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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	**:**	**FAD 20403**
SUBJECT TITLE	**:**	**PROGRAMMABLE LOGIC CONTROLLER**
LEVEL	**:**	**DIPLOMA**
TIME / DURATION	**:**	**3 HOURS**
DATE	**:**	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) questions only.**
6. **Answer all questions in English.**

THERE ARE *12* PAGES OF QUESTIONS AND 4 PAGES OF APPENDIXES, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) State **three(3**) advantages of using PLC in industrial sector.

(3 marks)

(b) Determine **five (5)** standard PLC programming languages.

(5 marks)

(c) Explain the procedure to **Edit On Line** the program.

(4 marks)

(d) Draw the PLC input wiring for all the input devices shown in ladder diagram **figure 1**. Limit switch is **Normally Close (NC)** in physical.

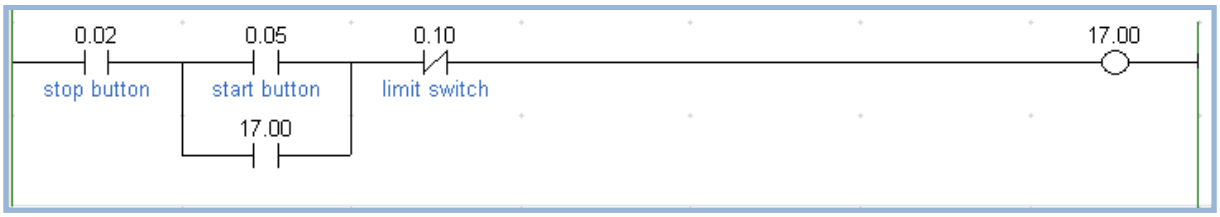


Figure 1: Ladder diagram

Question 2

(a) Convert the ladder diagram in **Figure 2** below to Instruction list

(7 marks)

(b) Define the Set Value for Counter in Ladder diagram **Figure 2**

(2marks)

