



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2011 SESSION

SUBJECT CODE : FAD 30502
SUBJECT TITLE : PROGRAMMABLE LOGIC CONTROLLER 2
LEVEL : DIPLOMA
TIME / DURATION : 12.30pm – 2.30pm
(2 HOURS)
DATE : 11 MAY 2011

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 11 PAGES OF QUESTIONS AND 4 PAGES OF APPENDIX , EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.****Question 1**

- (a) Explain the procedure to download the program in CX programmer into PLC.

(5 marks)

- (b) Explain the procedure to edit the program on-line.

(5 marks)

Question 2

Answer all the questions below by referring ladder diagram in **Figure 1** and layout in **Figure 2** and below.

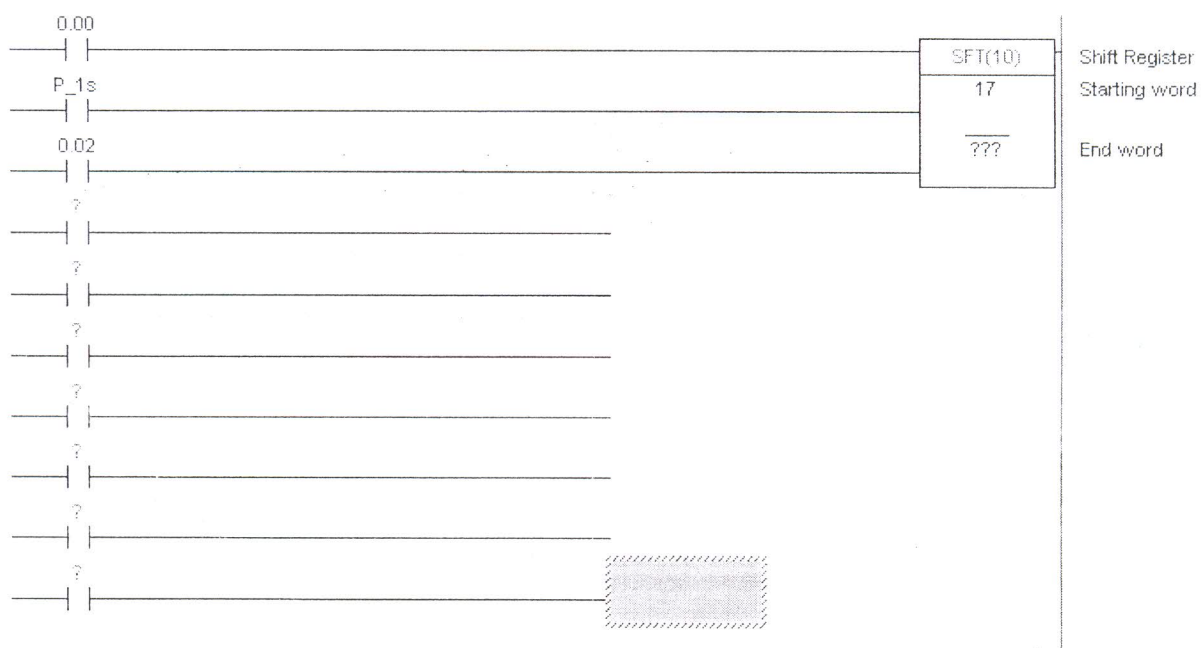


Figure 1: Incomplete Ladder diagram

- (a) Based on **Figure 1**, define the function of 0.00, 0.02 and P_1s. (3 marks)
- (b) Define the **Ending Word** of this Shift Register by referring the **Figure 1**. (2 marks)
- (c) Complete and redraw the Ladder diagram in **Figure 1** by referring the running light layout shows in **Figure 2**. The sequence of the process is shows in **Tables 1** and the output address is shown in **Table 2**. (10 marks)

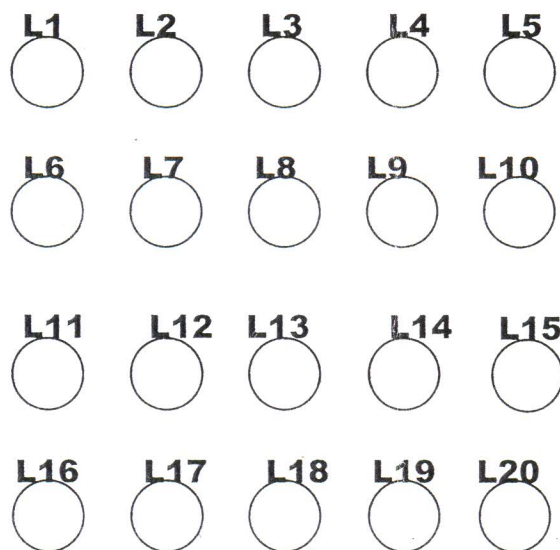


Figure 2 : Running light Layout (L1 – L20 : lamp)

