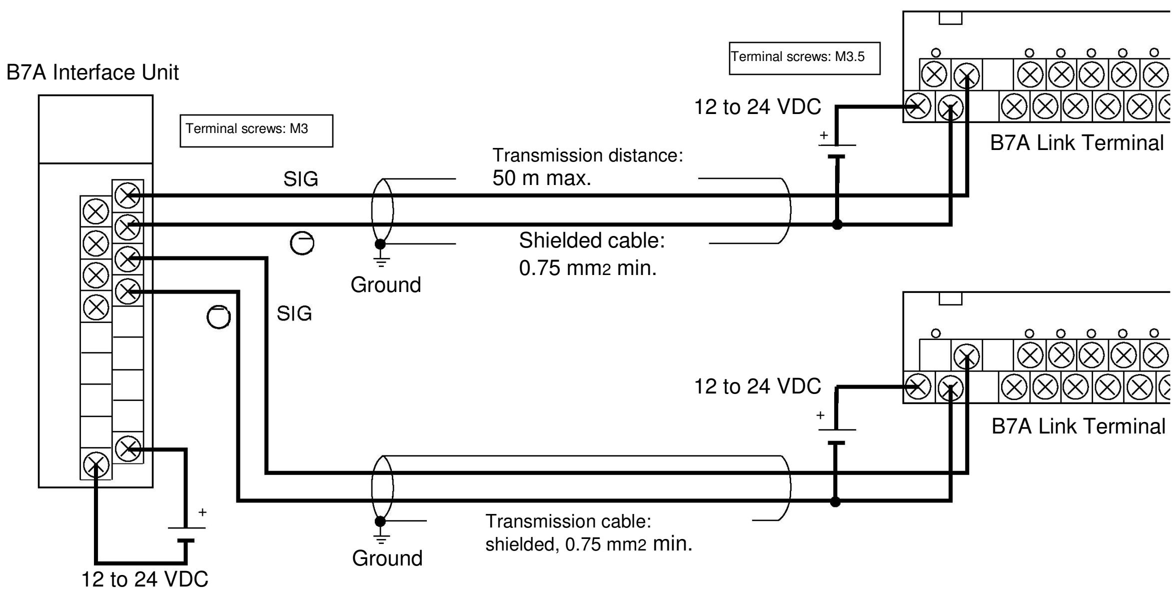
3. Locate transmission cables away from power cables and high-voltage cables to eliminate the effects of noise.

Rapid Transmission Delay-time Link Terminal

Single Power Supply



Independent Power Supplies



Note

1. The transmission distance depends on the type of wiring used.
2. The size of terminal screw differs for the B7A Interface Unit and B7A Link Terminal. Consider the size of the terminal screws when using crimped terminals.
3. It is recommend that the shield wire be grounded.
4. If shielded cable is not used, the transmission distance is not to exceed 10 m regardless of whether power supply is common or wired separately (using VCTF 0.75 mm^2 min.).
5. Locate transmission cables away from power cables and high-voltage cables to eliminate the effects of noise.

Standard Specifications

The standard specifications of the B7A Interface Unit conform to those of the CQM1H/CQM1 PC.

Performance Specifications

Item	Specification
I/O points	B7A21: 16 input points (see note 1), 16 output points B7A13: 32 input points (see note 2) B7A03: 32 output points B7A12: 16 input points (see note 1) B7A02: 16 output points
I/O word allocation	B7A21: 1 word each for input and output (2 words in total) B7A13: 2 words for input B7A03: 2 words for output B7A12: 1 word for input B7A02: 1 word for output
Communication method	Unidirectional, time-division multiplex
Transmission distance (see note 3)	STANDARD: 500 m max. RAPID: 100 m max.
Transmission delay time	STANDARD: 19.2 ms (rated delay), 31 ms max. RAPID: 3 ms (rated delay), 5 ms max.
Minimum input time (see note 4)	STANDARD: 16 ms RAPID: 2.4 ms
Power consumption	100 mA at 5 VDC
External power supply	12 to 24 VDC ±10% (excluding the power required by the B7A Link Terminals) B7A21: 0.11 A min. B7A13: 0.07 A min. B7A03: 0.10 A min. B7A12: 0.05 A min. B7A02: 0.04 A min.
Weight	200 g max.
Dimensions	32 x 110 x 107 (W x H x D) mm

Note 1. Input mode setting allows selection between 16-point input and 15-point+1 error input.

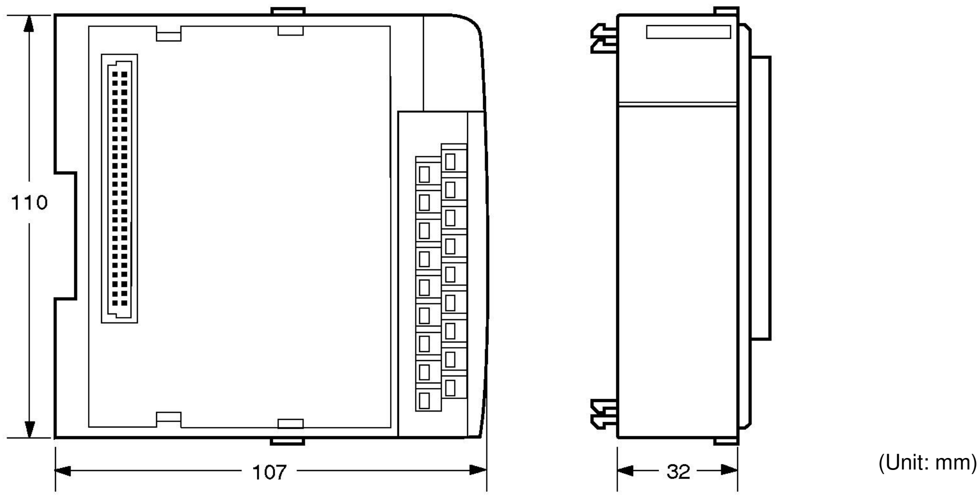
2. Input mode setting allows selection between 32-point input and 30-point+2 error input. Refer to *2-2 Switch Settings*.

3. The maximum transmission distance of the B7A Interface Unit varies with the transmission delay time and the method of wiring. Refer to *3-1 Connections to B7A Link Terminals* for details.

4. Minimum input time is the minimum required time to read an input signal from the CPU. The ON/OFF signal range from the CPU to the B7A Interface Unit's output bit should be larger than the minimum input time.

Dimensions

These dimensions are the same for all B7A Interface Unit models.



Modular PLC Series CQM1H

General

The SYSMAC CQM1H redefines the modular structure of controllers with up to 512 inputs and outputs. In contrast to traditional modular controllers, it does not require a rack that establishes the space requirements in advance. The individual I/O Units are simply connected to the CPU Unit and snapped onto the DIN rail.

Programming is carried out via the programming interface and a PC using the CX–Programmer programming software.

PLC program written for the CQM1 are also compatible with the CQM1H.

For programming software, see page 434.

Performance Data

	CQM1H–CPU11/–CPU21	CQM1H–CPU51	CQM1H–CPU61
Local inputs/outputs	256	512	512
Remote inputs/outputs	224	480	480
Execution time (bit instruction)	0.4 ∝s	0.4 ∝s	0.4 ∝s
Program memory	3.2 kwords	7.2 kwords	15.2 kwords
Data memory	3 kwords	6 kwords	12 kwords
Input interrupts	4	4	4
Time–controlled interrupts	3 (0.5 ms..5 min)	3 (0.5 ms..5 min)	3 (0.5 ms..5 min)
Special I/O Module	–	2 slots	2 slots

Networks and Communication

Networks, see page 213

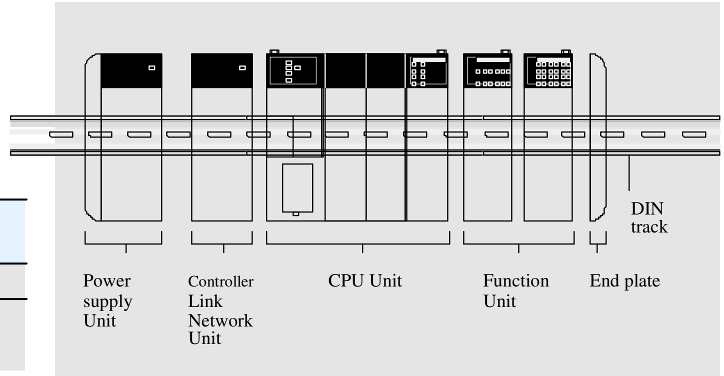
Ethernet (open network)	–	–	–
Controller Link (network)	–	Yes	Yes
Host Link SYSMAC WAY (network)	Yes	Yes	Yes
DeviceNet (open fieldbus)	Yes (slave)	Yes (slave)	Yes (slave)
CompoBus/S (fieldbus)	Yes	Yes	Yes
ASI–Interface (open fieldbus)	Yes	Yes	Yes
PROFIBUS–DP (open fieldbus)	Yes (slave)	Yes (slave)	Yes (slave)

Modular PLC Series CQM1H

System Configuration

The individual Units of the CQM1H system are plugged in to one another and secured using 2 locking sliders. The system must be mounted on a DIN rail.

