

**PROJECT COMPLETION REPORT
FOR
SHORT TEAM RESEARCH GRANT**

**MULTIPLE METHOD SWITCHING SYSTEM FOR DOMESTIC AND INDUSTRIAL
ELECTRICAL APPLIANCES**

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CHAPTER I

INTRODUCTION

1.1 Background

In this decade there are many new technologies which are being implemented in either small scale or big scale to improve their practice of output. Some of these devices are expensive but consist of reliable system and there are some cheaper devices which are productive too but still, all this devices has their own limitations. Even though technology plays a main role in developing good automated smart switching module but still there are many addicts who are concern on the price tag (costing) of the device itself.

Looking into all this aspect in the real life habit, a stable and acceptable solution which is the PLC/PIC Multiple Switching modules for remote access and control of electrical appliances via GSM modem has been designed. This project is to develop a smart switching system for electrical appliances using Real Time Programmable Logic Controller (PLC) or Peripheral Interface Controller (PIC). Smart home will be the future of homes. Equipped with the latest technology, smart home has the potential to become a reality in the new home market. The functional block diagram of the Smart Home System is as shown below in Figure 1.1 and the hardware connection of the application on Figure 1.2. The PLC/PIC as the primary control unit provides reliable structured approach and monitoring status compare to the conventional method (CM). In this system, the PLC/PIC is used for switching basic electrical appliances using conventional method and also remote switching via Short Messaging System (SMS). This system is capable of switching an electrical appliances manually (conventional method) and preprogrammed switching is realized with the help of the PLC/PIC. Preprogrammed switching is done based on the requirements by the end users. Applying state of the art technology in this system enables the end users to control and monitor the entire system remotely via SMS. To accomplish this, the Global System for Mobile Communication Modulator & Demodulator (GSM modem) is integrated to the PLC/PIC using a communication

interface (CI). This entire system enables the end user to interactively communicate with the PLC in any circumstances.

The home appliances controlled by using the PLC/PIC are as appended below:-

- 1 Light
- 2 Air Conditioner agitated with Automatic Temperature Sensor
- 3 Fan
- 4 Error Detection System