Table 1 : Sequence Process

| Bit | Output Activate (Lamp will ON) |
|-----|--------------------------------|
| 0 | L1 AND L6 |
| 1 | L2 AND L7 |
| 2 | L3 AND L8 |
| 3 | L4 AND L9 |
| 4 | L5 AND L10 |
| 5 | L11 AND L16 |
| 6 | L12 AND L17 |
| 7 | L13 AND L18 |
| 8 | L14 AND L19 |
| 9 | L15 AND L20 |

Table 2 :Output List

| Output | Address | Output | Address |
|--------|---------|--------|---------|
| L1 | 10000 | L11 | 10010 |
| L2 | 10001 | L12 | 10011 |
| L3 | 10002 | L13 | 10012 |
| L4 | 10003 | L14 | 10013 |
| L5 | 10004 | L15 | 10014 |
| L6 | 10005 | L16 | 10015 |
| L7 | 10006 | L17 | 10100 |
| L8 | 10007 | L18 | 10101 |
| L9 | 10008 | L19 | 10102 |
| L10 | 10009 | L20 | 10103 |

Question 3

- (a) Design a simple ladder diagram to calculate the following arithmetic instruction:

(8 marks)

$$Y = 10_{\text{BCD}} + (7_{\text{BCD}} - x) \quad (\text{All the numbers and values are in BCD format})$$

Where **DM100** will be use as variable **Y**

and **DM105** will use as variable **x**

- (b) By using **MOVE** instructions, change the variable **x** to value **10_{BCD}**

(3 Marks)

- (c) What will be the value in **DM100**.

(2 marks)

Question 4

A PLC CQM1H has been chosen to control the boiling system, in order to deal with the analog processing control an Analog Inner Board MAB42 which it consist of 4 channels of analog inputs and 2 channels of analog outputs.

The setting for analog inputs channels in DM6611 is shown in **Figure 3**

DM6611 =

| | | | |
|---|---|---|---|
| 0 | 8 | D | 8 |
|---|---|---|---|

Figure 3 : Setting result

Refer to **Appendix 3**, determine the address of the analog sensors in the PLC register and what type of signal injected into this channel.

(10 marks)

Question 5

An input module in **Figure 4** which is connected to a Temperature transducer, has an A/D with a 12-bit resolution. The Temperature transducer receives a valid signal from the process from 0 to 100 °C , The analog input module accepts a 0 -10Vdc Unipolar signal range converts it to a range of 0 - 4095 counts.