To make installation easier, the I/O Unit terminal blocks can be removed.



The following information should be noted when selecting I/O Units:

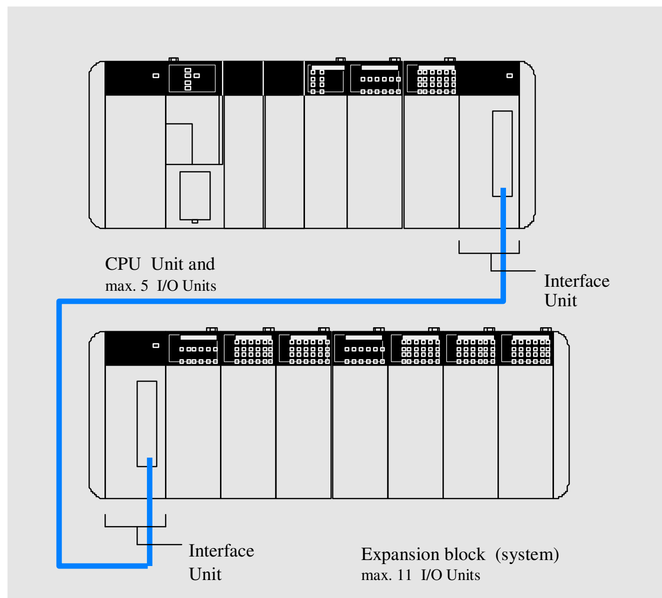
CPU type	Number of free I/O*	Max. number of Units*
CQM1H–CPU11/–CPU21	240 (15 words)	11
CQM1H–CPU51/–CPU61	496 (31 words)	11 (5+11 with exp.)

* Excluding the 16 transistor inputs integrated into the CPU

I/O expansion

It is possible to expand the CQM1H system by one I/O Unit block (system) using interface units and a bus cable. This allows a maximum configuration of 5 I/O Units on the CPU and 11 I/O Units on the expansion block (system) to be achieved.

The power consumption of all CPU Units may not exceed 3.0 A and that of the Expansion Block (system) Units may not exceed 2.0 A.

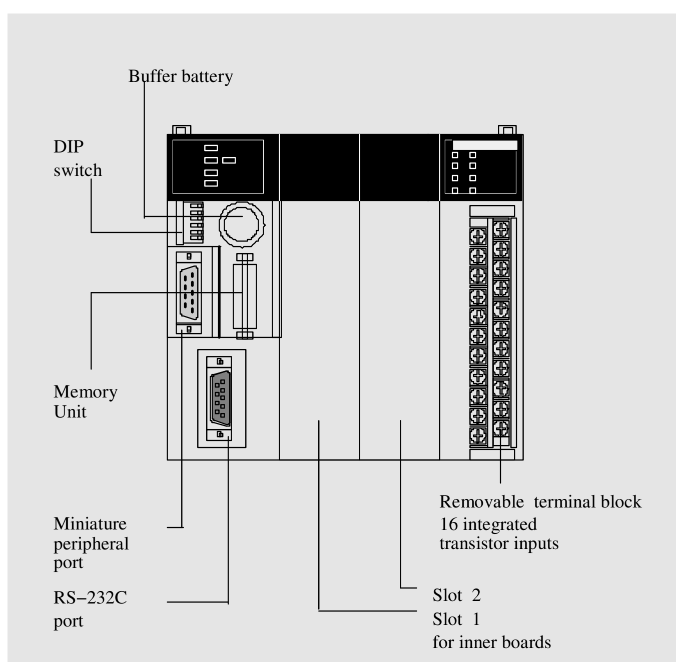


Special features of the CQM1H CPU

Each CPU has 16 transistor inputs. Four of these inputs can be configured as interrupt inputs. The response time before the interrupt subroutine is called up is max. 0.1 ms.

Furthermore, three inputs can be used to connect an encoder as a high–speed counter input. Pulses of up to 5 kHz are counted.

Each CQM1H CPU can output pulses up to 1 kHz via a Transistor Output Unit.

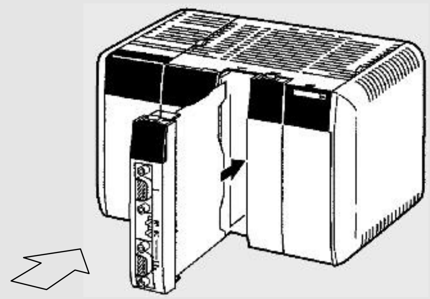


System Configuration (Continued)

Inner Boards

A further special feature of the CQM1H CPU51/CPU61 is slots 1 and 2.

Slots 1 and 2 can hold inner boards with various functions. It should be noted that some inner boards may only be used in slot 1 and others may only be used in slot 2.



Protocol macro function

The special I/O Module CQM1H–SCB41 with one RS–232C and one RS–422/485 port supports the protocol macro function.

This function provides a simple method of generating transmission protocols for other devices, such as a modem, barcode reader or printer. Using the CX–Protocol software, ASCII character strings can be assigned to different sequence numbers. The PLC program only has to call up the sequence number.

The reference data for the response can be automatically filtered.

For CX–Protocol software, see page 438.

CPU Units

CPU Unit	Model code	CQM1H–CPU11
– Peripheral port – 16 built–in transistor inputs	Local I/O	256
	Program memory	3.2 kwords
	Data memory	3 kwords
	Current consumption	820 mA

CPU Unit	Model code	CQM1H–CPU21
– Peripheral port – RS–232C port – 16 built–in transistor inputs	Local I/O	256
	Program memory	3.2 kwords
	Data memory	3 kwords
	Current consumption	820 mA

CPU Unit	Model code	CQM1H–CPU51
– Peripheral port – RS–232C port – Controller Link network capable – Inner boards possible 16 i t t d t i t i t	Local I/O	512
	Program memory	7.2 kwords
	Data memory	6 kwords
	Current consumption	820 mA

CPU Unit	Model code	CQM1H–CPU61
– Peripheral port – RS–232C port – Controller Link network capable – Inner boards possible 16 i t t d t i t i t	Local I/O	512
	Program memory	15.2 kwords
	Data memory	12 kwords
	Current consumption	820 mA

Modular PLC Series CQM1H

Specifications (CPU Units)

Designation CQM1H	CPU11	CPU21	CPU51	CPU61
CPU integrated I/O	16 inputs 1 circuit	16 inputs 1 circuit	16 inputs 1 circuit	16 inputs 1 circuit
Max. local I/O	256	256	512	512
Max. remote I/O	224	224	480	480
Execution time ms	0.4	0.4	0.4	0.4
Real−time clock	Via Memory Module CQM1−M_			
Number of I/O Units	11	11	11 15 with interface unit	11 15 with interface unit
Program memory kwords	3.2	3.2	7.2	15.2
Data words kwords	3	3	6	12
Auxiliary relay bits (words)	3808 (238)	3808 (238)	3808 (238)	3808 (238)
Holding relay bits (words)	1600 (100)	1600 (100)	1600 (100)	1600 (100)
Timer/Counter	512	512	512	512
CPU ports	– Peripheral: RS−232C switchable with DIP switch 7, RS−422 via adapter	– Peripheral: RS−232C switchable with DIP switch 7, RS−422 via adapter – RS−232C	– Peripheral: RS−232C switchable with DIP switch 7, RS−422 via adapter – RS−232C	
I/O refresh method	Combination of cyclic scan with direct output and immediate refresh processing methods.		Combination of cyclic scan with direct output and immediate refresh processing methods.	
Number of instructions	14 basic, 103 special instructions with edge triggered execution		14 basic, 123 special instructions with edge triggered execution	
Special instructions	– Pulse output – Scaling, SIN/COS – I/O refresh – Interpolation – Macro – 7 segment decoder – 10/16 key scan – Subroutines – Indirect addressing		– Floating point arithmetic – PID control – Pulse output – Scaling – ASCII/HEX,SIN/COS – Interpolation – Table compare instructions – Arithmetic – Macro – 7 segment decoder – 10/16 key scan – Subroutine – I/O refresh – Indirect addressing	
Trace memory	–		Yes	
Data backup	Battery		Battery	
Program backup	Battery or Memory Module CQM1H−ME_ (5 years, at 25°C)		Battery or Memory Module CQM1−ME_ (5 years, at 25°C)	
Program protection	Password		Password	
Pulse output	1 (1 kHz)		1 (1 kHz)	
Pulse counter	1 (5 kHz)		1 (5 kHz)	
Input interrupts	4 (pulse width 0.1 ms)		4 (pulse width 0.1 ms)	
Counter interrupts	3 (1 kHz)		3 (1 kHz)	
Time−controlled interrupts	3 (0.5 ms..5 min)		3 (0.5 ms..5 min)	