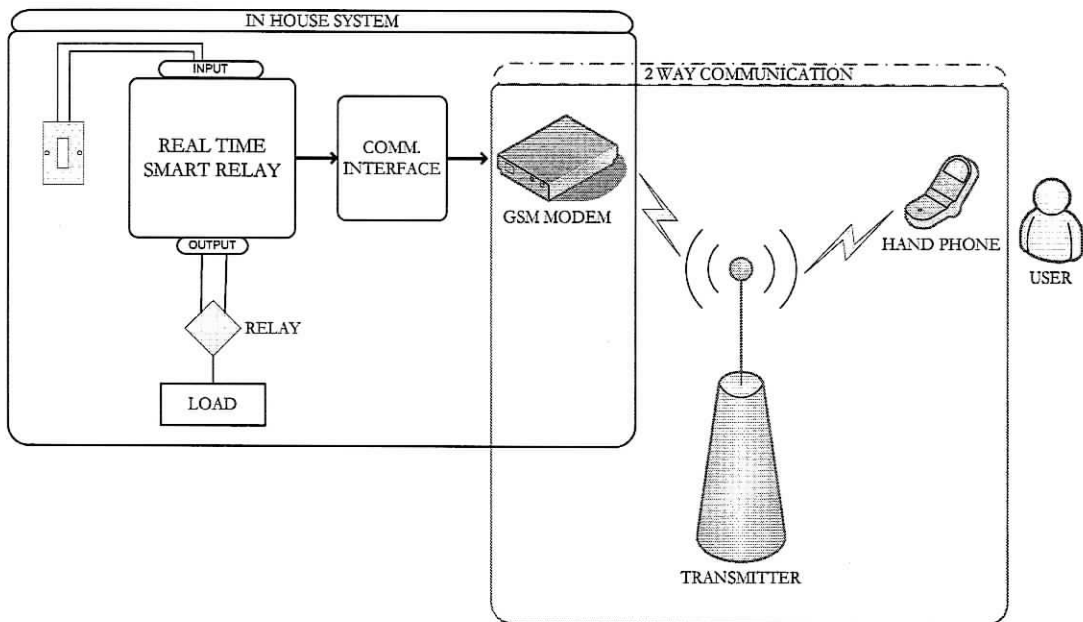


Figure 1.1: PLC/PIC Multiple Switching module functional block diagram

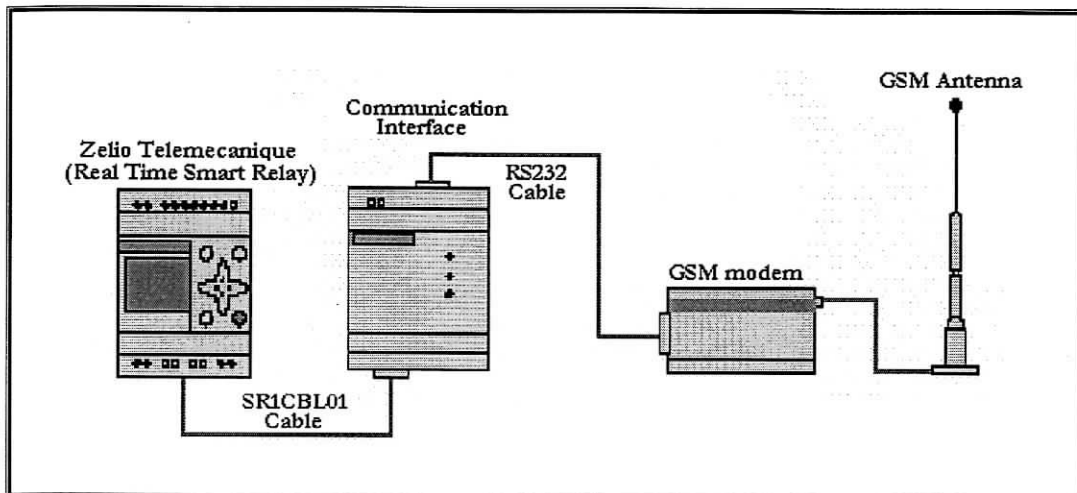


Figure 1.2: Multiple Switching module hardware connection

1.2 Objective

This project is designed to accomplish certain objectives such as below:

- Time Attenuation
This intelligent system enables a user to correspond with the system for preprogrammed and remote switching which hoard plenty of time.
- Costing
When the efficiency of the electrical appliances is maximized, in further extend it will prolong the life cycle of the appliances which directly safe the costing end.
- Limitation
No boundaries for the system to be used by any family member assigned to the GSM modem.

1.3 Problem Statement

As a solution provider, this system is capable to problem solve the existing inconvenience and limitations in switching electrical appliances. Time consuming is one of the major constrain in the CM. Accessibility on the electrical appliances is limited where by the existing method of switching is done manually and is not practical for the users remotely. Apart from that cost is also another factor which is the down turn on the CM. The users are tight with the electrical appliances when the device is in ON condition.

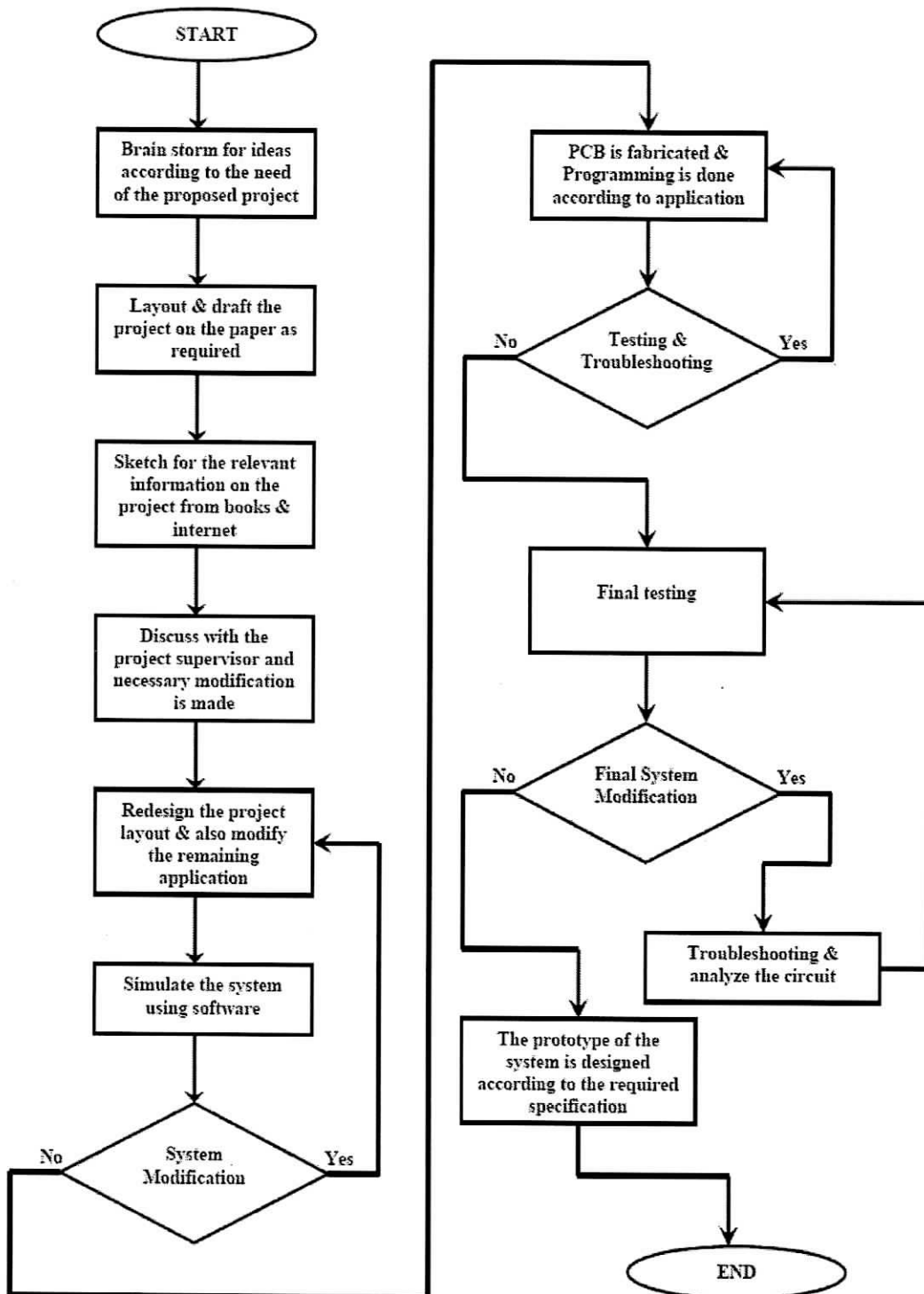
If the users is on the move then comes the power consumption factor where by the wastage in Ringgit Malaysia due to improper usage to electrical appliances. The most crucial factor is due to limitation or the accessibility for the user on the electrical appliances. The user should be able to be in charge of the entire system at any point of time. Looking into the current practice, this limits the end users by switching the electrical appliances in the specific scope.