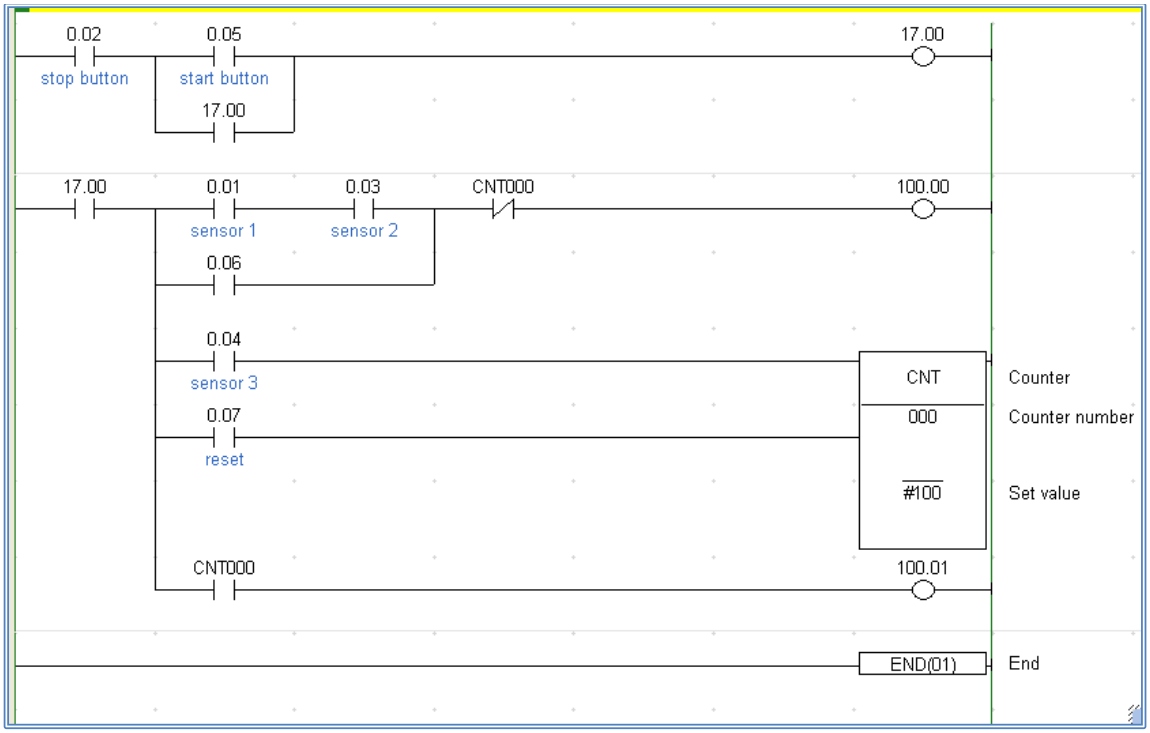


Figure 2 : Ladder diagram

(c) Draw the ladder diagram based on the instruction list in **Table 1**.

(6 marks)

Table 1 : Instruction list

STEP	INSTRUCTIONS	OPERANDS/ADDRESS
00000	LD	00001
00001	AND	00002
00002	AND NOT	01601
00003	FUN SET	01600
00004	LD NOT	00003
00005	OR NOT	00004
00006	OR NOT	00005
00007	FUN RESET	01600
00008	LD	00006
00009	AND NOT	01600
00010	FUN SET	01601
00011	LD NOT	00003
00012	OR NOT	00005
00013	FUN RESET	01601
00014	LD	01600
00015	OR	01601
00016	TIM	00
		#100
00017	LD NOT	TIM 00
00018	OUT	10001
00019	OUT	10002
00020	OUT	10003
00021	END	-

Question 3

(a) **Figure 3** shows a ladder diagram with Shift Register Function. Answer all the following questions.

Figure 3 :Ladder diagram.

Based on **Figure 3**,

i. State the Input address of Shift register. (1 mark)

ii. State the Input address that gives Pulse to Shift Register. (1 mark)

iii. Define the Reset of Shift Register (2 marks)

iv. Starting Word(ST) and Ending word (E) of Shift Register (2 marks)

(b) Answer all the questions below

- When the push button 1 (00005) is pressed then released, internal bit 01700 will ON. It will stop when we press the stop button (00010)
- When Internal bit 01700 is equal to `1`, it will calculate the value $\mathbf{9999_{BCD} + 119_{BCD}}$ and store the result in word 019. The indicator lamp 10004 will ON when there is a carry in this operation, but if there is no carry, the output 10004 is OFF.
- The value in word 019 will always **MOVE** to address DM00
- When the internal bit 01700 is equal to 1, Move $\mathbf{150_{BCD}}$ to DM01.
- The program will always compare the value between DM00 and DM01. The result of comparison must respect all the condition below.

Table 2 : Results

Data	**10012**	**10013**	**10014**
DM00 **>** DM01	ON	OFF	OFF
DM00 **=** DM01	OFF	ON	OFF
DM00 **<** DM01	OFF	OFF	ON

(a) Design the ladder diagram according to following explanation.

(6 marks)

(b) List which output will ON when push button is pressed.

(1.5 marks)

(c) State the value in DM 00

(1.5 marks)

Question 4

An input module in **Figure 4** which is connected to a Pressure transducer, has an A/D with a 10-bit resolution. The Pressure transducer receives a valid signal from the process from 50 to 100 psi , The analog input module accepts a 0 -20mA unipolar signal.

