CHAPTER 3

METHODOLOGY

3.1 Introduction

There have a few phase or steps in designing the Intelligent Traffic Light. These steps are important to make this project successfully.

1. Primary Study
2. Software Simulation
3. Interfacing and Connection
4. Circuit Design
5. Prototypes Design
6. Testing

3.2 Primary Study

In this phase, the primary study should be made before designing of this project. This is important to confirm that all the entire items are necessity in this development. The detail of primary study can make the project flow smoothly and can reduce the probability of problem happen.

3.2.1 The problems of typical traffic light and the solutions

In Malaysia, traffic light typically controlled by a Programmable Logic Controller. However, there have a few problems of the typical traffic light and their solutions.

(a) Traffic light foundation the heavy traffic jams

By increasing the number of vehicle in road, have cause the heavy traffic jams. This happened usually at the main junctions commonly at the morning, before office hour and at the evening, after the office hour. The main effect of this matter is increasing time wasting of the people at the road.

The solution for this problem is by developing the PLC program which different setting delays for different junctions. The delay for junctions that have high volume of traffic should be setting longer than the delay for the junction that has low of traffic. This operation is calling Normal Mode.

(b) No traffic, but still need to wait

The traffic light has contributed more wasting time people at road. At the certain junction, sometime there have no traffic. But because the traffic light still red, the road users should wait until the light turn to green. If they run the red light, unfortunately they maybe should pay the fine about RM 300.

The solution of this problem is by developing a system which has a program and hardware that can detect the traffic volume. If the traffic low, the system will change to Normal Mode which pass the car instantly when it arrive at the junction. If the traffic high, the system will change to Normal Mode automatically.

(c) Emergency car stuck in traffic jam

Usually, during traffic jam, the emergency vehicle, such as ambulance, fire-brigade and police will be stuck especially at the traffic light junction. This is because the road users waiting for the traffic light turn to green. This is very critical problem because it can cause the emergency case become complicated and involving life.

The solution of this problem is by introducing the Emergency Mode. The traffic light will change automatically to green when there have a emergency vehicle approaching the junction. So it will prevent the emergency car stuck at the junction.

3.2.2 The operation of the traffic light

This traffic light is suitable to install at four junction of traffic light. Figure 3.0 shows the suit cross-junction for this project.

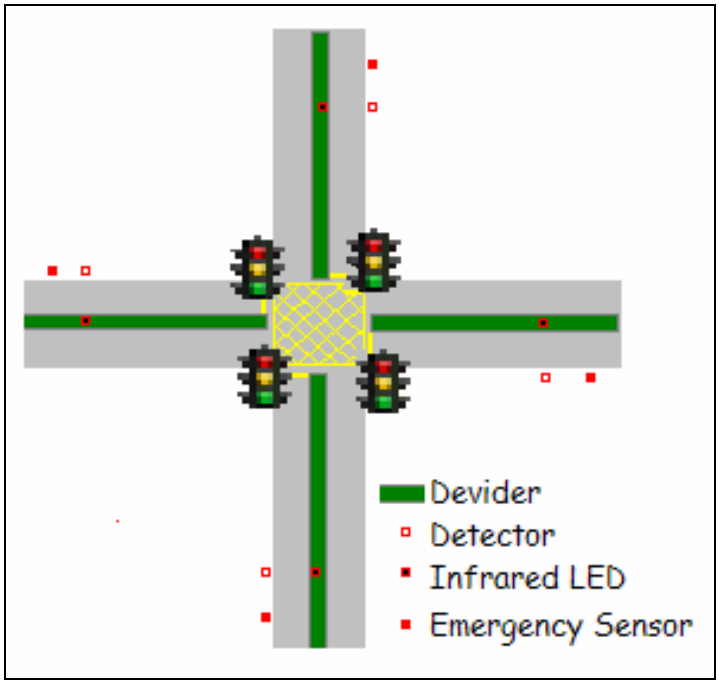

Figure 3.0: Cross-junction for the project

There have been many different form of traffic flow used at the cross-junction. In this project all modes (normal mode, emergency mode and night mode) using the same flow of traffic pattern which is only one way of traffic allowed to pass through the junction at a time. Figure 3.1 shows the phase of operation of traffic light.

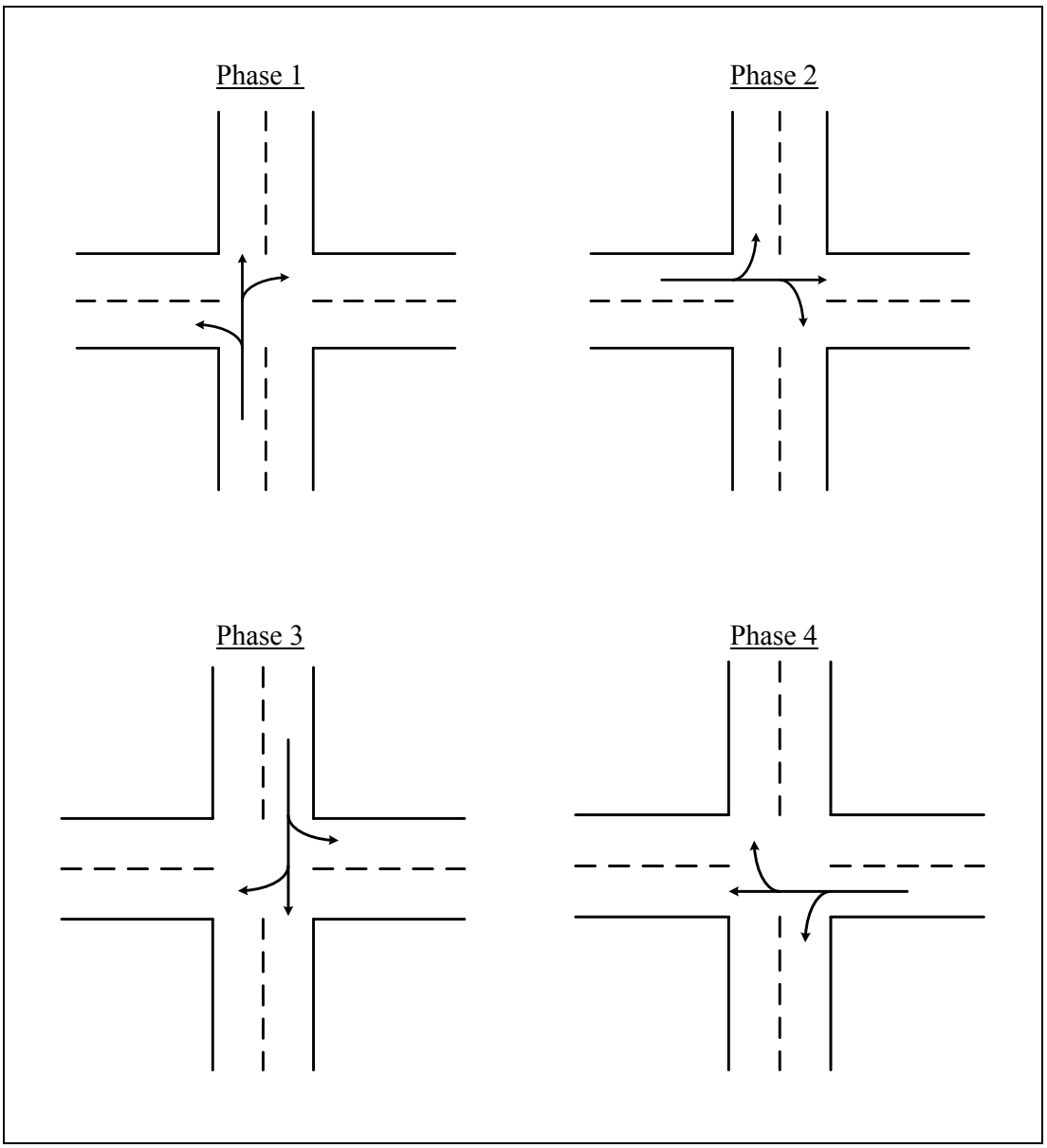

Figure 3.1: Phase operation of traffic light

3.3 Software Simulation

In this project, the main software that have been used for designing the program for 4 junction intelligent traffic light was CX programmer. The main functions of CX programmer for this project are:

- The place to design the logic ladder diagram in the PC and convert it to the mnemonic program. Figure 3.2 and 3.3 show the ladder logic diagram and the mnemonic program respectively. The complete program and its mnemonic can refer to Appendix A and Appendix B respectively.
- To check or ensure the program that has been design correct or no error
- To make the simulation for monitoring the program flow was correct or run as needed by connecting the PLC using RS232 cable. Figure 3.4 shows how CX programming simulating and monitoring the program flow.