Modular PLC Series CQM1H

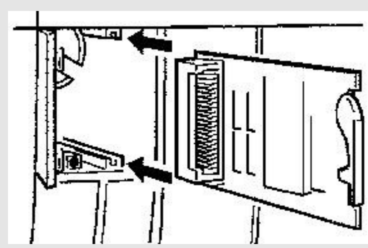
General Data (CPU and Power Supply Units)

Vibration resistance	10..57 Hz, 0.075 mm Amplitude, 57..100 Hz with an acceleration of 1 G in X, Y and Z directions each 10 sweeps of 8minutes
Shock resistance	15 G (12 G for contact outputs) in X, Y and Z directions, 3 times respectively
Temperature Operation Storage	0 °C..55 °C –20 °C..75 °C (without battery)
Ambient humidity	10%..90% (without condensation)
Atmosphere	Controller must not be exposed to the following conditions: – Corrosive gases – Severe temperature fluctuations – Air with an extreme dust and salt content – Metal filings or metallic dust – Splash water – Other chemicals
Degree of protection	IEC IP30 (Control cabinet mounting)
Grounding	According to EN60204
Insulation resistance	20 M& at 500 VDC, between AC terminal and GR terminal
Dielectric strength	2300 VAC; 50/60 Hz for 1 minute between AC terminal and housing, Leakage current: max. 10 mA 1000 VAC; 50/60 Hz for 1 minute between DC terminal and housing, Leakage current: max. 20 mA
Noise immunity Pulse duration Rise time	1500 Vss 100 ns..1 ∝s 1 ns

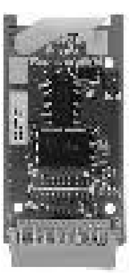
Memory Module (CPU Units)

The Memory Modules can be used to load the user program to the PLC. This allows independence from the life of the buffer battery. It does not represent a memory expansion.

When the PLC power supply is turned on, the content of the Memory Module is copied to the RAM area.



Memory Module

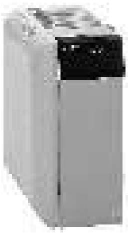


Memory Modules	Description	Size	Model code
	Flash ROM	16 kwords – With hardware clock	**CQM1H–ME16K** **CQM1H–ME16R**
	EPROM Module	Memory Module without IC – With hardware clock	**CQM1–MP08K** **CQM1–MP08R**
	– EPROM–IC	16 kwords, 150 ns, 27256 32 kwords, 150 ns, 27512	**ROM–JD–B** **ROM–KD–B**

Modular PLC Series CQM1H

Power Supplies

In order to calculate the required output capacity, the power consumption of the Units must be added to the system configuration.

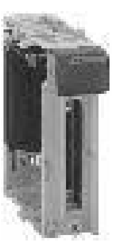


Power supply	Model code	CQM1–PA203
	Input voltage	100..240 VAC, 50/60 Hz
	Input voltage range	85..265 VAC, 50/60 Hz
	Current	Max. 3.6 A
	Auxiliary voltage output	–

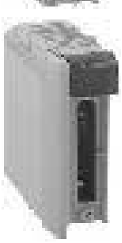
Power supply	Model code	CQM1–PA216
	Input voltage	100..240 VAC, 50/60 Hz
	Input voltage range	85..265 VAC, 50/60 Hz
	Current	Max. 6 A
	Auxiliary voltage output	24 VDC, 0.5 A

Power supply	Model code	CQM1–PD026
	Input voltage	24 VDC
	Input voltage range	20..28 VDC
	Current	Max. 6 A
	Auxiliary voltage output	–

Expansion Units



Interface unit CPU U it 51/61	Model code	CQM1H–IC101
	Max. 5 I/O Units	3.0 A



Interface unit E i bl k	Model code	CQM1H–II101
	Max. 11 I/O Units	2.0 A

Bus cable	Cable length: 0.3 m	CS1W–CN313
	Cable length: 0.7 m	CS1W–CN713

RS–422 port adapter – CQM1H adapter for connection to the peripheral port – DIN rail mounting	Cable length: 15 cm	CQM1H–CIF12

Programming, Accessories and Documentation

Programming

Description		Cable length	Model code
CX–Programmer. PLC programming software. For WINDOWS 95/98/ME/2000/NT4.0–SP5/XP – see page 434		–	**WS02–CXPC1–EV3.0**
Programming cable, peripheral port < > PC (RS 232C) DIP switch: no. 7 = ON		2 m	**CS1W–CN226**
		6 m	**CS1W–CN626**
Programming consoles	Programming console with cable	2 m	**CQM1H–PRO01–E**
	Programming console without cable for installation in control cabinet door	–	**C200H–PRO27–E**
	Cable for PRO27 to CPU	2 m	**CS1W–CN224**
	Cable for PRO27 to CPU	4 m	**CS1W–CN624**
Program copy device	Writing of the user program, the PLC configuration, the expanded instruction set and the data words from DM6144 to DM6655 on EEPROM, as well as down loading of EEPROM data in the PLC. For PLC systems: CPM and CQM1H Supported EEPROMs: Atmel AT28C256 NEC ∝PD28C256 (CS1W–CN114 adapter required)	20 cm	**CPM1–EMU01–V1**

Accessories, cables etc.

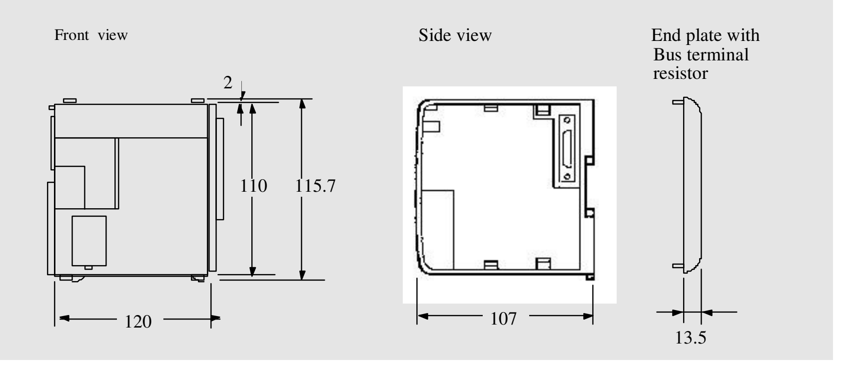
Description	Model code
Adapter for miniature peripheral port to peripheral port	**CS1W–CN114**
Connecting cable for relay modules G70A–ZOC16–3 for connection to Output Unit CQM1–OD213	**G79–O_C–_**
Terminal block for servo drives	**XW2B–20J6–3B**
Spare battery for all CPU types	**CPM2A–BAT01**
End plate with Bus terminal resistor	**CQM1–TER01**
Clamp for DIN rail mounting	**PFP–M**
Front connector, solder terminal, 40–pin	**C500–CE404**
Front connector, crimp terminal, 40–pin	**C500–CE405**
Front connector for ribbon cable, 40–pin	**C500–CE403**

Technical documentation

English **d t ti**	**Product**	**Title**	**Model code**
	CQM1_ Dedicated I/O Units	Operation Manual	**W238–E1**
	CQM1H–CLK21 Controller Link	Operation Manual	**W309–E1**
	CQM1H	Operation Manual	**W363–E1**
	CQM1H	Programming Manual	**W364–E1**
	CQM1H–SCB41	Communications	**W365–E1**
	CompoBus/S	Operation Manual	**W266–E1**
	DeviceNet	Operation Manual	**W267–E1**
	AS–Interface	Operation Manual	**W357–E1**

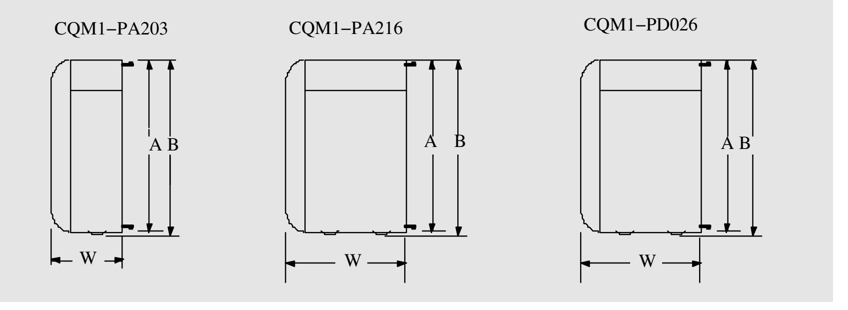
Dimensions (mm)