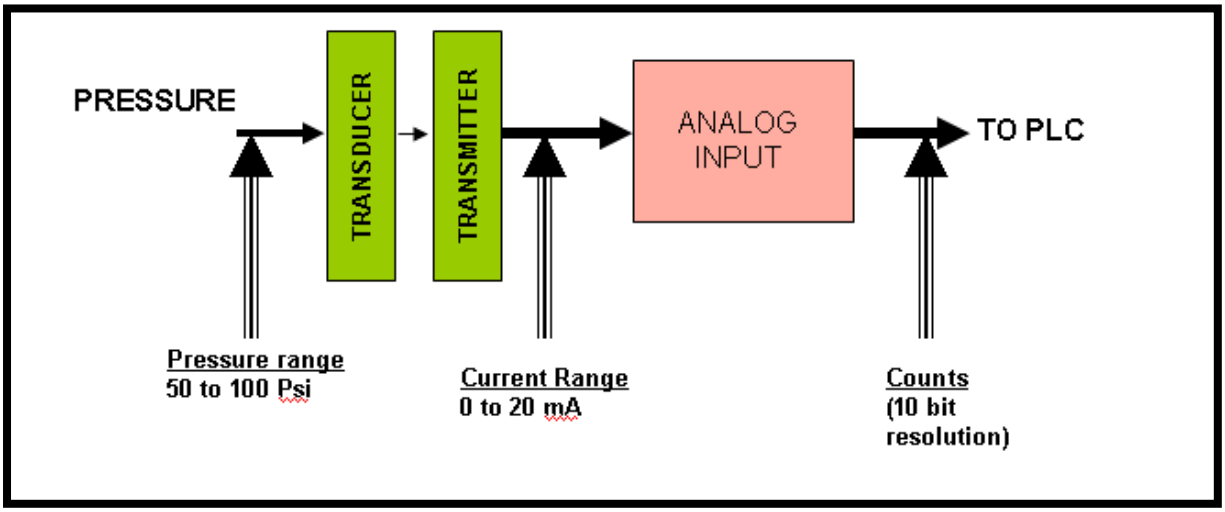


Figure 4: Transformation of an analog signal into a binary or BCD value

Answer all the question based on **Figure 4**.

(a) Tabulate the relationship between Pressure, input current in mA and counts where the current is increase every 2 A.

(5 marks)

(b) Find the equivalent current change for each count change.

(3 marks)

(c) Find the equivalent current change for each pressure change

(3 marks)

(d) Draw a curve of Pressure (Pascal) versus Output transducer (Current) where the equation of the curve is Y = mX +C. Find the value of m and C.

(4 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer TWO (2) questions only.
Please use the answer booklet provided.

Question 5

Counting System

Figure 5: A photoelectric counting sweets

In **Figure 5**, a photoelectric sensor is installed in the middle of the conveyor. This sensor will calculate the amount of bottles passing through the conveyor. Previous an instruction called COUNTER (CNT) is used in the ladder program. For upgrading purposes, the counter needs to be replacing with an arithmetic instruction. The old program is as in **Figure 6** below.