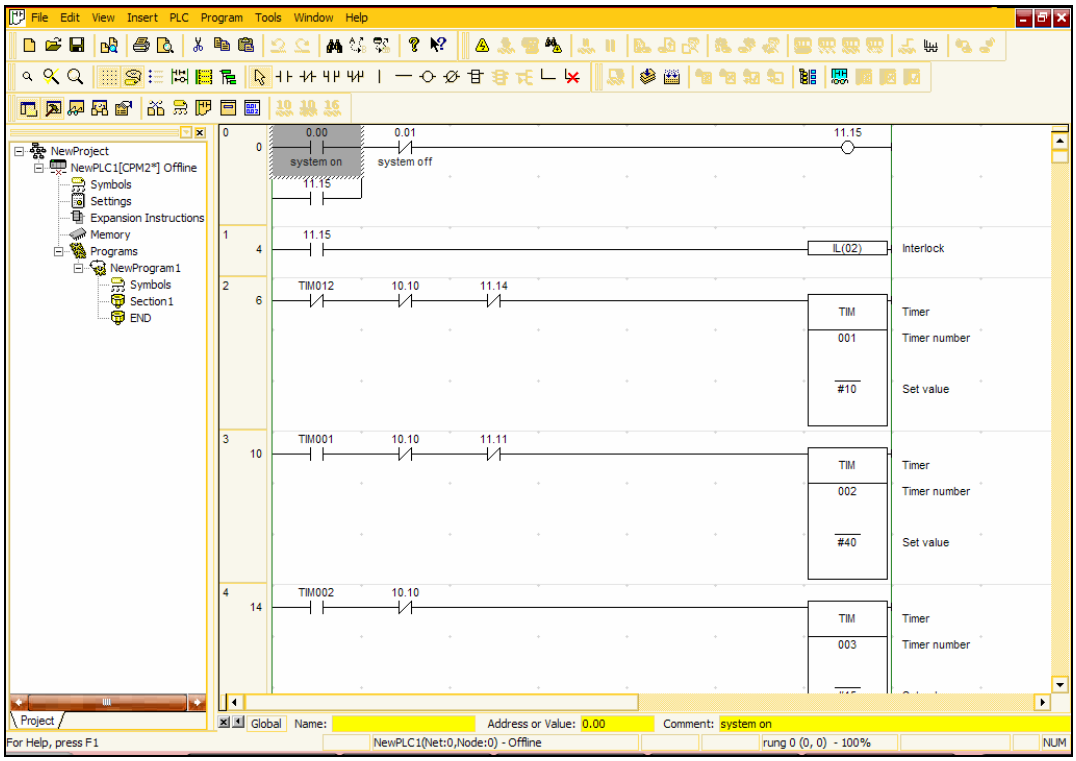

Figure 3.2: The ladder logic diagram that has been design using CX programmer.

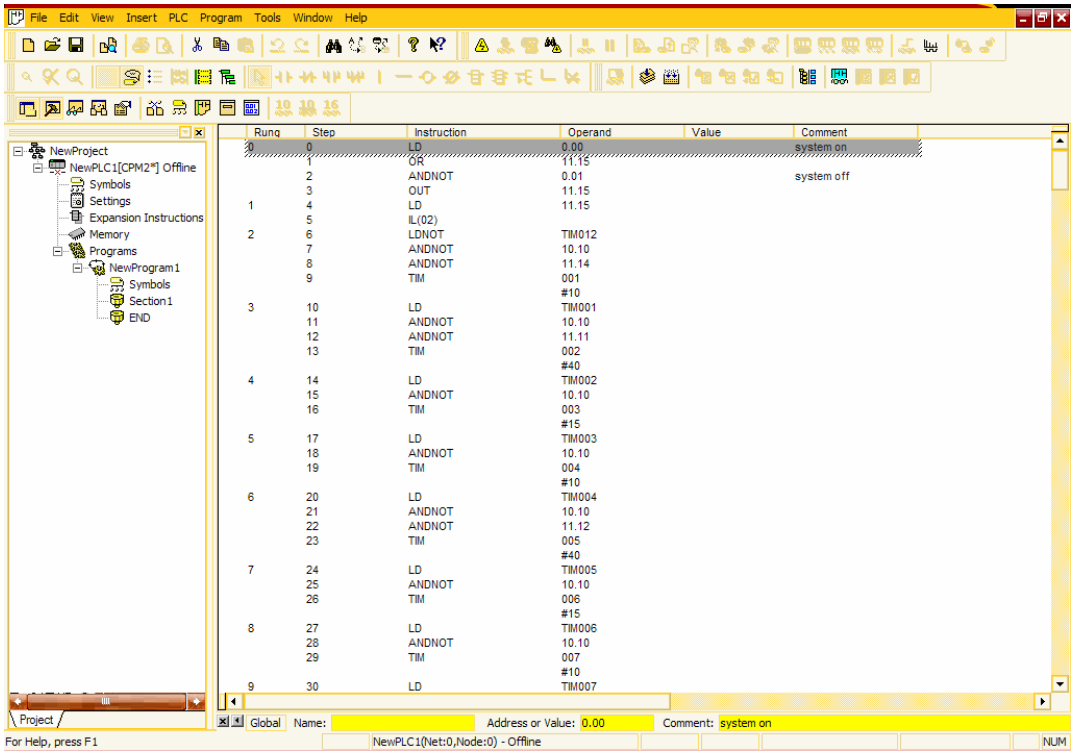

Figure 3.3: The mnemonic program display by CX programming.