CPU Units

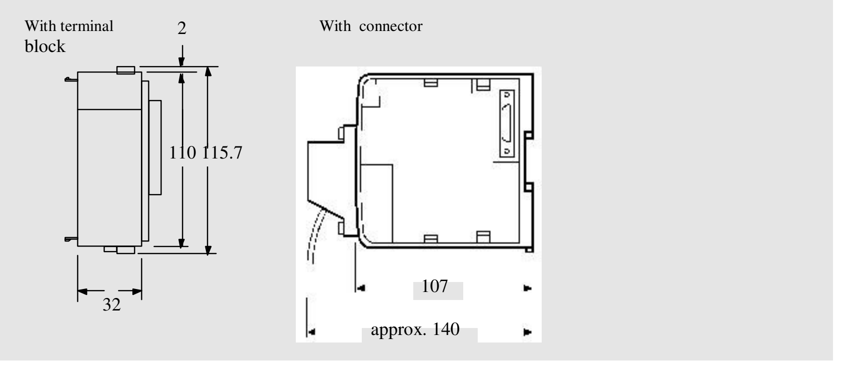


Power supply units

W	A	B	Model code
53.5	110	115.7	CQM1–PA203
85.5	110	115.7	CQM1–PA216
85.5	110	115.7	CQM1–PD026



I/O Units



Communication Examples

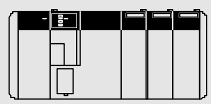
	CQM1H–CPU11/21	CQM1H–CPU51/61	Inner boards CQM1H–SCB41
SYSMAC WAY (network)	Yes	Yes	Yes
Active RS–232C	Yes	Yes	Yes + Protocol macro function
1:1 CPU Link	Yes	Yes	Yes
1:1 NT Link	Yes	Yes	Yes
1:n NT Link	–	–	Yes

SYSMAC WAY

SYSMAC WAY communicates via the RS–232C or RS–422 port and contains the open, OMRON–specific ASCII protocol called Host Link.

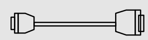
By default, the CQM1H communication port runs in Host Link slave mode and can therefore be easily operated from a PC, a supervisory controller or HMI.

The CQM1H CPU11 does not have an RS–232C port.

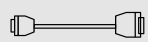


CQM1H

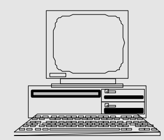
RS–232C port



Miniature peripheral port

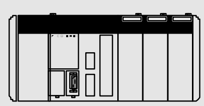


CS1W–CN226



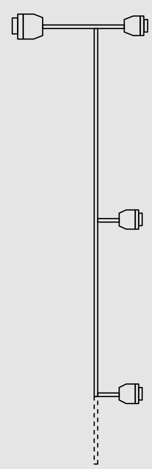
PC

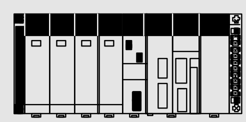
Up to 32 Host Link slaves can be integrated into a SYSMAC WAY network via RS–422 ports.



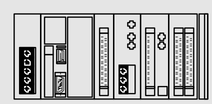
CQM1H +
CQM1H–SCB41
or
CQM1H–CIF12

RS–422 cable

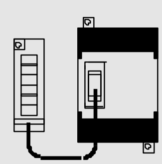




CS1 +
CS1W–SCB41



CJ1 +
CJ1W–SCU41



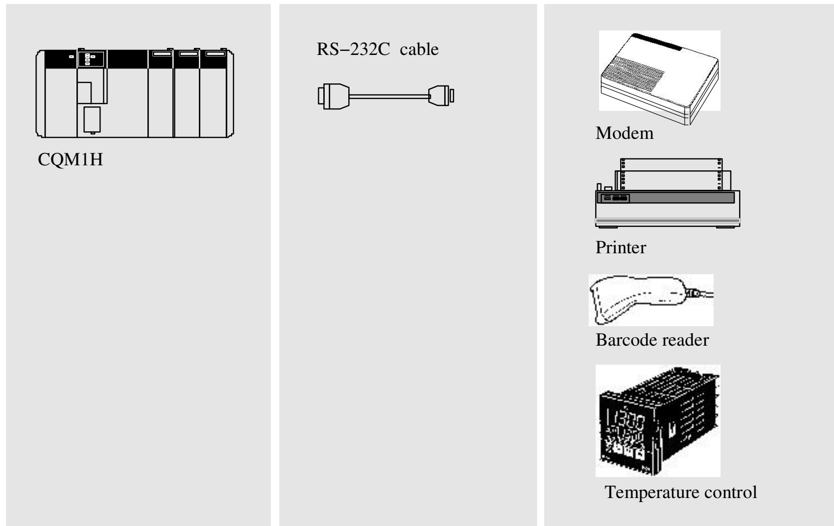
CPM1 +
CPM1–CIF11

Communication Examples (Continued)

Active RS–232C

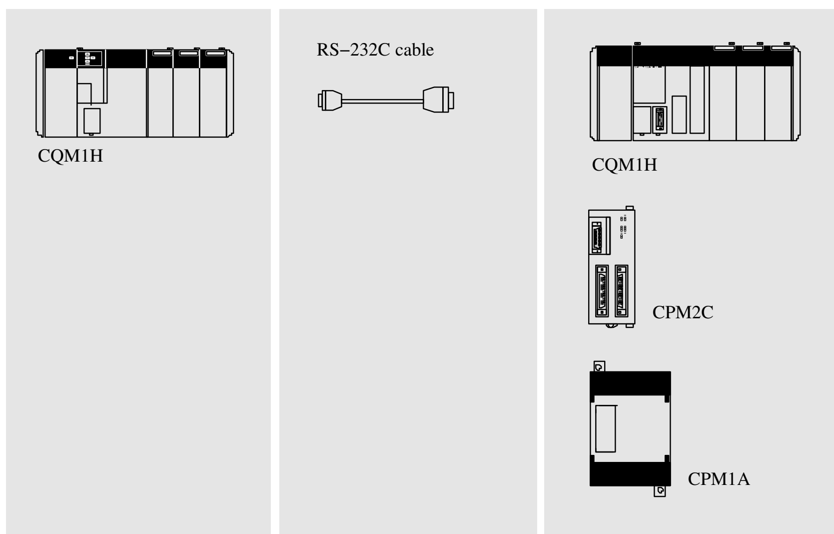
The CQM1H's ports can be switched to active RS–232C mode by the Host Link slave.

Transmit, Receive and Protocol macro instructions can be used to send and receive ASCII character strings. Peripherals such as modems, printers or barcode readers can be integrated.



1:1 CPU Link

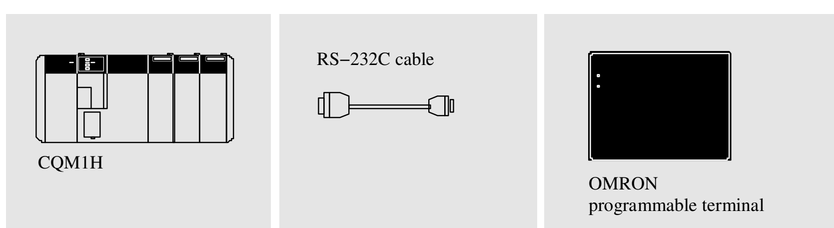
Via the 1:1 CPU Link, up to 64 words can be continuously exchanged between two PLC CPU Units without any programming effort, by means of a peripheral or RS–232C port.



1:1 NT Link

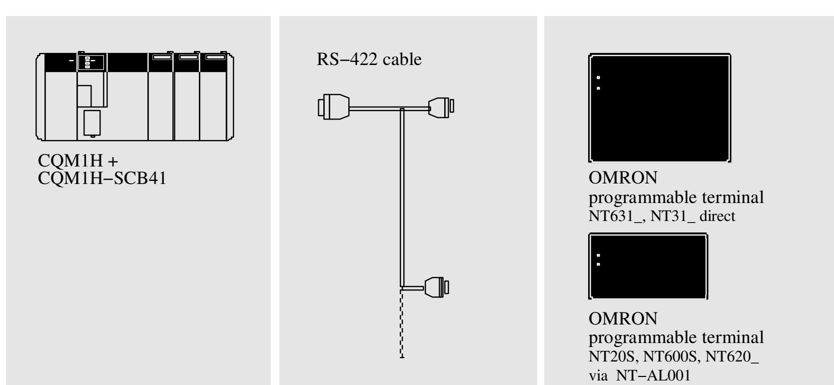
Various programmable terminals, from function keys to graphics–capable, touch–screen colour terminals, are available to the user as a human/ machine interface.

Data is exchanged very efficiently between a programmable terminal and the PLC via the 1:1 NT Link protocol.