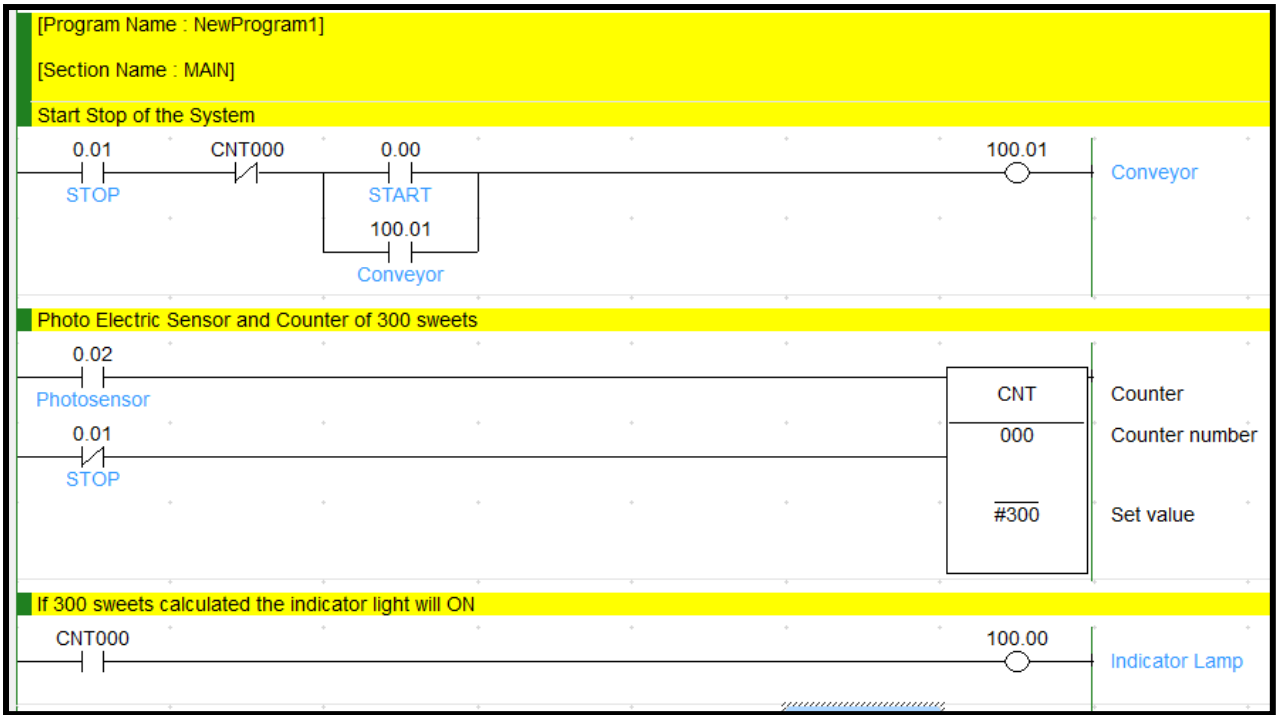


Figure 6: Ladder Diagram of the system using Counter

(a) Convert the ladder diagram in **Figure 6** to Instruction List

(4 marks)

(b) Define the Input and Output list of the system.

(2 marks)

(c) Draw the Input and Output wiring of the system

(4 marks)

(d) Redraw new ladder diagram of the system using Arithmetic Instructions (Additional, Subtraction, Multiplication, Division, Compare, Move, etc)

(10 marks)

Question 6

Maintaining tank water level

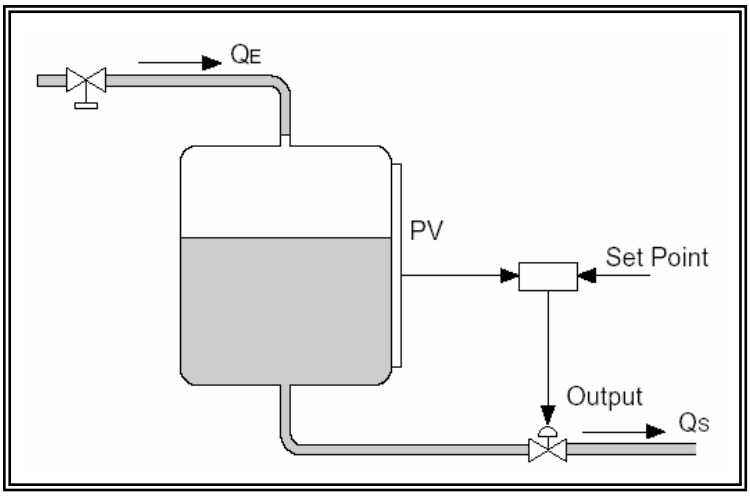


Figure 7: Single loop tank water level system

A water level system of a tank consists of:

- Pressure sensor (PV) to measure the level of the water in the tank. This sensor operates at 0-20mA range giving a variation of 0% to 100% of water level in the tank.
- Two discrete valves, Q_E at the inlet and Q_S at the outlet.
- An Omron PLC CQM1H CPU51 with the Analog Input/Output card MAB42. (refer appendix 1,2,3,4)

Operations:

- The Set Point (SP) of the level will be given by the operator in the range of 20% to 80% of the water level.
- During the operation:
    - If the value of PV is less than SP, the Outlet valve Q_S will close and the inlet valve Q_E will open.
    - If the value of PV is greater than or equal with SP, the outlet valve will open and the inlet valve will close.
- The inlet valve QE and outlet valve QS may also be controlled manually.

(a) The pressure sensor is connected to the analog input channel 1, state the address of the PLC register associated.

(2 marks)

(b) Complete the **Table 3** below. *(You have to redraw the complete table in your answer booklet)*

(5 marks)

Table 3: Data Conversion table

Water level (%)	Output Transducer (mA)	12 bits data convertered (decimal)
0	0	
20		
40		
60		
80		
100	20	

(c) Draw a curve water level (%) versus Output transducer (mA) where the equation of the curve is Y = mX +C. Find the value of m and C.

(5 marks)

(d) Design the ladder where the value read from the analog input channel 1 is compared to the value $0E65_{HEX}$. If the read value is greater than $0E65_{Hex}$ then output 10001 will energize. If the read value is less than or equal to $0E65_{HEX}$ then output 10002 will energize.