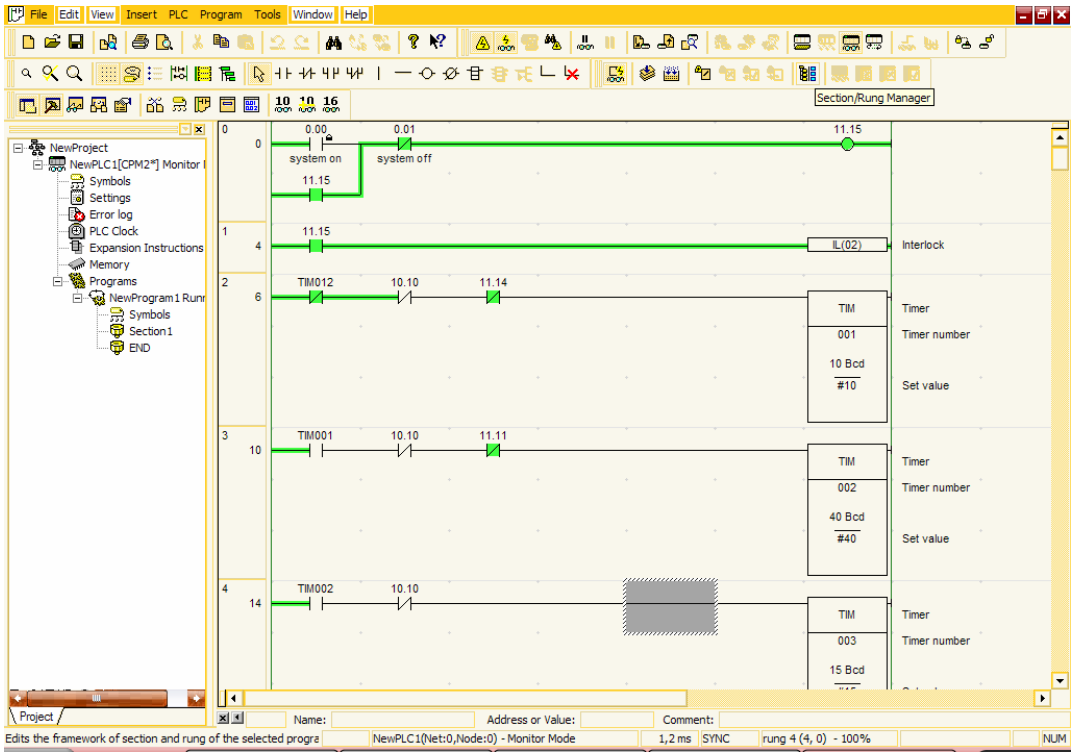

Figure 3.4: Simulate and monitoring the program flow

Figure 3.5 shows the flow chat of systematic approach in designing the program of this project. Before begin designing, the requirement of the control system that want to be design should be understand firmly. The numbers of I/O that have been used for this project should be identified. Based on this project, it required the 10 inputs and 12 outputs. After that, the general flowchart of the control system has been drawn. Then, the flowchart has been translated to the ladder diagram and programmed it into the CX programmer. After completed, the program should be debugging and if it's not ok, the program should be altered. Start connect all the input and output device and interfacing to the PLC. All the connections should be check cautiously and after that start to transfer the program into PLC. The program should be tested running after complete transferring. If the program is not OK, the relevant troubleshoot or editing should be made. The designing program process was completed when the program can work as requirement.

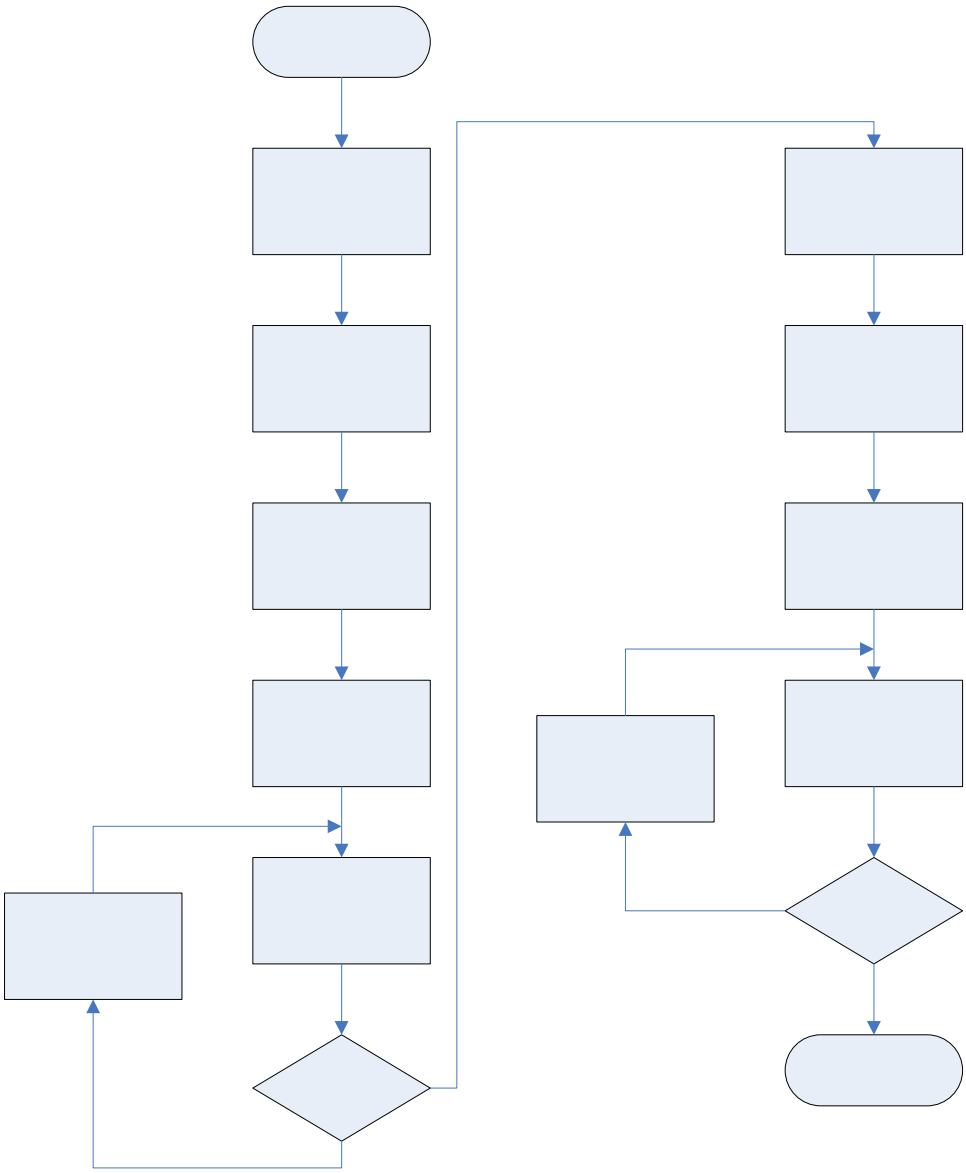

Figure 3.5: The flowchart of designing program

3.4 Connection and Interfacing

In this phase is discussed about how the PLC is connected to the power supply 240V AC, input (switch button, IR circuit) and the output (LED external circuit). Figure 3.6 below shows the unit components of SYSMAC CMP2A 20 I/O and their explanation. However the explanation only covered the unit components that have been used for this project.

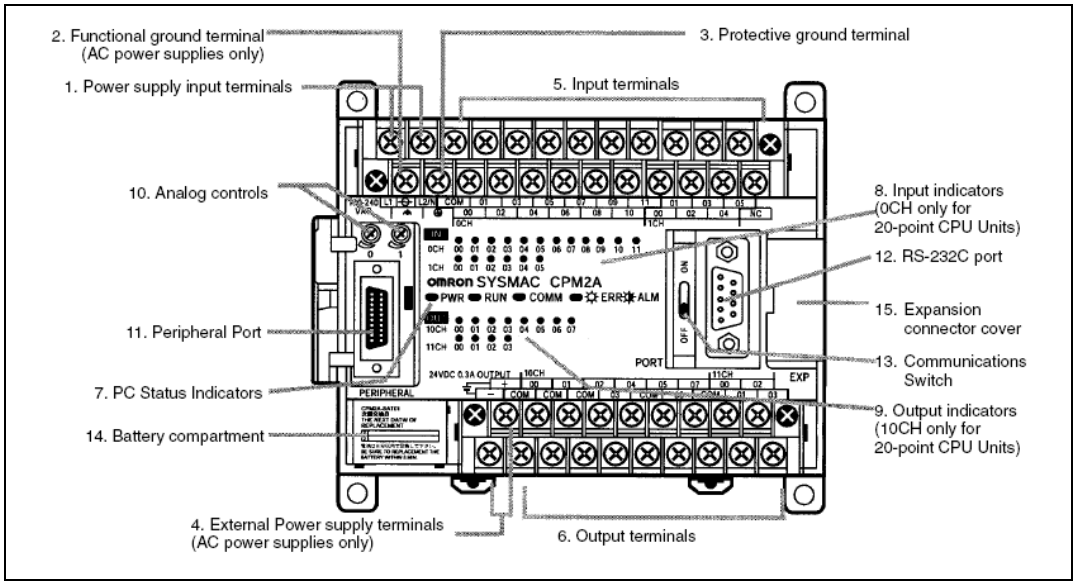

Figure 3.6: Unit components of CPM 2A 20 I/O

3.4.1 Power supply connection

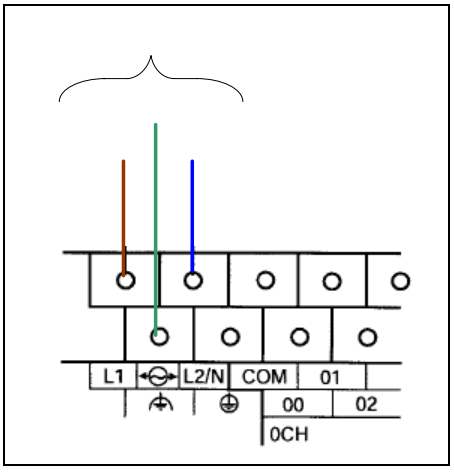

Figure 3.7: Supply 240V AC connection to PLC

3.4.2 Input Terminal Connection

The PLC that has been used for this project is CPM 2A 20 CDR which only have 20 I/O (12 for input and 8 for output). Table 3.1 shows the input terminal function for this project and Figure 3.8 shows their connection.