1:n NT Link

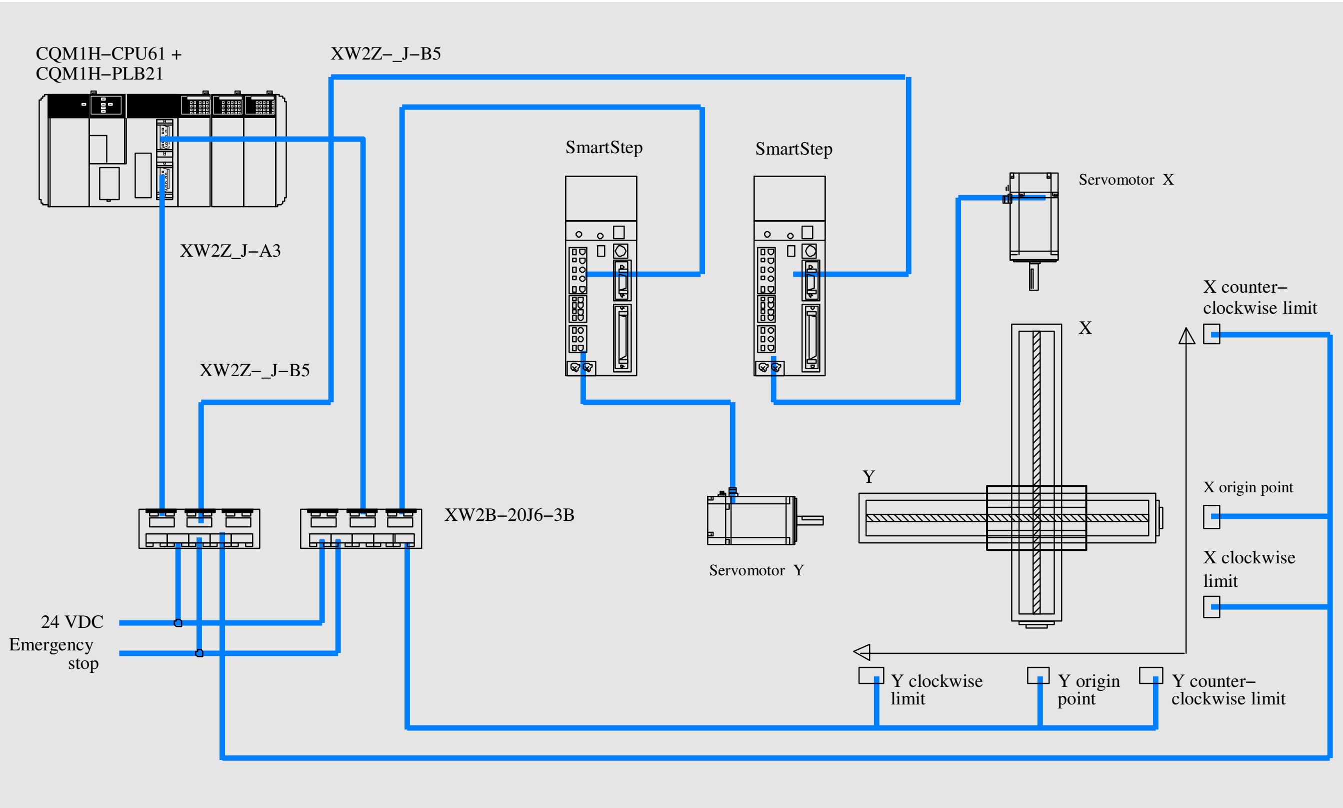
Several NT series control terminals can be connected to the CQM1H series via an RS–422 network.



Application Examples

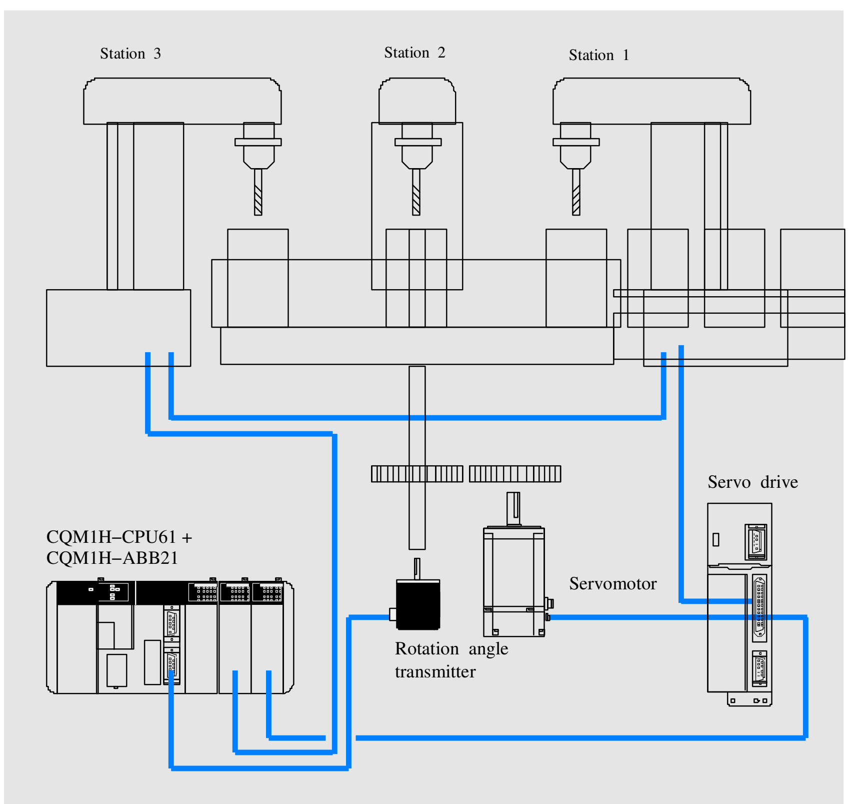
2 Axes positioning

The two pulse outputs in the special I/O Module CQM1H–PLB21 can output pulses at up to 50 kHz.
This allows 2 axes positioning tasks to be triggered when used in conjunction with a servo or stepper motor.



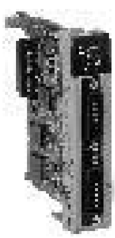
Absolute encoding

The optional inner board CQM1H–ABB21 has two inputs for absolute value encoders, e.g. to determine the absolute position of a rotary table.
When defined positions are reached, working processes can be started.



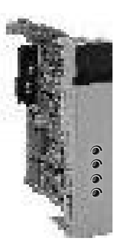
Overview of Optional Inner Boards (for CPU51, CPU61 only)

Communication	CPU slot	Description	Model code	Page
Analogue I/O Modules	Only slot 2	4 analogue inputs: −10..10 VDC, 0..10 VDC, 0..20 mA 2 analogue outputs: −10..10 VDC, 0..20 mA	**CQM1H–MAB42**	82
	Slot 1 or Slot 2	Four built–in potentiometers: Range 0..200 BCD	**CQM1H–AVB41**	82
Communication	Only slot 1	One RS−232C and one RS−422/485 port Protocol macro function	**CQM1H–SCB41**	83
Pulse I/O Modules	Slot 1 and Slot 2	Four high–speed counter inputs: max. 500 kHz	**CQM1H–CTB41**	84
	Only slot 2	Two high–speed counter inputs: max. 50 kHz Two pulse outputs: max. 50 kHz	**CQM1H–PLB21–CE**	84
	Only slot 2	Two absolute encoder inputs 8, 10 and 12 bit Gray code	**CQM1H–ABB21**	84



Analogue I/O Module
– Plugs into slot 2 only

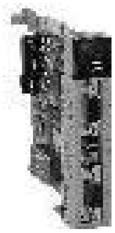
Model code	**CQM1H–MAB42**
Number of analogue inputs	4 inputs
Number of analogue outputs	2 inputs
Inputs – Range per input – Resolution – Conversion time – Precision – Input impedance	 0..10 VDC, −10..10 VDC, 0..5 V 0..20 mA 1/4096 of full scale (12 bit) Max. 6.8 ms for all inputs ±0.5% at 23 °C Voltage: 1 M& Current: 250 &
Outputs – Range per output – Resolution (voltage) – Conversion time – Precision – Load resistor – Resolution (current)	 −10..10 VDC 0..20 mA 1/4096 of full scale (12 bit) Max. 3.4 ms for all outputs ±0.5% at 23 °C Voltage: min. 2 k& Current: max. 350 & 1/2047 of full scale (11 bit)
Internal power consumption	250 mA



Analogue setting module
– Plugs into slot 1 or slot 2
– One module possible

Model code	**CQM1H–AVB41**
Number of potentiometers	4
Range for PLC address	0..200 BCD
Internal power consumption	10 mA