(5 marks)

(e) The Output (10001 and 10002) will ON when the water is reached in certain level. Calculate the percentage of water level when the two outputs is ON

(3 marks)

Question 7

Automatic Carrier

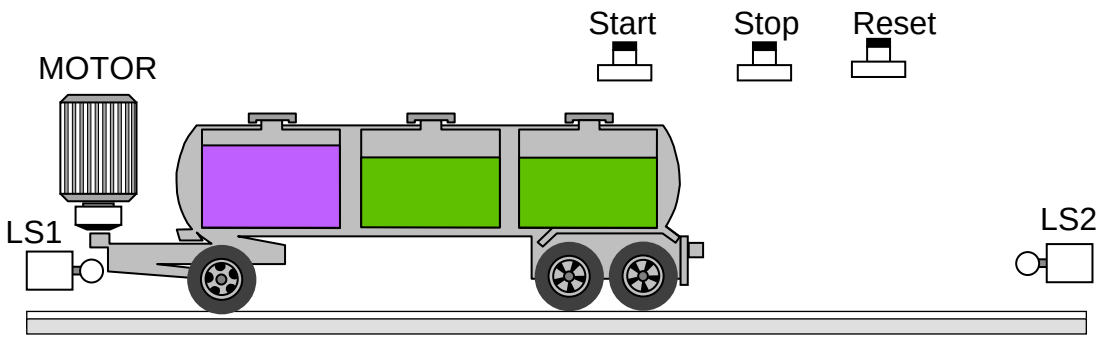


Figure 8 : Automatic Carrier

The wagon is moved by the forward/reverse motor. The initial position of the wagon is the left position indicated by the limit switch LS1 (NC). When the start push button is pressed (then release), the wagon will move to the right until it touches the right limit switch LS2 (NC), After 10 Second , the wagon will moves to the left. Once it touches LS1; the wagon will stop. The stop button stops the motor regardless of which direction it is turning. The movement forward/reverse will be limited to 5 times only. The operator needs to press a reset button before the operation can resume. Ladder diagram for the system is shown in **Figure 9.**

Answer all the Questions below

(a) Convert the ladder diagram in **Figure 9** to Instruction List.

(6 marks)

(b) Redraw the Ladder diagram and replace the **Self Holding Contact** to **SET RESET.**

(4 Marks)

(c) Determine the address of the reset button.

(1 mark)

(d) Determine the Set value of the Counter and Timer .

(2 Marks)

(e) Draw the PLC Input Wiring .

(4 marks)

(f) Draw The PLC Output Wiring

(3 marks)