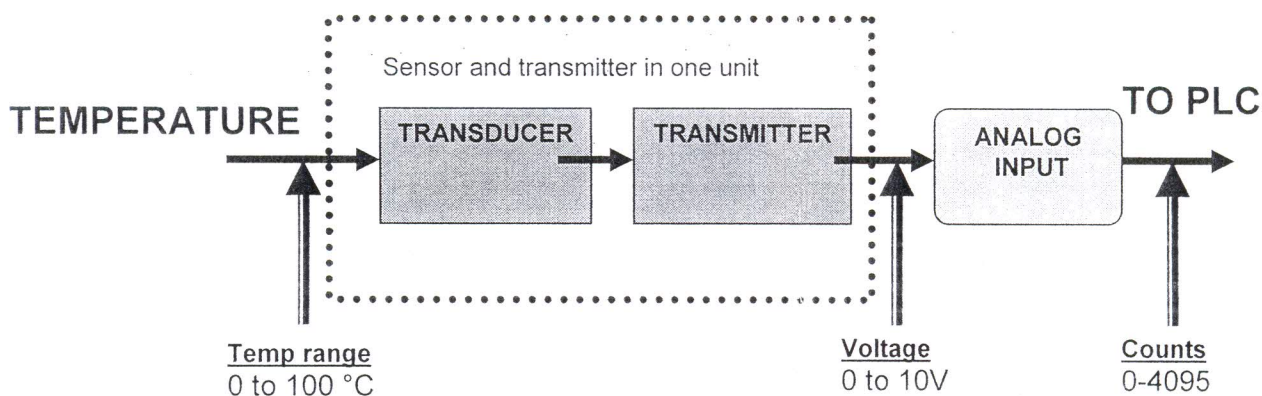
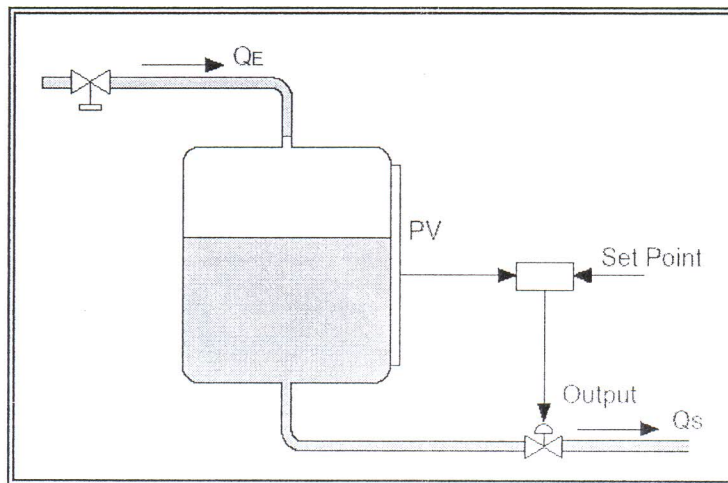


Figure 4: Transformation of an analog signal into a binary or BCD value

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

- (a) Tabulate the relationship between temperature, input voltage and counts
(6 marks)
- (b) Find the equivalent voltage change for each count change.
(3 marks)
- (c) Find the equivalent voltage change per degree celsius change.
(3 marks)

SECTION B (Total: 40 marks)**INSTRUCTION: Answer TWO questions only.****Please use the answer booklet provided.****Question 6****Maintaining tank water level****Figure 5: 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)

Operation:

- 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 Q_E and outlet valve Q_S 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 converted (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 $0E65_{\text{HEX}}$. If the read value is greater than $0E65_{\text{HEX}}$ then output 10001 will energize. If the read value is less than or equal to $0E65_{\text{HEX}}$ 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

Weighing system in Charcoal Factory

In a charcoal factory, a conveyor system is used as transferring system of the charcoal from warehouse A to warehouse B with 3 different speeds depending how much the weight of the charcoal on the conveyor.

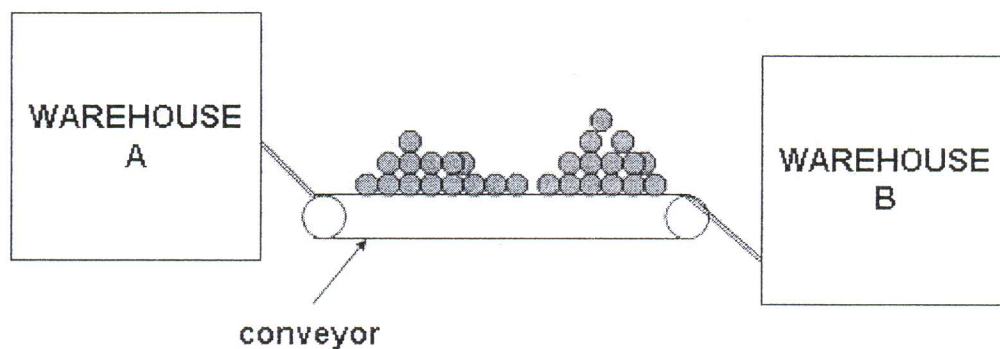


Figure 6 - Transferring charcoals from Warehouse A to Warehouse B

The three different speeds of the conveyor will be set in the programs with 3 different values of register **IR237**. This value will be sent to Analog Output channel via Analog Output Card. The data will be converting by the Analog Output Card, within a range of 0-10Vdc.