Input		Function	
00	I/O Address : 00.00	ON switch	
01	I/O Address : 00.01	OFF switch	
02	I/O Address : 00.02	Emergency 1	
03	I/O Address : 00.03	Emergency 2	
04	I/O Address : 00.04	Emergency 3	
05	I/O Address : 00.05	Emergency 4	
06	I/O Address : 00.06	Sensor 1	IR (Infrared) Transceiver
07	I/O Address : 00.07	Sensor 2	
08	I/O Address : 00.08	Sensor 3	
09	I/O Address : 00.09	Sensor 4	

Table 3.1: Function of the PLC input terminal

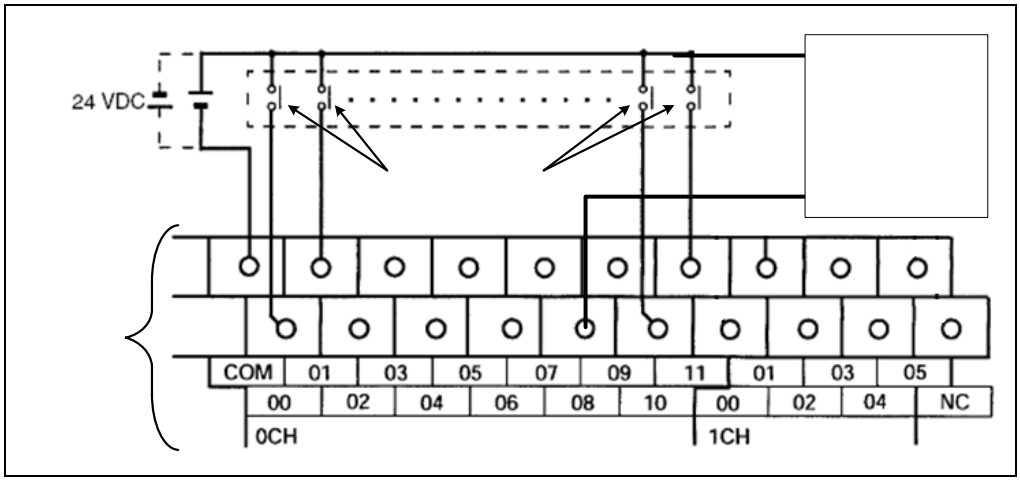

Figure 3.8: The connection of the PLC input terminals

3.4.3 Output Terminal

The PLC CPM2A 20CDR have only 8 outputs (I/O Address: 01000 – 01007). All the outputs have been dedicated directly to the LED external circuit. The entire pin COM are connected together and dedicated to the -ve point of 24 VDC (external power supply from PLC). The +ve 24 VDC have been dedicated to the LED external circuit. The explanations about LED external circuit are in the Circuit Design section. Figure 3.9 shows the connection of the output terminal.

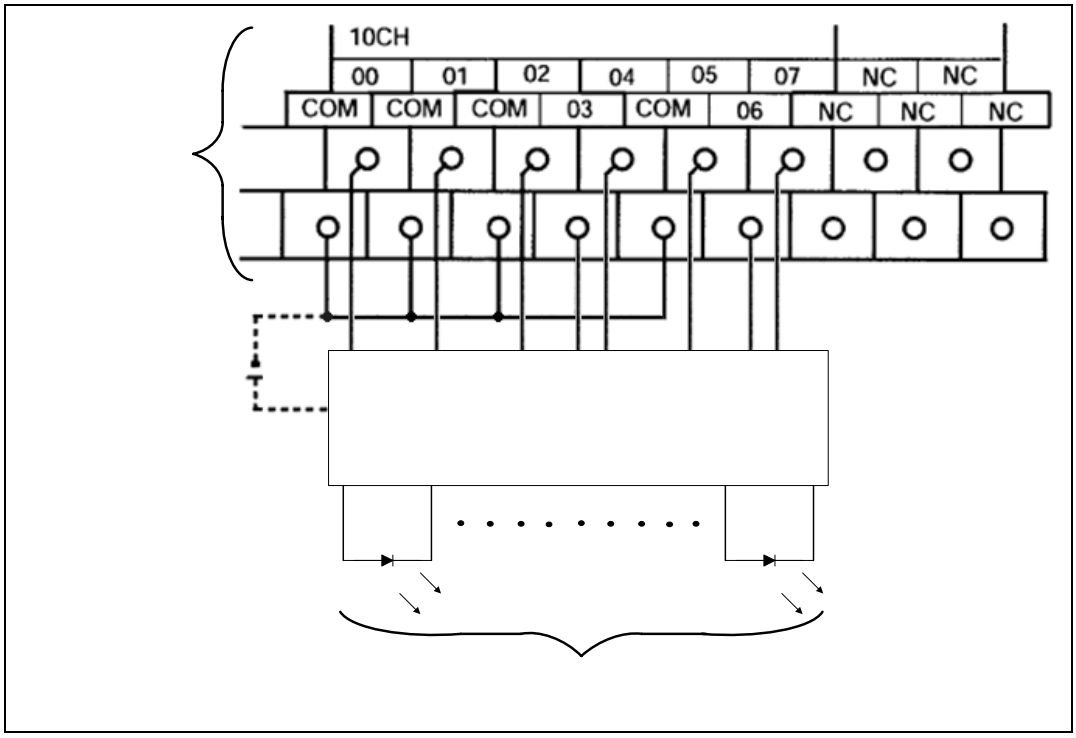

Figure 3.9: Output terminals connection

3.4.4 External Power Supply Terminals

The CPM2A PLC is equipped with these 24-VDC power output terminals to supply power to input devices and output devices. This connection is shown in Figure 3.10 below.

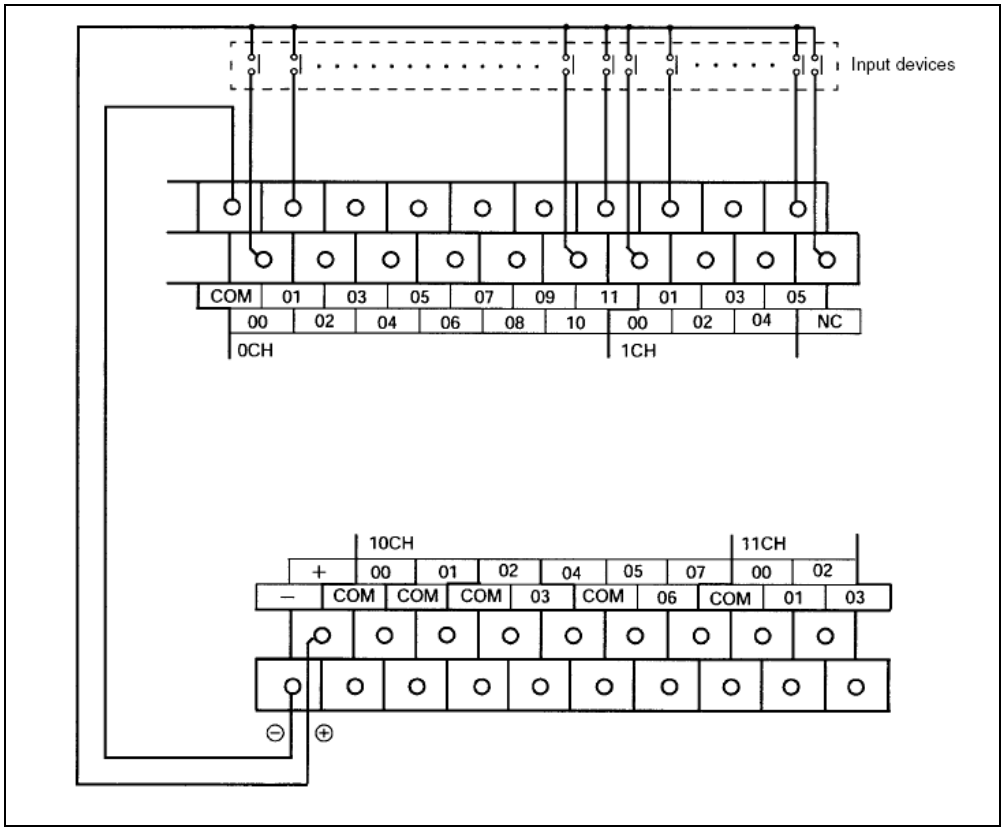

Figure 3.10: The connection of external 24-VDC supply for input

3.4.5 CPM2A Communication Function

In this section describe how the CPM 2A communication function use in this project. Basically, there are a few types of communications; Host Link, No-Protocol, NT Link or one-to-one link communications. But, the types of communication that have been used for this project is Host Link Communication.