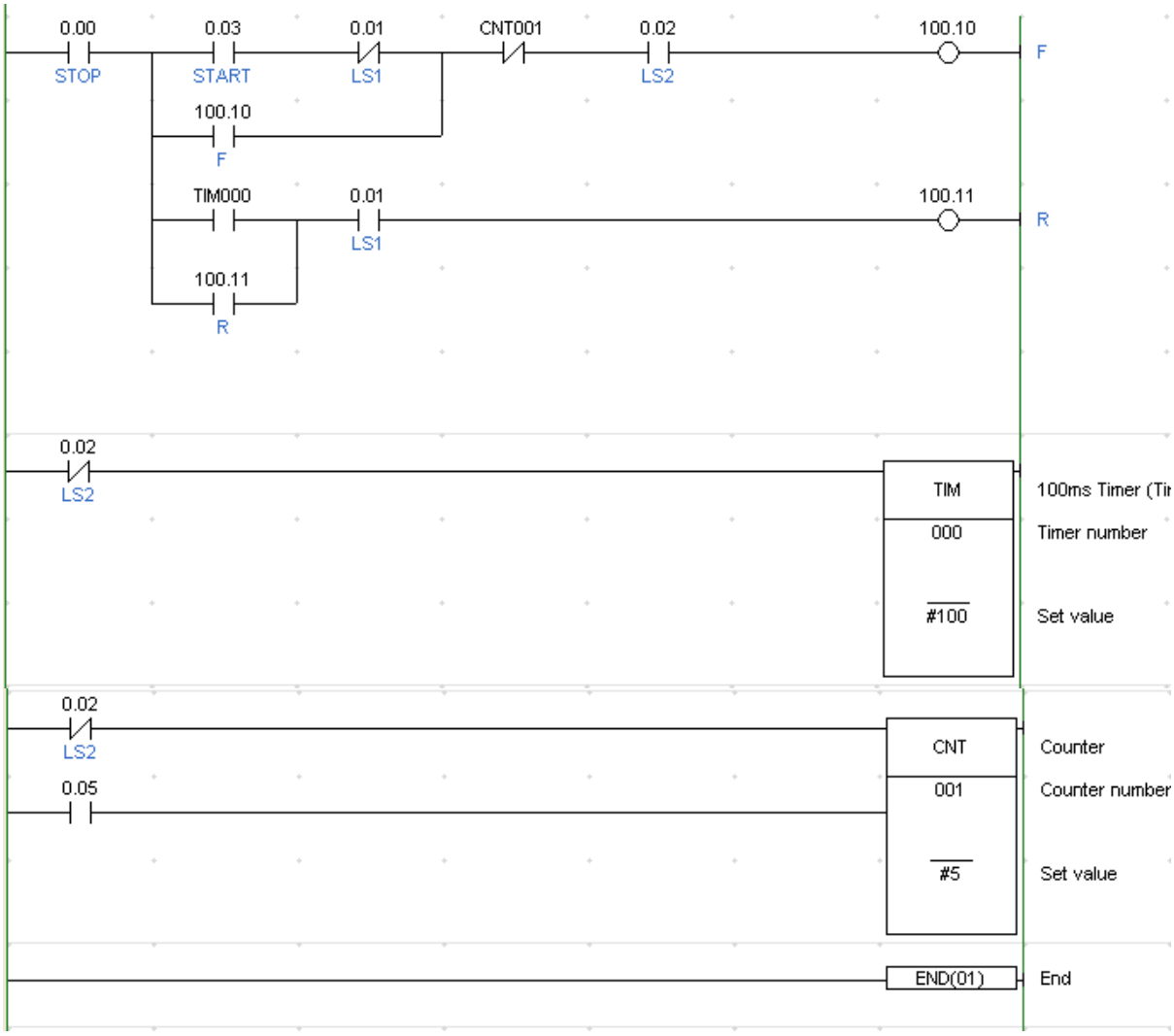


Figure 9: Ladder Diagram

END OF QUESTION

APPENDIX 1

Related PC Setup Settings None

2-5 Analog I/O Board

2-5-1 Model

Name	Model	Specifications
Analog I/O Board	CQM1H-MAB42	4 analog inputs (–10 to +10 V; 0 to 5 V; 0 to 20 mA; separate signal range for each point) 2 analog outputs (–10 to +10 V; 0 to 20 mA; separate signal range for each point)

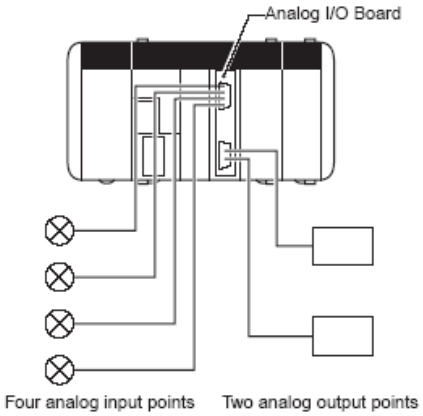
2-5-2 Function

The Analog I/O Board is an Inner Board featuring four analog inputs and two analog outputs.

The signal ranges that can be used for each of the four analog input points are –10 to +10 V, 0 to 5 V, and 0 to 20 mA. A separate range is set for each point. The settings in DM 6611 determine the signal ranges.

The signal ranges that can be used for each of the two analog output points are –10 to +10 V and 0 to 20 mA. A separate signal range can be selected for each point. The settings in DM 6611 determine the signal range.