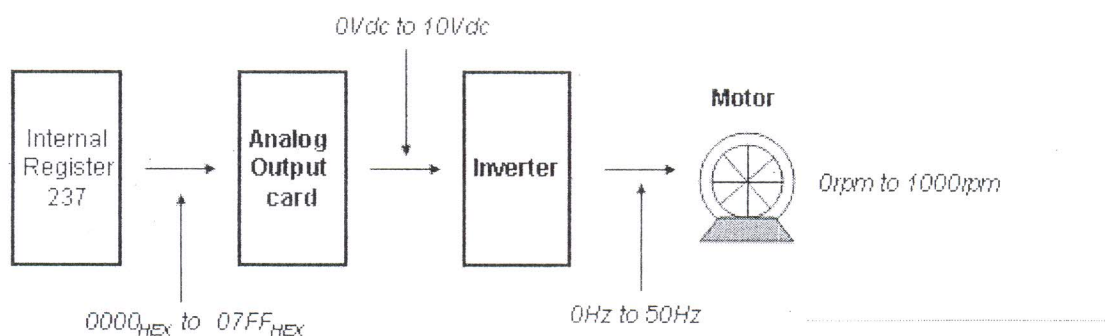


Figure 7 - Data conversion from PLC to the motor

These 0-10Vdc values will be sent to an Inverter which connected to a 3 Φ motor. The Inverter will convert the frequencies of the 3 Φ supply. The Inverter can convert 0-10Vdc to frequencies values of 0Hz minimum until 50Hz maximum. this means that the motor will stop at 0 Hz and at run in maximum speed at 50 Hz.

- (a) What are the values in the register IR237, if the conveyor run at 750rpm, 500rpm and 200rpm. (3 marks)
- (b) Complete the table below. *(you have to complete and redraw the table below in your answer booklet)* (7 marks)

Table 4: Data Conversion table

| Value in IR237 (Hexadecimal) | Voltage at the output of analog card (Vdc) | Value in frequency (Hz) | Motor Speed (Rpm) |
|---------------------------------|--|----------------------------|----------------------|
| 0000 | | 0 | 0 |
| | | | 100 |
| | | | 200 |
| | | | 300 |
| | | | 400 |
| | | | 500 |
| | | | 600 |
| | | | 700 |
| | | | 800 |
| | | | 900 |
| | 10 | | 1000 |

- (c) Create the ladder diagram based on the following statement
- The data in Data memory area **DM0** will always be transfered to Analog output channel 2 **IR237**. (2 marks)
 - If internal bit **01603** is on, the value for speed 200rpm will be transfer to **DM0**. (2 marks)
 - If internal bit **01604** is on, the value for speed 75000rpm will be transfer to **DM0**. (2 marks)
- (d) Draw a curve represent frequency (Hz) vs speed (rpm). Find the equation of the curve. (4 marks)

Question 8

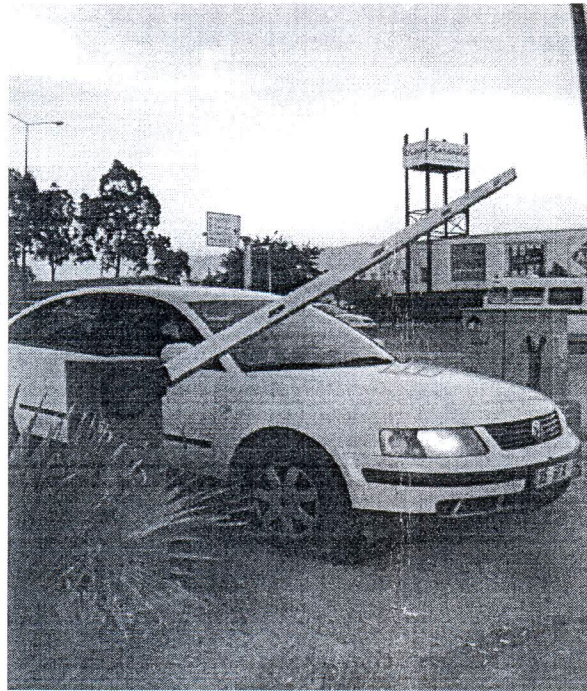


Figure 8 : Parking Lot

Arithmetic Function is used to keep track of the number of vehicles in a parking lot. The parking lot has a capacity of 250 places. As vehicles enter the lot through an entrance gate, the gate will open when sensor 1 detect the vehicle and closed when sensor 2 detected. The **ADDITIONAL** function (ADD) will counts up (detected by a sensor2). As vehicles exit the lot through an exit gate, the **SUBTRACTION** function (SUB) will subtract the total of the vehicles in a parking lot (detected by a sensor3). When the lot is full a sign at the entrance gate turns on indicating the lot is full (using red indicator light).