1.4 Scope of Work

The brain of the system stands on the main controller unit which is the PLC/PIC. While exercising conventional method of switching, at the same time, this product is capable of implementing intelligent switching as well. Via PLC/PIC, a few attribute is anticipated such as:

- Accomplish a conventional method of switching as well as smart switching.
- Exploit the preprogram switching pertaining the Real Time technique.
- Employ the remote licit method via GSM modem.
- Organize an immense error detection model to display and notify user on defects of the electrical appliances.
- Alert on each switching made through SMS.

1.5 Project Methodology



CHAPTER II

LITERATURE REVIEW

Multiple Switching will be the future of homes. Equipped with the latest technology, smart home has the potential to become a reality in the new home market. The key to smart homes is in the wiring. For example, the wall panels will host all wiring options in one panel instead of hosting just one cable outlet of the same size. Smart home technology has not made much progress in the past. However, it seems that it is starting to become a reality now as more companies are taking part in the smart home industry.

Multiple Switching technology offers the prospect of significant improvements in living standards for everyone including older or disabled people who are heavily reliant on home care. Multiple Switching is a home that emphasizes on safety, security and comfort with modern technology integrated in it. According to survey, almost half of those surveyed (45%) are interested in having the sort of functions offered by a smart home. The reason consumers embrace the idea of smart home technology is because of the safety and security features it offers, which, according to statistics, was agreed by about 70% of respondents.

The main idea is about the new generation of homes. Smart homes are actually ordinary homes turned extraordinary using the latest technology. A smart home is nearly fully automated and it ensures safety, security and comfort for everyone under its roof. By utilizing advance and complex technologies, life is made easier and simpler. Multiple Switching offer the best in security, safety and comfort. It was originally intended for the technologically inclined (techno geeks) but now, smart homes are aimed at the general public. This is because smart homes make everyday responsibilities easier and simpler, besides saving time and energy. Smart homes may prove especially convenient for those who have hectic lifestyles, aiding them in their daily house chores.

A Multiple Switching provides benefits to the home owner as it ensures the safety and security of the family members; simplify house chores and tasks and helps in efficient energy management, thus reducing energy bills for the home. Automation helps make a smart home more convenient. Safety and security features are installed in and around the house. For example, sensors that are installed can detect a person's movement and activates a certain preset function. This would prove extremely useful when the home owner is not at home or outstation. Any sign of break-ins would be detected immediately and the alarm would be let off.

2.1 Potential demand for Multiple Switching

The findings from the study's survey of 1,000 households indicate an underlying public interest in Smart Homes technology that could be unleashed if the market develops - and prices fall - appropriately. Multiple Switching technology offers a range of different benefits to the consumer. These include: safety and security features; centralized control of the home; remote access and convenience. Views about each of these particular features were tested with respondents using a series of attitude statements as shown in Figure 2.1.