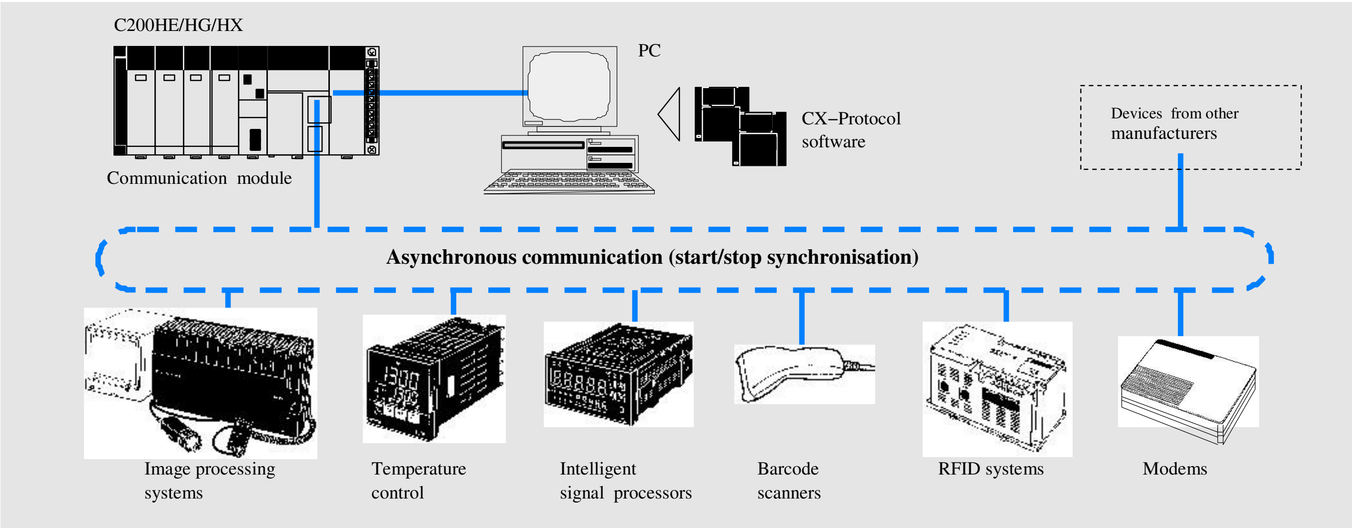
Inner Boards (Continued)



Communication module – Plugs into slot 1 only	Model code	CQM1H–SCB41
	Number of ports	One RS–232C and One RS–422A/485
	RS–232C port – Transmission method – Transmission rate – Media length	 Half duplex, 1:1 Max. 19.6 Kbps Max. 15 m
	RS–422A/485 port – Transmission method – Transmission rate – Media length	 Half duplex, 1:n Max. 19.6 Kbps Max. 500 m
	Protocols for each port	Host Link, ASCII, 1:1 CPU Link 1:1 NT Link, 1:n NT Link (n = 1..8)
	Protocol macro function – Number of protocols – Number of sequences – Available protocols	Communications sequences can be defined using the CX–Protocol software. Max. 20 Max. 1000 CompoWay/F Master, E5_K, E5ZE, E5_J, 3Z4L, V600/620 F200, F300, F350, Hayes Modem
	Internal power consumption	200 mA

Protocol Macro function

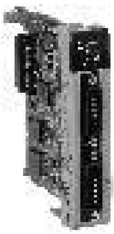
In the CQM1H–SCB41 communication modules, the data is processed via the protocol macro function, whereby the individual communication sequences are triggered by the PLC using the PMCR instruction.



Programming (Communication Modules)

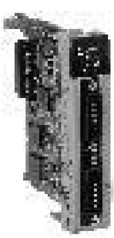
Programming	Description	Model code
	CX–Protocol. Programming software for Protocol Macro. For WINDOWS 95/98/ME/2000/NT4.0/XP – see page 438	**WS02–PSTC1–E**

Inner Boards (Continued)



High–speed counter module
– Plugs into slot 1 or slot 2
– Two modules possible

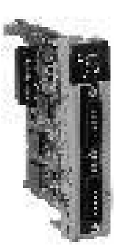
Model code	CQM1H–CTB41
Number of high–speed counters	4
Input frequency – Pulse direction mode – Phase differential (for encoder phases A, B and Z)	 Max. 500 kHz Max. 250 kHz
Input signal	24 VDC or RS–422A line driver
Input range – Linear counter mode – Ring counter mode	 –8,388,608..8,388,607 BCD 0..64,999 BCD
Counter reset	Hardware or software
Evaluation of actual counter value – Target value interrupts – Range interrupts	 48 target values 8 ranges
Number of digital outputs – Circuitry – Switching capacity – Response time after target value or range interrupt triggering	4 PNP or NPN 4.5 VDC/16 mA..26.5 VDC/80 mA 1.5 ms
Internal power consumption	400 mA



Pulse I/O Module
– Plugs into slot 2 only
– 2 axes positioning

For terminal blocks, see page 465

Model code	CQM1H–PLB21–CE
Number of high–speed counters	2
Number of pulse outputs	2
Specification of high–speed counters	
Input frequency – Pulse direction mode – Phase differential mode (for encoder phases A, B and Z)	 Max. 50 kHz Max. 25 kHz
Input signal	12 VDC or 24 VDC
Input range – Linear counter mode – Ring counter mode	 –8,388,608..8,388,607 BCD 0..64,999 BCD
Counter reset	Hardware or software
Evaluation of actual counter value – Target value interrupts – Range interrupts	 48 target values 8 ranges
Specification of pulse outputs	
Pulse output frequency – Signal direction – Pulse width modulation	Max. 50 kHz Clockwise or counter–clockwise (CW/CCW) 0..100% at output frequency 91.6 Hz, 1.5 kHz and 5.9 kHz
Circuitry	NPN transistor
Switching capacity	5..24 VDC, 30 mA
Functions	Pulse number and frequency Frequency increase and reduction
Internal power consumption	160 mA



Absolute encoder module
– Plugs into slot 2 only

Model code	CQM1H–ABB21
Number of absolute encoder inputs	2
Input frequency	Max. 4 kHz
Input signal	24 VDC, binary Gray code, 8, 10, 12 bit
Input range	BCD or 360° mode
Zero offset compensation	Offset setting
Evaluation of actual encoder value – Target value interrupts – Range interrupts	 48 target values 8 ranges
Internal power consumption	150 mA

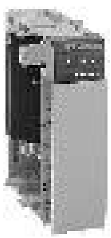
Overview of Expansion Units

	I/O type	Description	Model code	Page
Digital Input Units	8 DC inputs	12..24 VDC, 8 circuits, 1 input each	**CQM1–ID211**	86
	16 DC inputs	24 VDC, 1 circuit, 16 inputs	**CQM1–ID212**	86
	32 DC inputs	24 VDC, 1 circuit, 32 inputs in 4 groups	**CQM1–ID213**	86
	8 AC inputs	100..120 VAC, 1 circuit, 8 inputs	**CQM1–IA121**	*1
	8 AC inputs	200..240 VAC, 1 circuit, 8 inputs	**CQM1–IA221**	
Digital Output Units	8 relay	250 VAC, 2 A, 8 circuits, 1 output each Total switching capacity: 2 A per circuit	**CQM1–OC224**	87
	16 relay	250 VAC, 2 A, 1 circuit, 16 outputs Total switching capacity: 8 A per circuit	**CQM1–OC222**	87
	8 transistor, PNP	24 VDC, 1 A, 1 circuit, 8 outputs Total switching capacity: 4A per circuit	**CQM1–OD215**	87
	16 transistor PNP	24 VDC, 0.3 A, 1 circuit, 16 outputs Total switching capacity: 4.8 A per circuit	**CQM1–OD214**	88
	32, transistor, PNP, short circuit protection	24 VDC, 0.5 A, 1 circuit, 32 outp. in 4 groups Total switching capacity: 5 A per circuit	**CQM1–OD216**	88
	8 triac	100..240 VDC, 0.4 A, 2 circuits, 4 outputs each Total switching capacity: 1.2 A per circuit	**CQM1–OA221**	*1
	8 transistor, NPN, short circuit protection	24 VDC, 2 A, 1 circuit, 8 outputs Total switching capacity: 5 A per circuit	**CQM1–OD211**	
	16 transistor, NPN	24 VDC, 0.3 A, 1 circuit, 16 outputs Total switching capacity: 4.8 A per circuit	**CQM1–OD212**	
	32 transistor, NPN	24 VDC, 0.1 A, 1 circuit, 32 outp. in 4 groups Total switching capacity: 3.2 A per circuit	**CQM1–OD213**	
Safety Units	1 or 2 channels 4 DC inputs 2 NO contacts	Control class 4 to EN 954–1 24 VDC, 1 circuit, 4 inputs (PLC) 250 VAC, 5 A safety contacts	**CQM1–SF200**	89
Analogue Input Unit	4 or 2 inputs	–10..+10 V, 0..10 V, 0..20 mA, 12 bit resolution	**CQM1–AD042**	90
Analogue Output Unit	2 outputs	–10..+10 V, 0..20 mA, 12 bit resolution for voltage output 11 bit resolution for current output	**CQM1–DA022**	90
Temperature Controller Unit	4 loops	Thermocouple sensor, transistor output, PNP	**CQM1–TC202**	90
	4 loops	Pt100 sensor, transistor output, PNP	**CQM1–TC302**	90
	2 loops	Thermocouple sensor, transistor output, PNP, heating current monitoring	**CQM1–TC204**	90
	2 loops	Pt100 sensor, transistor output, PNP, heating current monitoring	**CQM1–TC304**	91
	4 loops	Thermocouple sensor, transistor output, NPN	**CQM1–TC201**	*2
	4 loops	Pt100 sensor, transistor output, NPN	**CQM1–TC301**	
	2 loops	Thermocouple sensor, transistor output, NPN, heating current monitoring	**CQM1–TC203**	
	2 loops	Pt100 sensor, transistor output, NPN, heating current monitoring	**CQM1–TC303**	
Communication Units	32 nodes	Controller Link (CLK), industrial network Bus length max. 1 km	**CQM1H–CLK21**	91
	16 input bits 16 output bits	I/O Link Unit DeviceNet	**CQM1–DRT21**	92
	64 inputs and 64 outputs	Fieldbus master (CompoBus/S) Bus length 500 m	**CQM1–SRM21–V1**	92
	128 input bits 128 output bits	I/O Link Unit PROFIBUS–DP	**CQM1–PRT21**	92
	31 Bus Modules	AS–Interface master (open Fieldbus standard) Bus length 100 m	**CQM1–ARM21**	92