Table 5 : PLC Input list

| Inputs symbol | PLC Address | Descriptions |
|---------------|-------------|--|
| S1 | 00001 | Detect vehicle for entrance gate opening and calculate the number of vehicle |
| S2 | 00002 | Detect vehicle for entrance gate closing. |
| S3 | 00003 | Detect vehicles exit from parking lot |
| RST | 00004 | Reset button |

Table 6 : PLC Output list

| Outputs symbol | PLC Address | Descriptions |
|----------------|-------------|----------------------|
| Km1 | 10000 | Entrance gate |
| L1 | 10001 | FULL indicator lamp. |

Answer these questions based on **Figure 8**:

- (a) Draw the PLC input and Output wiring. (3 marks)
- (b) Design the ladder diagram for the system by following the requirements below.
- 01600 will ON for one Scan Cycle when sensor 1 detect the vehicle
(1 mark)
 - 01700 will ON for one Scan Cycle when sensor 2 detect the vehicle
(1 mark)
 - Gate will open and close when Vehicle entering the parking lot
(Detected by sensor 1 and sensor 2)
(3 marks)
 - Counting the vehicles using **ADDITIONAL** function.
(3 marks)
 - FULL indicator light will ON when total of vehicles is equal or more than 250.
(3 marks)
 - 01800 will ON for one Scan Cycle when sensor 3 detect the vehicle
(1 mark)
 - Sensor 3 detects the vehicle exit, and subtracts the total number of vehicle in the Parking lot.
(3marks)
 - Reset Push button will initialize the value of the vehicle in parking lot to zero.
(2 marks)

END OF QUESTION

APPENDIX 1

Analog I/O Board

Section 2-5

Related PC Setup Settings None

2-5 Analog I/O Board**2-5-1 Model**

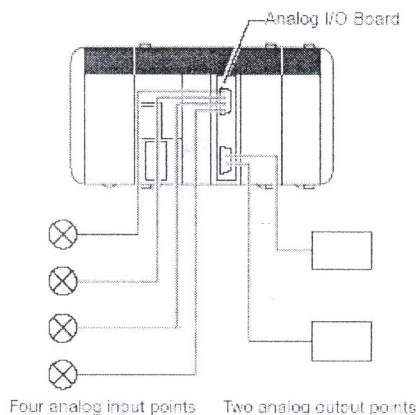
| Name | Model | Specifications |
|------------------|-------------|---|
| Analog I/O Board | CQM1H-MAB42 | 4 analog inputs (–10 to +10 V; 0 to 5 V; 0 to 20 mA; separate signal range for each point) 2 analog outputs (–10 to +10 V; 0 to 20 mA; separate signal range for each point) |

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

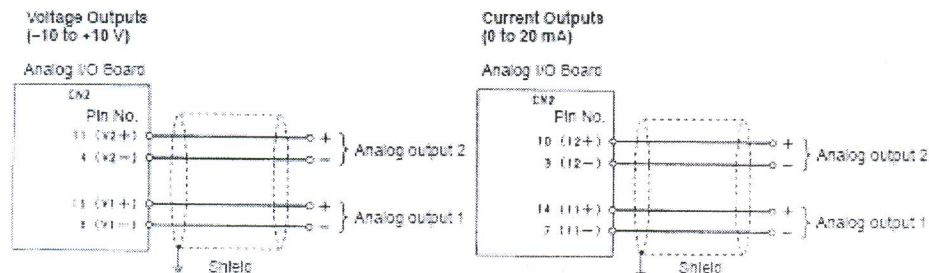
APPENDIX 2

Analog I/O Board

Section 8-5

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 <i>Analog Inputs</i> below for a details.) |
| Analog outputs | 2 outputs (Refer to <i>Analog Outputs</i> 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) | 6 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: XM2G-1511 (OMRON) x 2 |