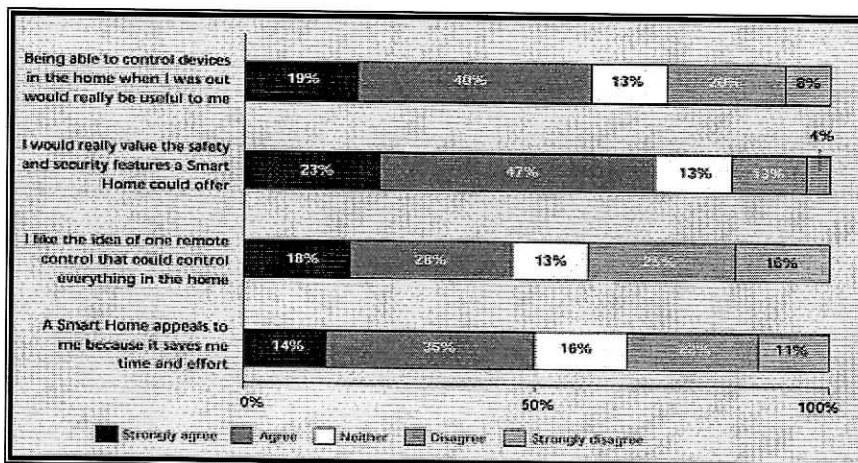


Figure 2.1: Views about Multiple Switching features

The security and safety aspects emerged as the feature which appealed most to consumers (70%) followed by the benefits of remote access (59%). Opinion was more divided on the merits of convenience and centralized control. Groups most likely to value the benefits of Multiple Switching were those in work, men, people aged 15-34, households with children and those who already have access to new technology in the home.

2.2 Concerns about Multiple Switching

Despite the support for Multiple Switching features, many respondents expressed worries about actually living in one. People were most concerned about "technical hitches and things going wrong" (65%) and around half (51%) indicated that they were worried that the system would be too complex. More than half (55%) said they would worry about the system being difficult to override. Older people (aged 55+) were the group most likely to be concerned about potential technical problems.

2.3 Interest in using a Multiple Switching

Opinions were fairly mixed in relation to how interested respondents were in living in a Smart Home themselves as shown in Figure 2.2. Less than half (45%) of those surveyed agreed with the statement "I am really interested in having the sort of functions a Smart Home could offer", while 37% disagreed. The remainders (19%) of those surveyed were ambivalent about the prospect of Multiple Switching.

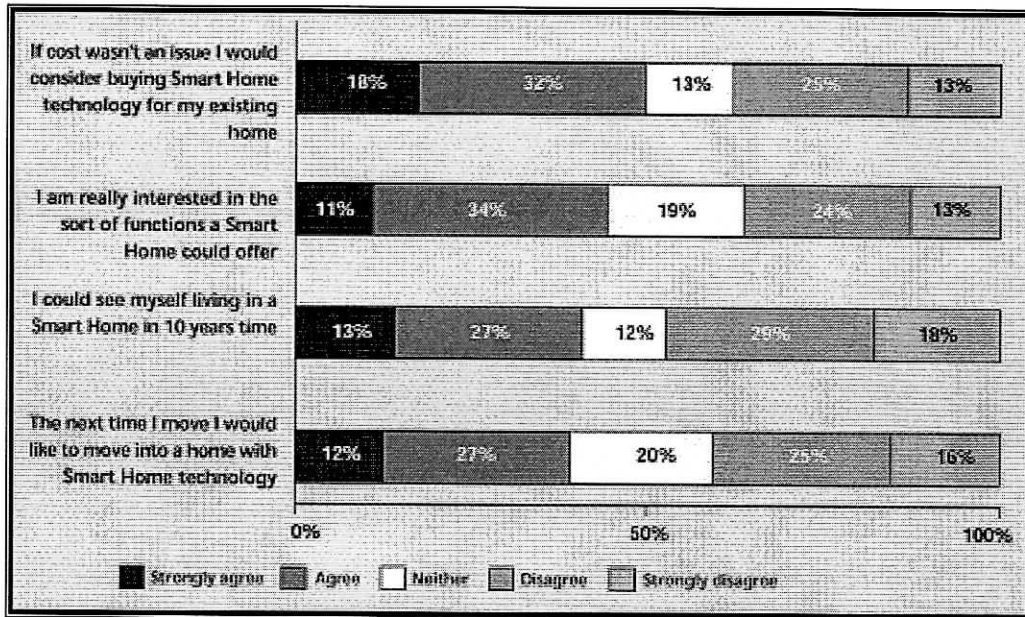


Figure 2.2: Interest in the Multiple Switching Concept

There was also some support for the idea of moving into a home with new technology although this was weaker (39%). In terms of future expectations, two in five people (40%) said they could see themselves living in a Multiple Switching in 10 years time.

Age emerges as one of the strongest predictors of someone's interest in living in a Smart Home. Generally, younger respondents reported higher levels of agreement with each interest statement. Those households which already owned home entertainment equipment or a PC were also more likely to be in favor of the idea of having a Smart Home.

The results suggest that consumers fall into one of three groups in terms of their attitude towards Smart Homes:

- **'The interested'** - those interested in living in a Smart Home: most likely to be people aged 15-34; family households; those on higher incomes; those who hold positive attitudes about new technology.

- **'The ambivalent'** - those who were neither interested nor uninterested in the idea: well-represented across all groups in the population, though marginally more likely to be older and on medium/low incomes.
- **'The uninterested'** - those not interested in living in a Smart Home: most likely to be aged 55 and over; households without children; those who hold negative attitudes towards new technology.