Host Link communication area a conversational-type communication protocol, in which the PLC sends responses to command issued from a host computer and can be used to read or write data in PLC data areas and control some PLC operations. In this project, the host link communication used the CPM2A's RS-232C port. The figure 3.11 shows the host link communication between the Computer and PLC CPM2A.

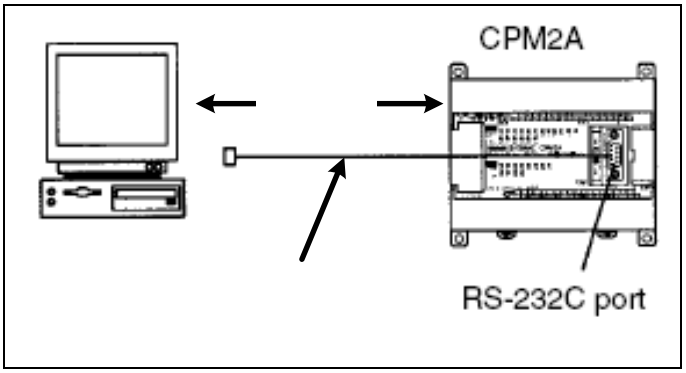

Figure 3.11: Host communication

3.5 Circuit Design

In this phase, 2 type of circuit should be design for this project. There are:

(a) IR (infrared) transceiver circuit

(b) LED external circuit

3.5.1 IR (infrared) Transceiver Circuit

The IR transceiver circuit consist IR transmitter and IR receiver. Both are them supplied by 12 VDC. When the initial condition where is no car/vehicle block between transmitter and receiver, the IR transceiver is acting like a close circuit. So, the current will flow from +ve 12 VDC through the R2 and directly to the ground without flow to the D1. When there have a car/vehicle block between the transmitter and receiver, the receiver is acting like the open circuit, so the current that come from R1 will flow to D1 and trigger the base of Q1. When this happened, the current from R3 will flow and energize the PLC Input 0004 and complete the circuit to the ground. Figure 3.12 shows the schematic diagram of IR transceiver circuit and Figure 3.13 shows the actual circuit that has been constructed.

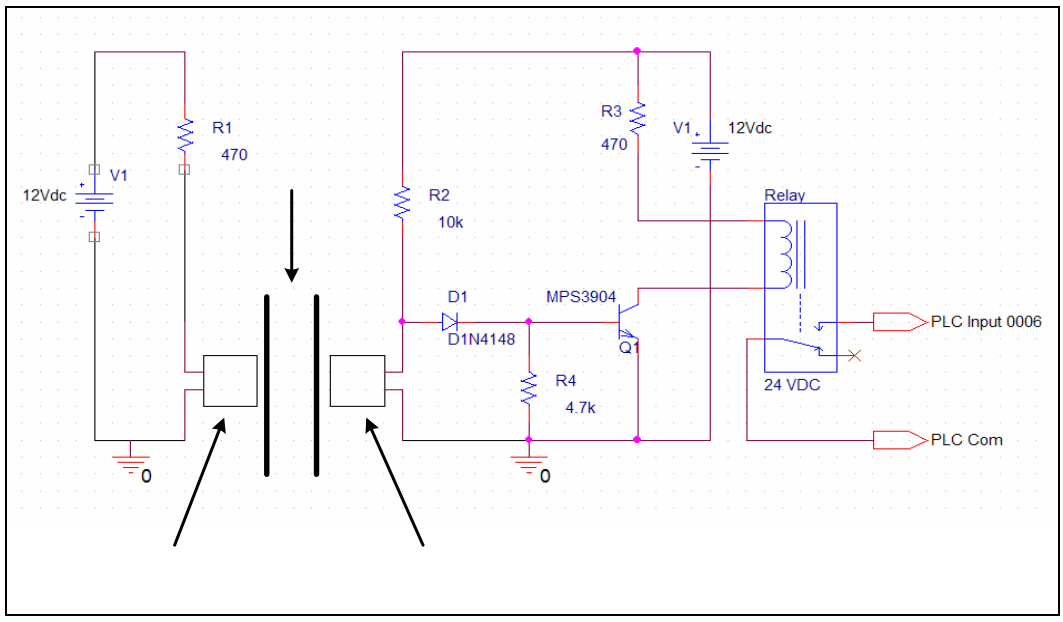

Figure 3.12: Schematic diagram of IR transceiver circuit

IR Receiver IR Transmitter

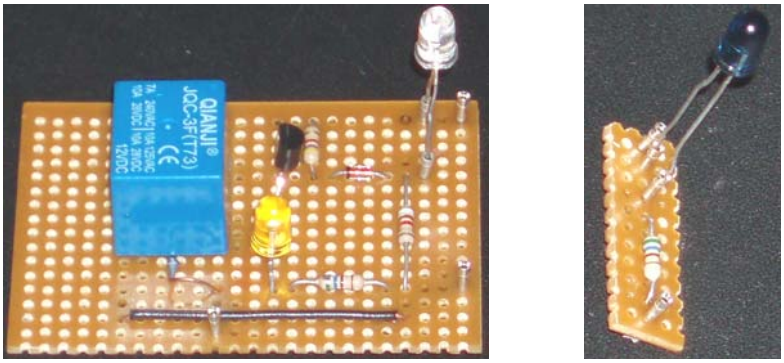

Figure 3.13: IR transceiver circuit

3.5.2 LED external circuit

LED external circuit was a circuit that consist 12 LED (3 red, 3 yellow and 3 green) and 8 relay 24 VDC. This circuit has been design because to overcome the limited I/O problem for the PLC CPM2A 20CDR which only have 8 outputs while this project needed 12 outputs totally. This circuit was basically using the relay concept. In figure 3.14, shows schematic diagram of the connection for one junction.

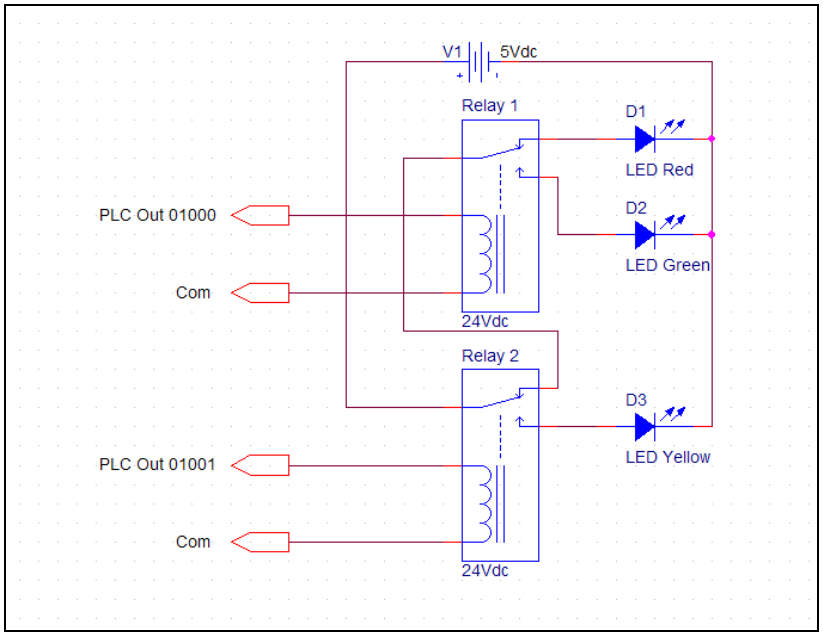

Figure 3.14: Schematic diagram of the LED external circuit for one junction

In initial condition, where is no output from PLC output port, the Red LED is lighting. When the program set High at the Out 01001, the Relay 2 will energizes and at the same time the switch inside the relay will close, so the LED Yellow is lighting. After the certain delay, the program will set High to the Out 01000 and set Low to the Out 01001. In this condition the switch inside the Relay 1 will close and the switch on relay 2 will off. So, in this time the LED Green is lighting. After the certain delay, the program will set all the output (01000 and 01001) Low. So, the entire switch inside relay turn to normally open and in this time the Red LED is lighting. This same process also happened in the other junctions too. Figure 3.15 shows the LED External circuit that have been constructed and Figure 3.16 shows the schematic diagram of the connection of four junctions.