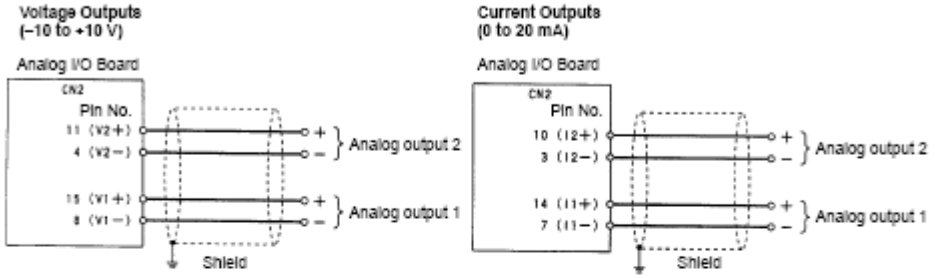
2-5-3 System Configuration



APPENDIX 2

Analog Output Connections

The output signal connections to CN2 depend on whether the output signals are voltage outputs or current outputs. The following diagrams show the correct wiring in each case.



8-5-8 Specifications

Item	Specifications
Name	Analog I/O Board
Model number	CQM1H-MAB42
Applicable CPU Unit	CQM1H-CPU51/61
Unit classification	CQM1H-series Inner Board
Mounting locations and number of Boards	1 Board in Inner Board slot 2 (right slot)
Analog inputs	4 inputs (Refer to *Analog Inputs* below for a details.)
Analog outputs	2 outputs (Refer to *Analog Outputs* below for a details.)
Isolation method	Between inputs and PC: Photocoupler isolation Between inputs: No isolation
Settings	None
Indicators	2 LED indicators on front panel: Ready (RDY) and Error (ERR)
Front connection section	Connectors CN1 and CN2 (Compatible connector: Sockets & connectors provided as standard accessories.)
Current consumption (Supplied from Power Supply Unit)	5 V DC 400 mA max.
Dimensions	25 × 110 × 107 mm (W × H × D)
Weight	100 g max.
Standard accessories	Sockets: XM2D-1501 (OMRON) x 2 Hoods: XM2S-1511 (OMRON) x 2

APPENDIX 3

Analog I/O Board Section 2-5

Relevant Bits **Bits Used by Inner Board in Slot 2**

Word	Bits	Name	Function
IR 232	00 to 15	Analog input 1 converted value	The converted value from each input from the Analog I/O Board is stored as a 4-digit Hex each cycle. −10 to +10 V: F800 to 07FFF Hex 0 to 10 V: 0000 to 0FFF Hex 0 to 5 V/0 to 20 mA: 0000 to 0FFF Hex
IR 233	00 to 15	Analog input 2 converted value	
IR 234	00 to 15	Analog input 3 converted value	
IR 235	00 to 15	Analog input 4 converted value	
IR 236	00 to 15	Analog output 1 setting	The setting of each output from the Analog I/O Board is stored as a 4-digit Hex. (Read each cycle.) −10 to +10 V: F800 to 07FF Hex 0 to 20 mA: 0000 to 07FF Hex
IR 237	00 to 15	Analog output 2 setting	

SR Area Flags

Word	Bit	Function
SR 254	15	Inner Board Error Flag

AR Area Flags

Word	Bits	Function	
AR 04	08 to 15	Error codes for Inner Board in slot 2	00 Hex: Normal 01 or 02 Hex: Hardware error 03 Hex: PC Setup error 04 Hex: A/D or D/A conversion error

Relevant PC Setup Settings

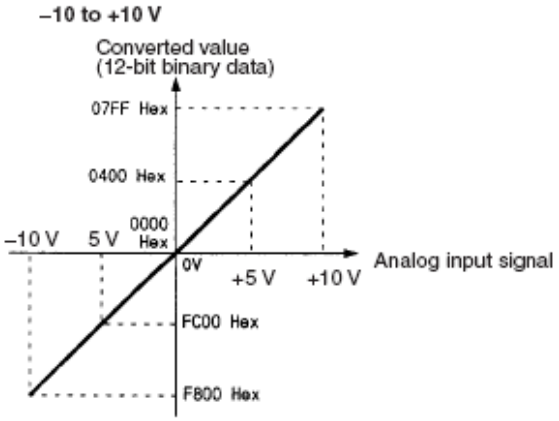
Word	Bits	Function	
DM 6611	00 to 07	00, 01: Analog input 1 input signal range 02, 03: Analog input 2 input signal range 04, 05: Analog input 3 input signal range 06, 07: Analog input 4 input signal range	00: −10 to +10 V 01: 0 to 10 V 10: 0 to 5 V/0 to 20 mA 11: Not used. (0 to 20 mA are distinguished by the connected terminal.)
	08	Analog input 1 usage selection	Specifies use or non-use of A/D conversion for each port. 0: Use input (conversion) 1: Do not use input (no conversion)
	09	Analog input 2 usage selection	
	10	Analog input 3 usage selection	
	11	Analog input 4 usage selection	
	12 to 15	Not used. (Fixed at 0.)	