2.4 The supply of Multiple Switching technology

Although the main thrust of the research concentrated on consumer attitudes, as part of the study the views of a small number of industry experts were also canvassed. These included architects, building contractors, property developers, equipment manufacturers and academic researchers all of whom were asked to give their views on potential future market growth. Desk research was also carried out to build up a picture of the current market.

The research revealed that although there are currently very few Smart Homes in the UK, there has been a recent, albeit fairly modest, increase in the building and conversion of properties that have embedded Smart Homes technology. Moreover, there has been increasing access to the technology for 'expert home improvers' and 'DIYers'.

There was a general lack of enthusiasm on the part of the construction and property industries, manufacturers and suppliers to push - or even properly promote - this technology. The lack of common standards, an inappropriately skilled workforce and concerns that "it's just a fad" have meant the Smart Home market has yet to develop a sustainable momentum.

However, the research did indicate that there might be changes on the horizon that could stimulate more activity from potential suppliers. These include:

- **Scale economies:** The growing use of Smart Homes technology could deliver the economies of scale necessary to reduce average costs and, hence, prices. Although it may take time to feed through, this could reduce prices here in certain places.
- **New technologies:** Up-coming technologies that will add to the functionality ease of use and convenience of Smart Home systems, while improving their cost-effectiveness. Moreover, the development of new communications technologies such as 'Bluetooth' and the 'XML' language offer the not-too-distant prospect of common standards for electronic dialogue between Smart Homes devices (although it is still unclear how many standards will exist).
- **Interest from the consumer electronics industry:** With an ever-increasing range of home and personal electronic gadgets available, many major corporations in the consumer electronics industry consider the user-friendly integration and combined control of multiple devices as crucial to their future success. As such, the addition of Smart Home devices to home entertainment systems is a realistic medium-term prospect.

With the infant Smart Homes and other associated high-technology markets changing so rapidly, any predictions for their future are highly uncertain. Nevertheless, this research does identify reasons to be optimistic that a mass consumer market for Smart Home type technology could develop if the market grows and prices fall appropriately.

There appears to be significant consumer interest in the concept which could be unlocked at the right price. Unsurprisingly, the Smart Homes idea is most attractive to more pro-technology consumers, including the so-called 'early-adopters' vital to the early development of high-technology markets. But, in addition, the Smart Home also could appeal to a broader range of consumers because of its potential safety and security benefits.

If a market does develop, it seems less likely to come from impetus in the building, construction or property sectors. The greater opportunity for growth in the use

of Smart Home technology appears to be from its addition to the burgeoning array of consumer electronics and initial demand from the more technology-literate early-adopter households.

PLC/PIC Multiple Switching module using telemecanique is a new approach for home automation. The existing systems are more on security purposes only. Using telemecanique, this PLC/PIC Multiple Switching module is capable of producing extensive utility in many fields. The flexibility of this system generates a wide relevance which can be practiced even in industrial sites, hospitals, office lots, apartments and many more. In order to provide a proficient and dominant smart home module, significance is more concentrated on the gadgets used to fabricate this organism. Furthermore, using superior devices directly enlarge the scope of functions for this module.

2.5 Programmable Logic Controller (PLC)

The brain of the system stands on the main controller unit which is the PLC. There are many types of PLC which produces various usages for human nature such as Omron PLC, Keyence PLC, Siemens PLC, Mitsubishi PLC and many more. As a new approach mentioned before, Zelio Logic real time smart relay exploits the main control unit of this system. The Zelio real time smart relay is as shown in Figure 2.3.

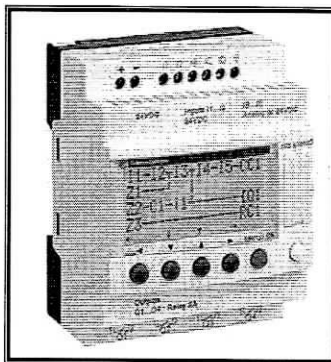


Figure 2.3: Zelio Telemechanique real time smart relay

Real Time Smart Relay (RTSR) intelligent controller is a new type of programmable controller. It is programmed by the use of a Function Block Diagram. The programming of RTSR is simpler and easier to learn than the programming of a conventional PLC, that uses ladder diagrams and associated instructions. The design concept, for the RTSR series of products, includes a Liquid Crystal Display (LCD) panel. The program can be written directly into the RTSR using this LCD panel. The use of a computer is recommended for more complex control schemes.

Products within the RTSR series are very compact and light in weight. RTSR intelligent controls series can be used for both local and remote control, communication, networking and monitoring. RTSR series can realize telephone-control, voice alarm and information. RTSR is widely used in many fields of industry, commerce, mining, agriculture, home automation etc.

2.5.1 Structure of RTSR

Main Hardware Structure of RTSR includes:

- Basic Function Blocks and Special Function Blocks
- Operation Display Panel
- Real-time Clock Circuit
- Programming Interface
- Voice Module/ Remote-control Module/ Extended Module
- Input & Output Terminal

2.5.2 Features of RTSR

- Programming panel with Liquid Crystal Display

There is an operating panel with LCD display on the front side of RTSR. The operating keys on this panel are used to edit directly the control program for RTSR. It can remove the LCD form the machine by the private interface to program remotely. Moreover, this LCD display panel can be set up according to users need.