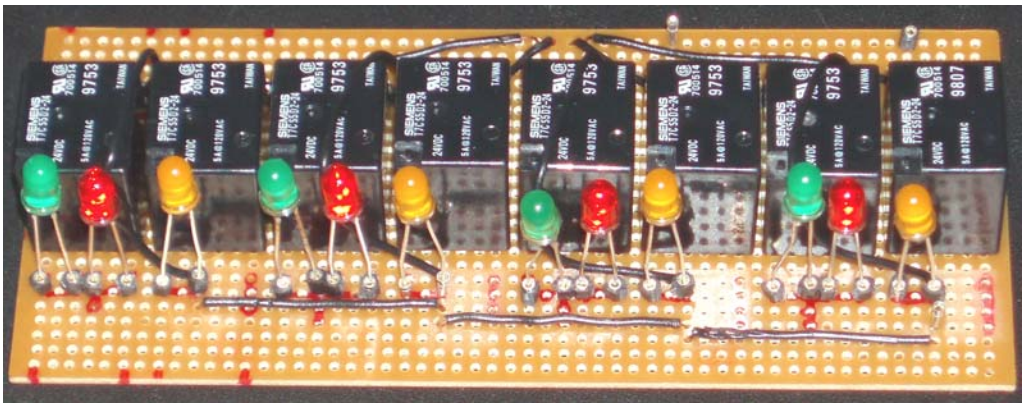

Figure 3.15: The LED External circuit

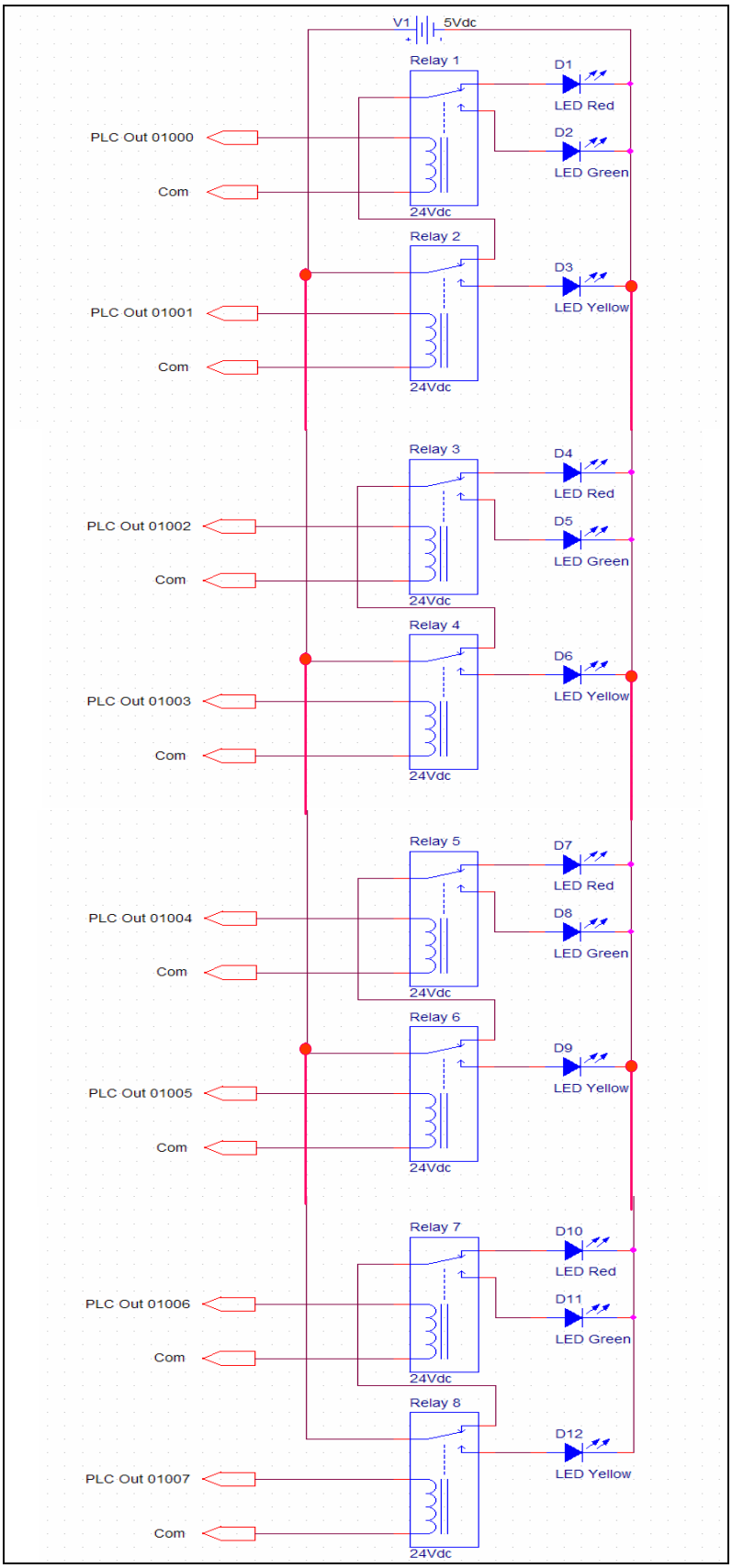

Figure 3.16: Schematic diagram of LED External Circuit for 4-junction

All the circuits that have been design should be testing. Testing involving the all kind of possibility such as, in initial condition, in off condition and when current cut off suddenly and connecting again. These to make sure the circuits are stable and safe without faulty components. Figure 3.17 shows flow chart process that involved during designing circuits.

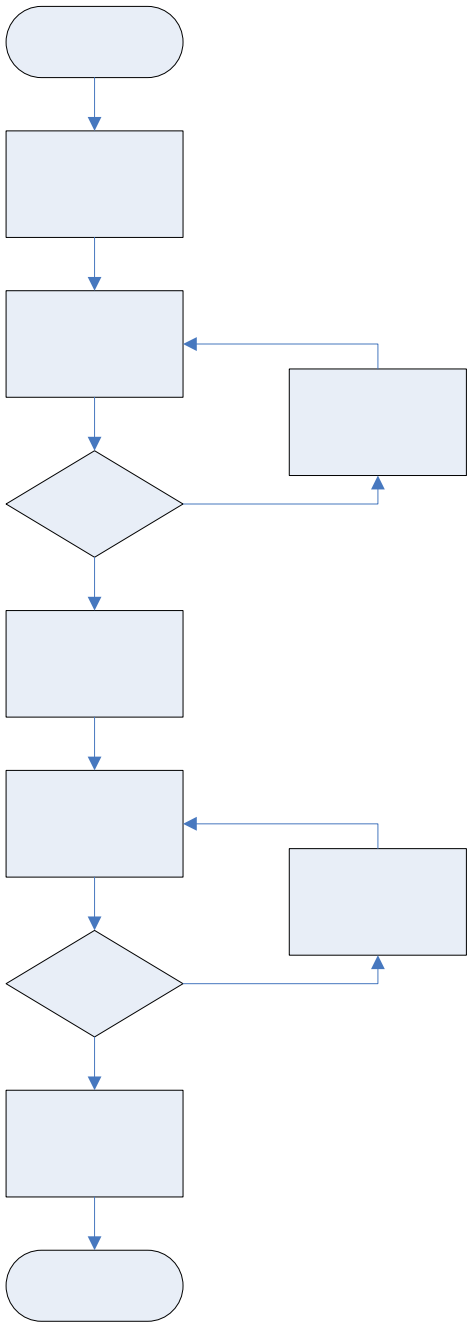

Figure 3.17: Flow chart circuit designing

3.6 Prototype Design

In this stage, the model/prototype will be design. The designing will consider on the circuit of four junction traffic lights with PLC control that functioning as the real situation. All the sub circuit; IR transceiver and LED external circuit, have been combined together with the PLC and model of traffic light. In Figure 3.18 shows the connection of sub circuits, PLC and traffic light model.