APPENDIX 3

Analog I/O BoardSection 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

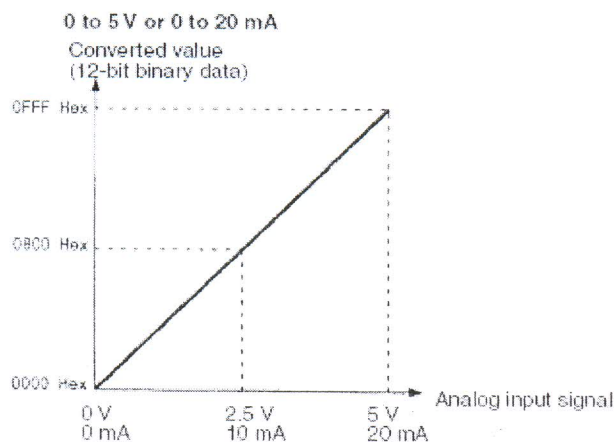
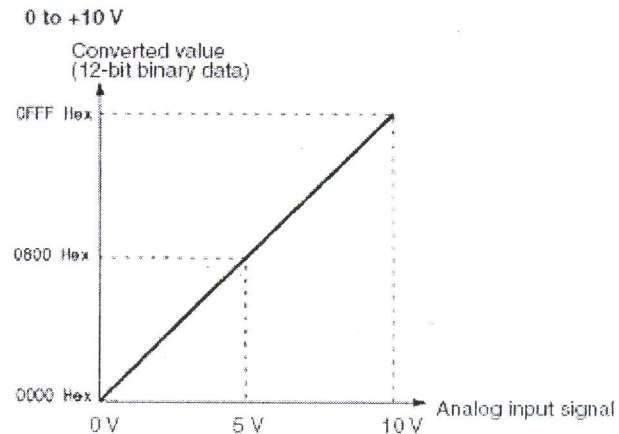
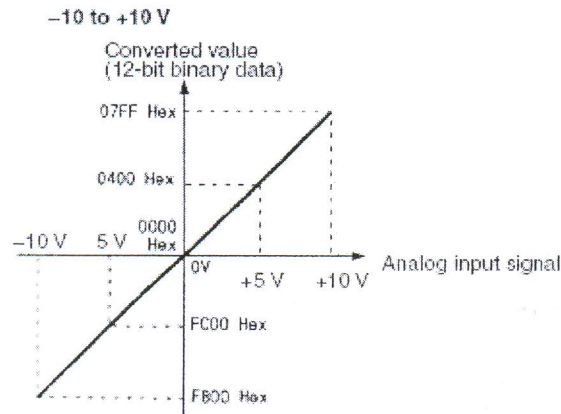
| Word | Bits | Function |
|---------|----------|--|
| DM 6811 | 00 to 07 | 00, 01: Analog input 1 input signal range 02, 03: Analog input 2 input signal range 04, 05: Analog input 3 input signal range 06, 07: Analog input 4 input signal range 00: -10 to +10 V 01: 0 to 10 V 10: 0 to 5 V/0 to 20 mA 11: 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. |
| | 09 | Analog input 2 usage selection 0: Use input (conversion) 1: Do not use input (no conversion) |
| | 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.

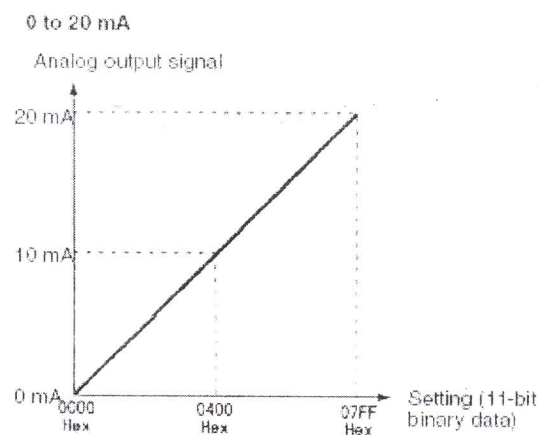
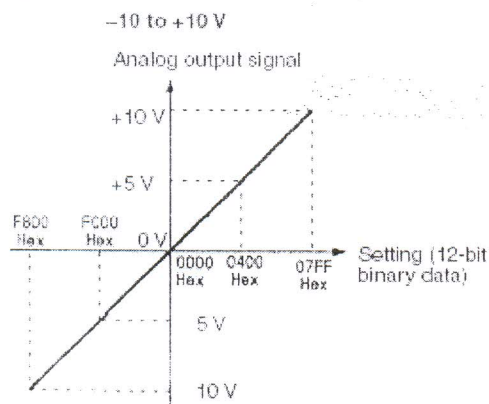
APPENDIX 4

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.