- Flexible LCD Display Interface

Comparison with conditional LCD, here we provide 64 human-machine interfaces. When using RTSR, users can add the human machine interface no more than 64 according to the need. It will display the following data, such as time, status of input & output, counter, timer, analog and so on. When using, user can modify, add or delete the interface. Thus a free and easily using LCD module is given to the user.

- Well featured and compact design
 - 71mm x 106mm x 67mm (12 points type/voice module)
 - 126mm x 106mm x 67mm (22 points type/20points extended type/remote control receiver)
- Basic Function Blocks and Special Function Blocks

The control functions of RTSR can be implemented only with function blocks incorporated into a function block diagram. The same level of control implemented by a conventional PLC would require a much larger and more detailed program. When several function blocks are linked together in a specific way, then relatively complicated control functions can be implemented. RTSR has a storage capacity of programs for up to 127 function blocks. There is a large application resource to satisfy the requirements for

complicated control. A program, when downloaded into RTSR will never be lost as RTSR does not rely on a battery for the memory function.

- External Extendable Input/output

RTSR series machine can be connected with the relative Extended Module. Thus it can be extended to 20 points input/output once (12 points input and 8 points output). One set of RTSR series machine can be externally connected with 5 extended modules. Thus 22 points machine can be extended to 120 points input/output (74 points input and 48 points output). And it gives you a large storage capacity.

- Real time clock function

RTSR series intelligent controller has the real time clock recording function. It can run and time according to the random time of your desiring and the accuracy can reach second, which make your control of time be correct and accurate. And you can set 127 periods of different time. It is suitable for the system that needs the time control.

- Analog input and transmission

In addition to receiving a switching input, RTSR can also receive the analog input to implement the control of temperature, humidity, pressure, flow, level unit, etc., and transmit them remotely to a computer for monitoring.

- Security cipher code function

RTSR is provided with protection for the programs downloaded into it. A security cipher code can be set before programs are written. The programs can then only be modified after the correct cipher code is entered.

- Telephone function

RTSR is equipped with telephone and voice function blocks. It is possible to dial directly through a telephone line after the required telephone number has been preset. RTSR can be dialed automatically, when the conditions are satisfied so as to implement advice or alarm functions. Moreover, RTSR can also receive remote signals transmitted through a telephone line in order to control the terminal equipment.

- Wireless Control

Wireless control functions can wirelessly remote control the RTSR to realize the control to the voice module, input/output. This function can be used in some specific control site, such as the control to the start and stop of RTSR with no means by hands, or control the RTSR at site in the working house. Using wireless control module it will be readily solved. In general, wireless control function can make it convenient to realize the control to the RTSR.

- Function Keys

32 function keys are provided. The function of these keys is the same as IN (Input I0-In), relatively the same as the soft switch. On the LCD panel, all the defined function keys are displayed. Also the explanation and the password protection function of each function key can be show in Super Relay Logic. The Super Relay Logic provides 4 function keys pages and in each page there may be 4 function key. The front panels of the smart relay as been observe in Figure 2.4 and the description about the components in RTSR is as shown in Table 2.1.

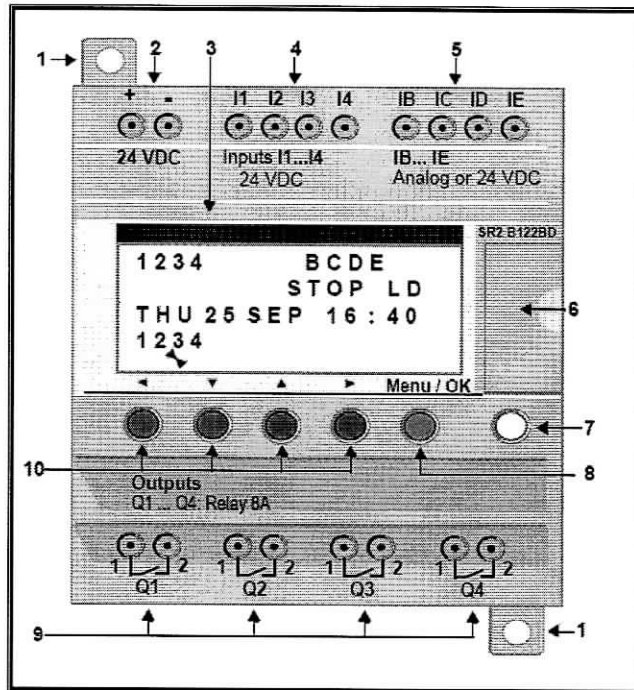


Figure 2.4: RTSR front panel

Table 2.1: Elements of RTSR front panel

Prompt	Element
1	Retractable mounting feet.
2	Screw terminal block for the power supply.
3	LCD display, 4 lines, 18 characters.
4	Screw terminal block for discrete inputs.
5	Screw terminal block for analog inputs. 0-10 Volts, usable in discrete input mode depending on model.
6	Slot for backup memory or PC connection cable.
7	Shift key (white).
8	Menu/OK key (green) for selection and confirmation.
9	Relay output screw terminal block.
10	Navigation keys (gray) or after configuring Z pushbuttons.