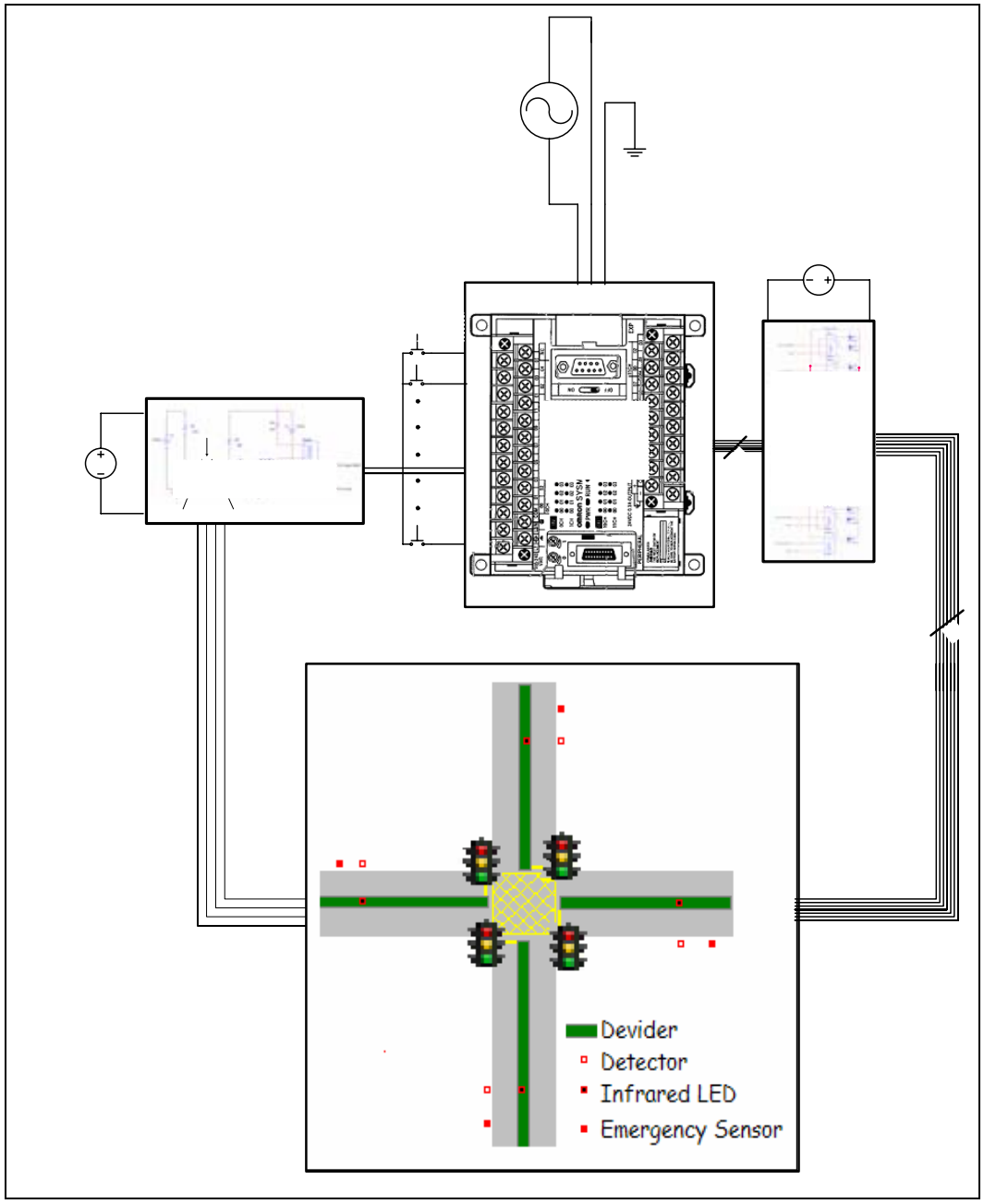

Figure 3.18: Connection of the 4-junction traffic light prototype

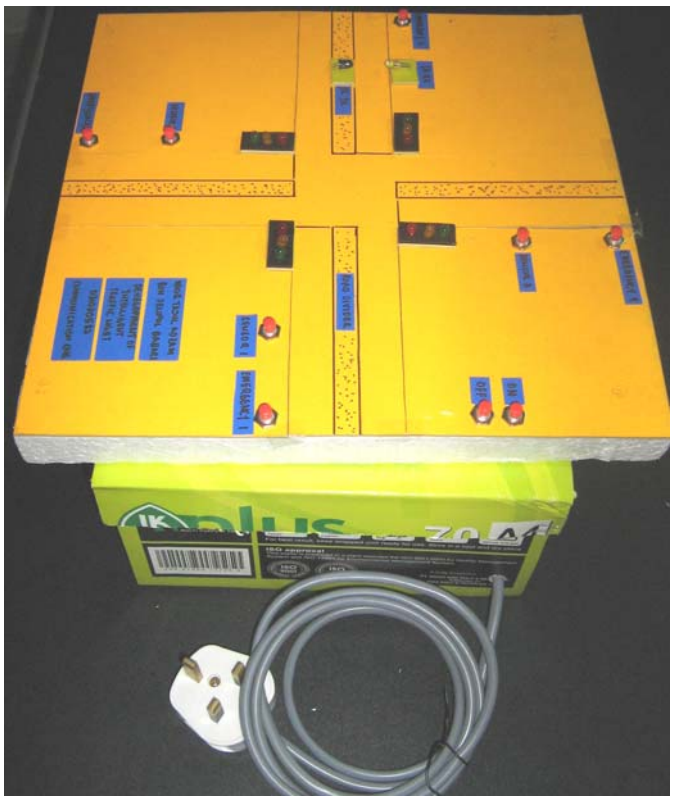

Figure 3.19: Intelligent Traffic Light Prototype

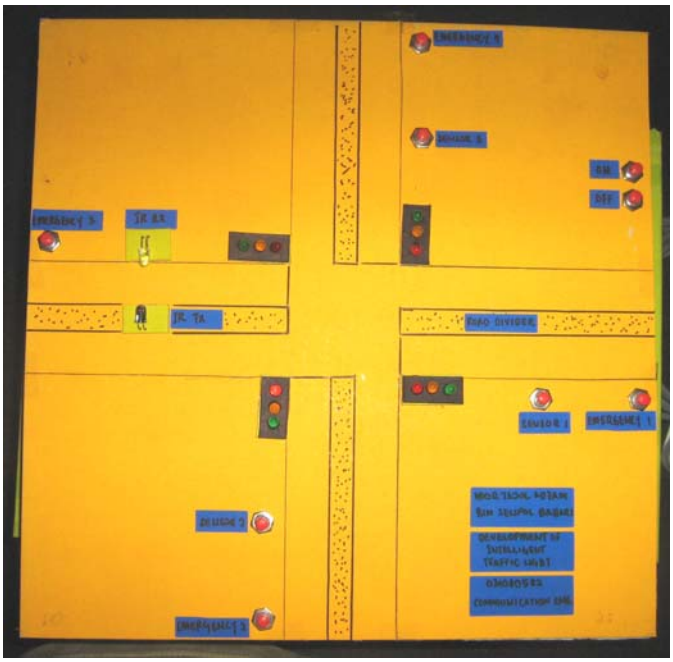

Figure 3.20: Intelligent Traffic Light Prototype (Top View)

3.7 Testing

In this stage, the complete prototype of 4-junction traffic light should be testing, observing and investigating. To guarantee the prototype is working properly, variety input/situations should be approach. If there have a problem, make troubleshoot to circuits, program or connections. Figure 3.21 shows the testing procedure flow chart.