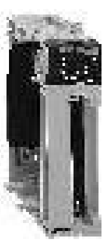
* Information on these Units can be found in the technical manuals:
1 = W363–E1–2
2 = W238–E1–8

Digital Input Units

Digital Input Units – With 8 inputs	**Model code**	**CQM1–ID211**
	Inputs	8 DC inputs 8 circuits, 1 input each
	Connection method	Screw terminal connectors
	Status display	LED
	Internal power consumption	50 mA, 5 VDC
Specification for DC inputs	Input voltage ON level OFF level	12..24 VDC (10.2..26.4 VDC) Min. 10.2 V Max. 3.0 V
	Input impedance	2.4 k&
	Input current	10 mA at 24 V
	ON/OFF delay	8 ms (adjustable 1..128 ms)

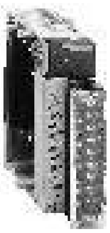


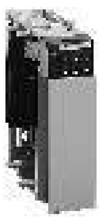
Digital Input Unit – With 16 inputs	**Model code**	**CQM1–ID212**
	Inputs	16 DC inputs 1 circuit, 16 inputs
	Connection method	Screw terminal connectors
	Status display	LED
	Internal power consumption	85 mA, 5 VDC
Specification for DC inputs	Input voltage ON level OFF level	24 VDC (20.4..26.4 VDC) Min. 14.4 V Max. 5.0 V
	Input impedance	3.9 k&
	Input current	6 mA at 24 V
	ON/FF delay	8 ms (adjustable 1..128 ms)



Digital Input Unit – With 32 inputs – Front connector is not included in the delivery package – Prefabricated cable and terminal blocks, see page 465	**Model code**	**CQM1–ID213**
	Inputs	32 DC inputs 1 circuit, 32 inputs
	Connection method	1 piece, 40–pin connector
	Status display	LED
	Internal power consumption	170 mA, 5 VDC
Specification for DC inputs	Input voltage ON level OFF level	24 VDC (20.4..26.4 VDC) Min. 14.4 V Max. 5.0 V
	Input impedance	5.6 k&
	Input current	4 mA at 24 V
	ON/OFF delay	8 ms (adjustable 1..128 ms)

Digital Output Units



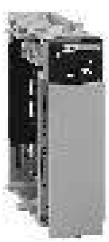


Digital Relay Output Unit

Model code	**CQM1–OC224**
Outputs	8, relay 8 circuits, 1 output each
Total switching capacity	2 A per circuit
Connection method	Screw terminal connectors
Status display	LED
Internal power consumption	440 mA, 5 VDC
Model code	**CQM1–OC222**
Outputs	16, relay 1 circuit, 16 outputs
Total switching capacity	8 A per circuit
Connection method	Screw terminal connectors
Status display	LED
Internal power consumption	850 mA, 5 VDC

Specification for relay outputs

Switching capacity	maximum	250 VAC, 2 A (cos∏=1) R load 250 VAC, 2 A (cos∏=0.4) L load 24 VDC, 2 A
	minimum	10 mA, 5 VDC
Relay life	electrical	300,000 operations, R load 100,000 operations, L load
	mechanical	50,000,000 operations
ON delay		Max. 15 ms
OFF delay		Max. 5 ms



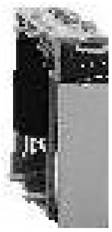
Digital Transistor Output Unit
– with 8 outputs

Model code	**CQM1–OD215**
Outputs	8, transistor, PNP 1 circuit, 8 outputs
Total switching capacity	4 A per circuit
Connection method	Screw terminal connectors
Status display	LED
Internal power consumption	110 mA, 5 VDC
External power supply	Min. 26 mA (20.4..26.4 VDC)

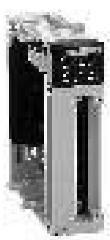
Specification for transistor outputs

Switching capacity	24 VDC, 1 A
Leakage current	0.1 mA max.
Residual voltage	0.2 V max.
ON delay	Max. 0.2 ms
OFF delay	Max. 0.8 ms
Short–circuit protection	1.6..2.0 A electronic, transistor PNP, indicator output per 4 outputs
Reset	24 VDC input per 4 outputs

Digital Output Units (Continued)



Digital Transistor Output Unit – With 16 outputs	Model code	CQM1–OD214
	Outputs	16, transistor, PNP 1 circuit, 16 outputs
	Total switching capacity	4.8 A per circuit
	Connection method	Screw terminal connectors
	Status display	LED
	Internal power consumption	170 mA, 5 VDC
	External power supply	Min. 60 mA, 20.4..26.4 VDC
Specification for transistor outputs	Switching capacity	24 VDC, 0.3 A
	Leakage current	0.1 mA max.
	Residual voltage	0.8 V max.
	ON delay	Max. 0.1 ms
	OFF delay	Max. 0.4 ms
	Short–circuit protection	3.5 A fuse per 8 outputs



Digital Transistor Output Unit – With 32 outputs – Front connector is not included in the delivery package – Prefabricated cable and terminal blocks, see page 465.	Model code	CQM1–OD216
	Outputs	32, transistor, PNP 1 circuit, 32 inputs in 4 groups
	Total switching capacity	5 A per circuit
	Connection method	1 piece, 40–pin connector
	Status display	LED
	Internal power consumption	240 mA, 5 VDC
	External power supply	Min. 160 mA, 20.4..26.4 VDC
Specification for transistor outputs	Switching capacity	24 VDC, 0.5 A
	Leakage current	0.1 mA max.
	Residual voltage	0.8 V max.
	ON delay	Max. 0.1 ms
	OFF delay	Max. 0.3 ms
	Short–circuit protection	7 A fuse per group

Safety Unit

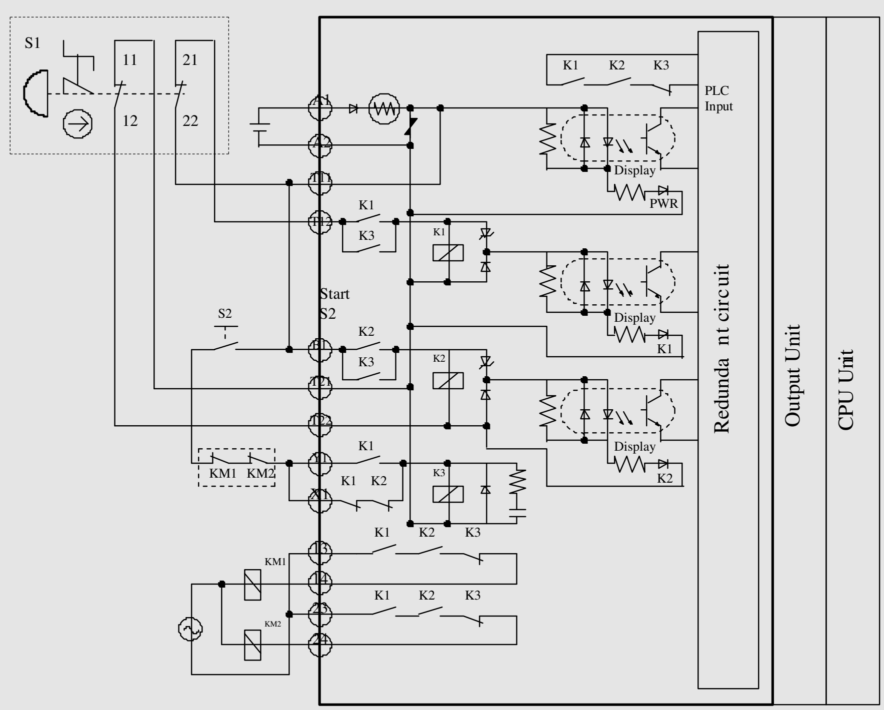
Safety Unit – Conforms to EN954–1 and EN60204–1 up to control g y category 4	**Model code**		**CQM1–SF200**
	Inputs (emergency stop)		1 or 2 channels
	Input current		Max. 75 mA
	Inputs (PLC)		4 DC inputs 1 circuit, 4 inputs
	Connection method		Screw terminal block connector
	Status display		LED
	Internal power consumption		50 mA, 5 VDC
	External power supply		70 mA, 10.2..26.4 VDC
Specification for DC inputs	Input voltage		24 VDC (20.4..26.4 VDC)
		ON level	Min. 14.4 V
		OFF level	Max. 5 V
	Input impedance		4 k&
	Input current		6 mA at 24 V
	ON/OFF delay		8 ms (adjustable 1..128 ms)
Specification for relay outputs – Controlled by safety circuit	Switching capacity	maximum	250 VAC, 5 A (cos∏=1) R load
		minimum	1 mA, 5 VDC
	Relay life	electrical	100,000 operations, R load
		mechanical	5,000,000 operations
	ON delay		Max. 300 ms
	OFF delay		Max. 10 ms