- Super Relay Logic: Programming Software

The control program can be downloaded directly, with the use of the LCD panel, into a RTSR unit. With more complicated control schemes the use of an ancillary computer, loaded with ZelioSoft (V4.1) software, is recommended. The control program can then be written into the memory of the RTSR is a very friendly human-machine interface programming software. It can edit the function diagrams and also can analogously run the written program. It provides an off-line testing function to the user. This feature overcomes much of the possible inconveniences normally experienced with on-line testing and commissioning. The system can be proven before being put into actual service. ZelioSoft will not only guide you to implement the editing of the control programs, but will also perform the real-time monitoring for the field environment and the operational conditions of RTSR.

- Brief advantage of RTSR

The RTSM has lots of advantages as we can observe from its description above. This RTSR cost around 1000 Ringgit Malaysia, which comes with a front panel. The best part is, RTSR has the capability to communicate with the GSM modem for remote switching with the existence of a device called the Zelio Communication Interface. The Z keys on the front panel makes easy the programming process where the RTSR also can be programmed without using any computer.

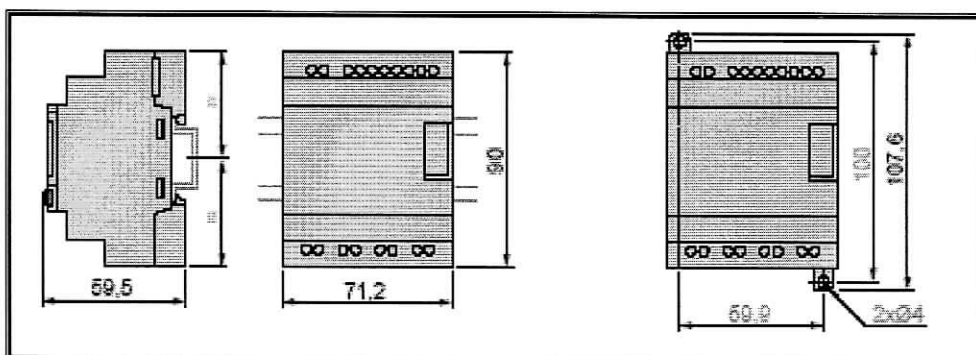


Figure 2.5: Real Time Smart Relay dimension

Extended input and output are also possible to be mounted with the RTSR. With a light mass structure, the RTSM are easily mounted onto the din reel by just clipping the back portion designed to the din reel. The small size of the RTSR avoid the din reel from any wreckage or publicize from the mounting itself. RTSR are manufactured with built in contact relays which facilitate it for either AC or DC devices as outputs. These contact relays are capable of triggering any electrical appliances with or less than 8 Amperes directly without using any external relay contacts.

2.6 SR2COM01 Communication Interface

Zelio Communication interface operates on 12V – 24V VDC. The communication interface is designed mainly for monitoring or remote control of machines or installations which operate without personnel for example lift pumps, alert in the event of failure of industrial or domestic heating boilers, control of lighting and many more. The communication range comprises in many way. The communication interface connected between a smart relay and a modem, analogue (PSTN) or GSM modems, and also “Zelio Soft Com” software. This device is connected between real time smart relay using the SR2CBL01 communication cable and the GSM modem using RS232 communication protocol. Furthermore, this communication interface allows messages, telephone numbers and call conditions to be stored. In addition, messages are dated and application program comments are stored. The communication interface scales analogue values to the physical values (degrees, bar, Pascal, etc.) required by the user. Figure 2.6 shows the actual view of the Zelio Communication Interface.



Figure 2.6: Zelio Communication Interface

In this application of PLC based smart home module, the communication interface plays a main role. This device functions as an interface between the GSM modem and the RTSR. As mentioned earlier, the programming for this application can be done in neither using ladder diagram nor using the block diagram. Even supposing by using one of the programming method, for compiling the program structure into the RTSR, it has to pass through the communication interface for encoding. The description of the communication interface is shown in Figure 2.7.