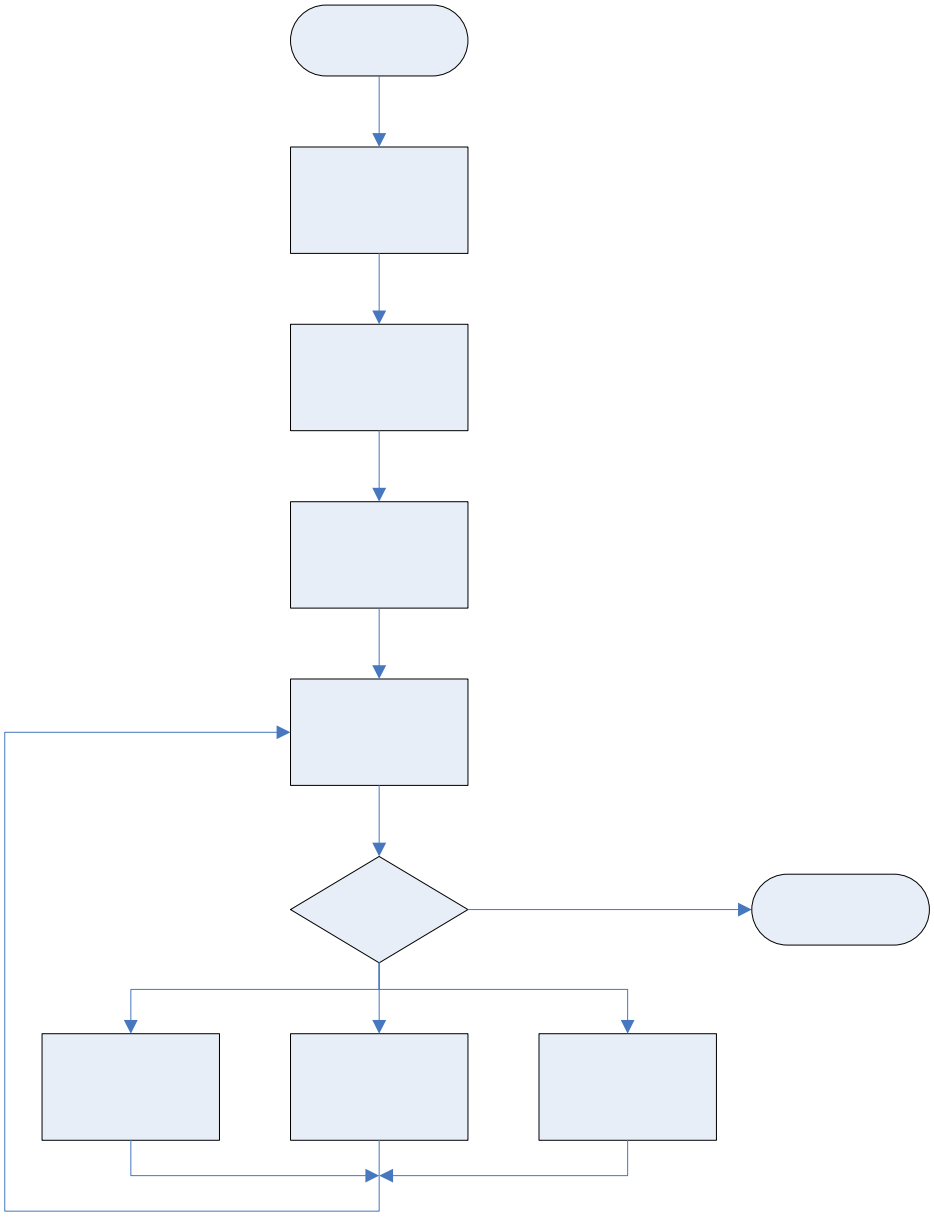

Figure 3.21: Testing procedure flow chart

Figure 3.22 shows the testing of LED external circuit connecting with the PLC while Figure 3.23 shows the testing of IR transceiver circuit.

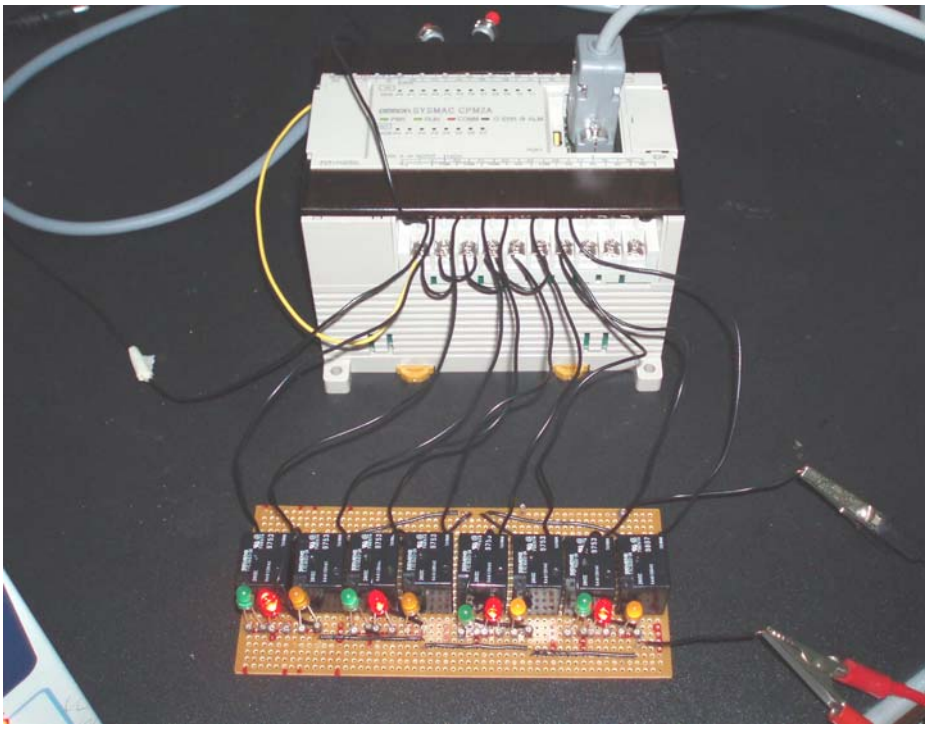

Figure 3.22: LED External circuit testing

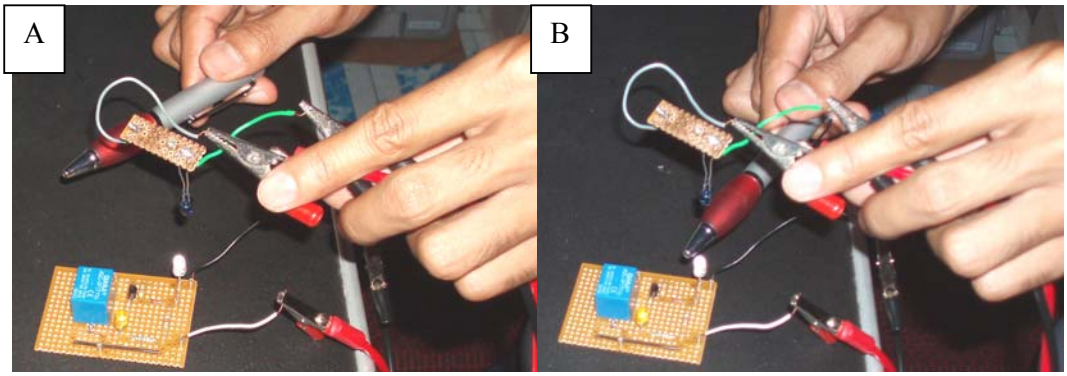

Figure 3.23: IR Transceiver circuit testing

Refer to Figure 3.23 A, there have no block between IR transmitter and IR receiver while in Figure 3.23 B, there have been block, so the LED yellow light up which mean indicate that there have a block between transmitter and receiver.