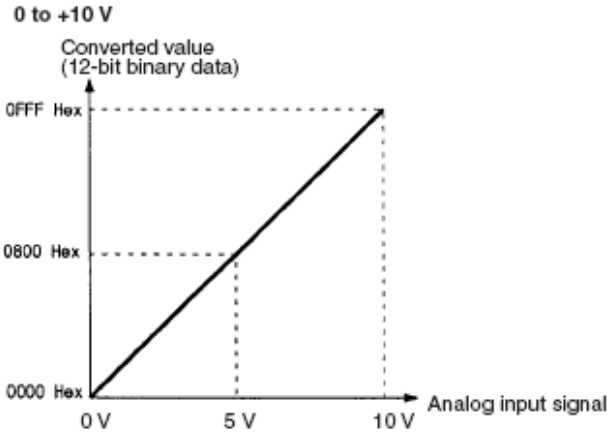
Note The level of the analog output signal is determined by the connected terminal, and there is no PC Setup setting. These settings are reflected in status at power ON.

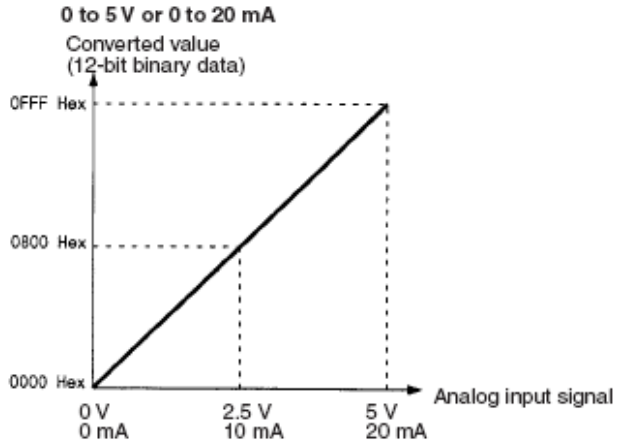
APPENDIX 4

2-5-6 Specifications

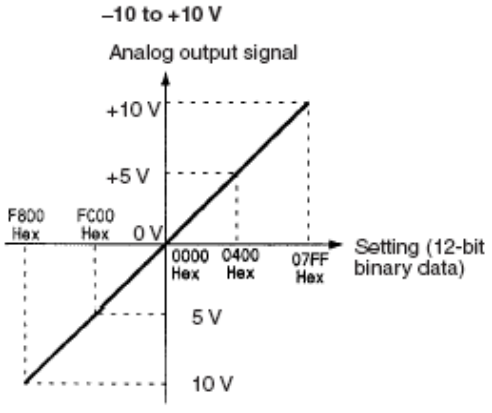
Analog Inputs: Input Data and Converted Values

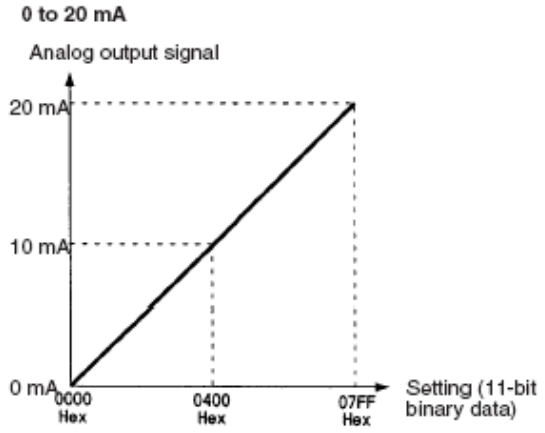






Analog Outputs: Settings and Output Data





Applications Examples The Board uses no special instructions. MOV(21) is used to read analog input values and set analog output values.