Application Example

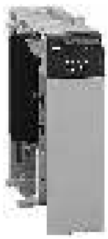
CQM1H–SF200/CS1W–SF200
Emergency stop circuit

– 2 channel
– With cross fault detection
– With earth detection
– Redundancy inputs
– Manual start (release)/Stop
– 2 safety circuits
(category 4)

S1: Emergency stop switch A22E
S2: Start A22
KM1/KM2: J7K contactor
KM3: Soft starter G3J
⊖ EN 418

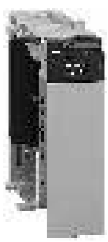


Analogue I/O Units



Analogue Input Unit
– With 4 or 2 inputs
– Input range, can be set separately for each input
– Removable terminal block

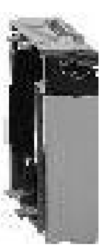
Model code		CQM1–AD042
Number of analogue inputs		4 or 2
	Number of reserved words	4 or 2 (64 or 32 I/O bits)
Range per input		(separately adjustable)
	Voltage	−10..+10 V; 0..10 V, 0..5 V
	Current	0..20 mA
Input resistance	Voltage	1 M&
	Current	250 &
Resolution		12 bits (1/4096)
Deviation		±0.5% (25°C); ±1% (0°..55 °C)
Max. input signal	Voltage	±15 V
	Current	±30 mA
Conversion time		1.2 ms per input Data refresh every 10 ms
Potential isolation		Photocoupler
Internal power consumption		170 mA, 5 VDC



Analogue Output Unit
– With 2 outputs
– Output range, separately adjusta ble for each input
– Removable terminal block

Model code		CQM1–DA022
Number of analogue inputs		2
	Number of reserved words	2 (32 I/O bits)
Range per output		(separately adjustable)
	Voltage	−10..+10 V
	Current	0..20 mA
Load resistance limit values for	Voltage	Min. 2 k&
	Current	Max. 350 &
Resolution		12 bits
	Voltage	1/4096
	Current	1/2048
Deviation		±1%
Conversion time		0.5 ms (both inputs)
Potential isolation		Photocoupler
Internal power consumption		340 mA

Temperature Controller Unit



Temperature Controller Unit
– LED status display
– 1 input word
– 1 output word
– Data transfer with IOTC instruction (CQM1H only)

Model code	CQM1–TC202
Number of loops	4
Measuring sensor	Thermocouples
Output	Transistor, PNP
Connection method	Screw terminal connectors

Model code	CQM1–TC302
Number of loops	4
Measuring sensor	Pt100
Output	Transistor, PNP
Connection method	Screw terminal connectors

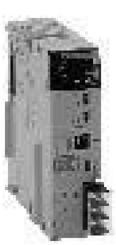
Model code	CQM1–TC204
Number of loops	2
Measuring sensor	Thermocouples
Output	Transistor, PNP
Connection method	Screw terminal connectors
Type of monitoring	Heater current

Temperature Controller Units (continued)

	Model code	**CQM1–TC304**
	Number of loops	2
	Measuring sensor	Pt100
	Output	Transistor, PNP
	Connection method	Screw terminal connectors
	Type of monitoring	Heater current
Thermocouple inputs	Sensor types	K, J, T, L, R, S, B
	Precision	0.3% of set value or 1°C, whichever is larger than a maximum of +1 digit
Pt100 inputs	Sensor types	Pt, JPt
	Precision	0.3% of set value or 0.8°C, whichever is larger than a maximum of +1 digit
Control loop	Control type	ON/OFF, PID and manual mode
	Hysteresis (ON/OFF)	0.1..999.9 °C/°F
	Proportional band	0.1..999.9 °C/°F
	Integral time (reset time)	0..3999 s
	Differential time (rate time)	0..3999 s
	Output in manual mode	0..100.0%
	Control cycle	1..99 s
	Scanning period	500 ms
	Output refresh	500 ms
Transistor outputs	Circuitry	PNP
	External supply	24 VDC (20.4..26.4 VDC)
	Switching capacity	24 VDC, 100 mA
	Leakage current	Max. 0.1 mA
	Residual voltage	Max. 0.8 V
Power demand	Internal power consumption	5 V, 190 mA
Alarm function	Heater current detection	Max. 5 A, AC
	Display accuracy	5% of minimum value x 1 place
	Signal threshold	0.1..49.9 A
	Min. detectable ON time	200 ms

Communication Units

Controller Link the industrial network for the manufacturing cell

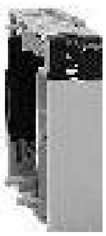


Controller Link Unit – 2–wire connection	**Model code**	**CQM1H–CLK21**
	Connection method	Screw terminals
	Status display	LED
	Internal power consumption	290 mA, 5 VDC
	Max. number of units per CPU	1
	Suitable CPU types	CQM1H–CPU51/61

For further information about "Controller Link" see page 221.

Communication Units (Continued)

DeviceNet open fieldbus

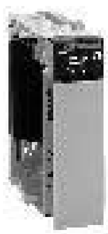


DeviceNet Unit
– I/O Link function
– Screw terminal block connector is not included in the delivery package

Model code	CQM1–DRT21
Number of I/O points per unit maximum	32 96/160
Status display	LED
Connection method	Screw terminal block connector
Internal power consumption	80 mA, 5 VDC
External power supply	40 mA, 11..25 VDC
Max. number of units per CPU	3 (CPU11/21), 5 (CPU51/61)

For further information about “DeviceNet” see page 231

CompoBus/S a high–speed fieldbus for 128 inputs and 128 outputs

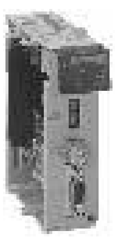


CompoBus/S Master Unit
– Supports high–speed mode and Long–distance mode
– No parameter settings required. Communication cycle time: 1 ms in high–speed mode

Model code	CQM1–SRM21–V1
Number of inputs/outputs	Adjustable via DIP switch: 128 (64 inputs and 64 outputs) 64 (32 inputs and 32 outputs) 32 (16 inputs and 16 outputs)
Number of Bus Modules	Max. 32
Number of units per CPU	Max. 3 (CPU11/21), 5 (CPU51/61)
Current consumption	180 mA, 5 VDC

For further information about “CompoBus/S”, see page 256

PROFIBUS–DP open fieldbus standard

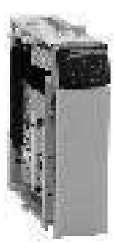


PROFIBUS–DP I/O Link Unit

Model code	CQM1–PRT21
Number of inputs/outputs (selectable)	32+32..128+128
Number of reserved I/O words	2+2..8+8
CQM1H	all (8+8 with CPU51/61 only)
Current consumption	350 mA, 5 VDC
Bus and unit status display	LED
Bus status message	24 VDC, 2 A, relay
Data exchange with CPU	Max. 0.16 ms
Accessories	GSD file on disk

For further information about “PROFIBUS–DP”, see page 264

AS–Interface – standard fieldbus direct for components



AS Interface Master Unit
– ASi, open fieldbus standard
– Installation using cutter technique
– Slave modules have IP67
– Bus length max. 100 m

Model code	CQM1–ARM21
Number of reserved words	Min. 6 Max. 16 (adjustable)
Transmission medium	Special ribbon cable
Number of Bus Modules	Max. 31 (4 bits IN + 4 bits OUT each)
Number of units per CPU	Max. 1 (CPU11/21), 2 (CPU51/61)
Communication cycle time	5 ms (with 31 Bus Modules)
Current consumption	300 mA

For further information about “AS–Interface” see page 267