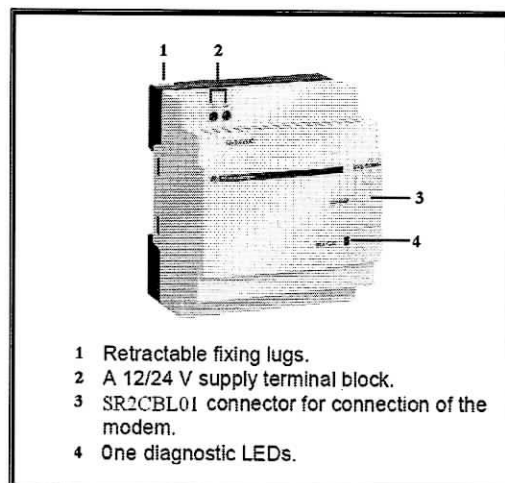


Figure 2.7: Zelio Communication Interface description

Ladder diagram programming is used to fabricate this smart home module application. The programming is done using the ZelioSoft programming software. Since a desktop or laptop computer is being used to course the ladder diagram, a serial port or RS232 cable protocol have to be absent first of all on the desktop or laptop computer. Once the programming is done using the ZelioSoft software, a test run or simulation can be done. The results of the simulation are shown on the computer screen. When a contented simulation results are obtained, the communication interface is connected to the computer using the RS232 cable provided. The uploading process into RTSR is as shown in Figure 2.8.

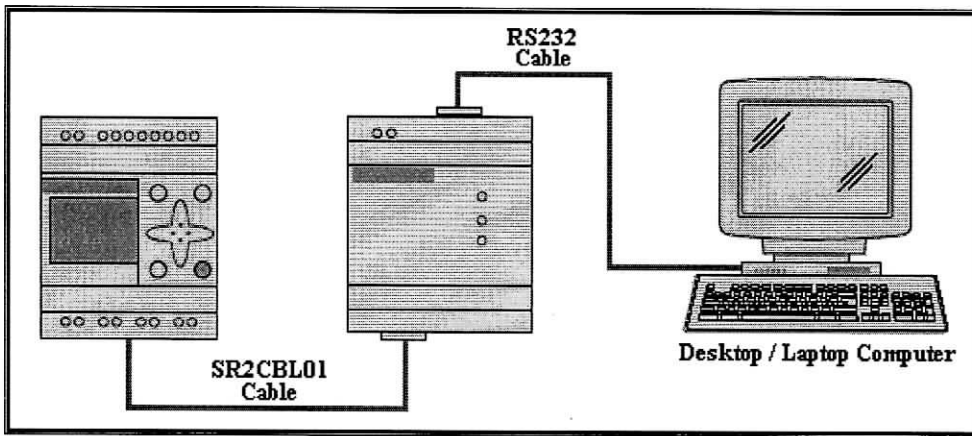


Figure 2.8: Uploading program to RTSR

After having powered up the smart relay and the interface, the application program can be transferred in order to simultaneously load the control system program into the smart relay and the alert conditions, messages and telephone numbers into the interface. This operation can also be carried out remotely using "transfer" mode, after having made the following operating connections. The status [4] will turn into green and the program is ready to be uploaded into the RTSR. Once done, the system has to be restarted before going much further. The module is ready to be executed once the program has been uploaded to RTSR with a complete connection as appended in Figure 2.9.

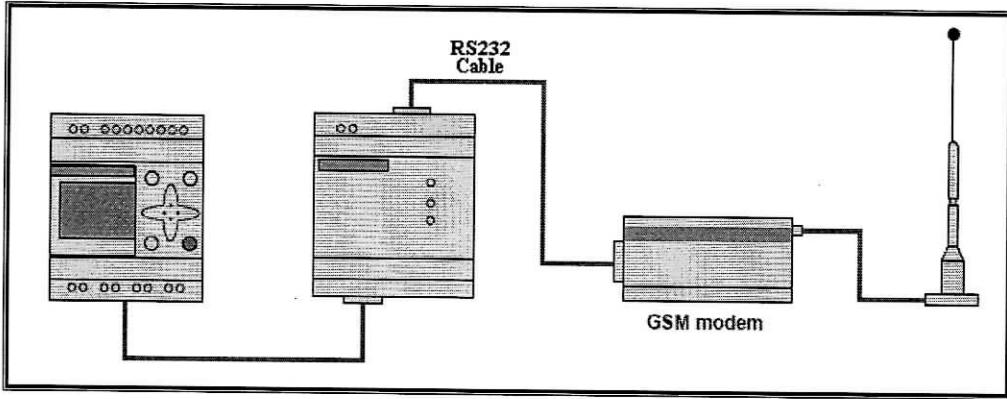


Figure 2.9: Complete Connection

2.7 Wavecom Fastrack M1213 GSM Modem

This smart home module is capable remote switching via a GSM modem. A reliable and specific GSM modem is required to accomplish this application. Certain functions should be able to pitch by the GSM modem to produce an excellent outcome from this module. Comprehend this fact, the Wavecom Fastrack M1213 GSM modem as shown in Figure 2.10, is chosen as it is compatible with the RTSR used in this system and also for the features endow with this module.



Figure 2.10: Wavecom Fastrack M1213 GSM modem

2.7.1 Fastrack M1213 description

The Fastrack modem is small, fast, and efficient. It supports the transmission:

- data
- fax
- short messages (Point to Point and Cell Broadcast)
- voice calls

The Fastrack modem is a Dual Band product using GSM 900/1800 MHz or GSM 900/1900 MHz. The basic elements received allow simple installation and operation of the modem. Following Table 2.2 contains information on the physical characteristics of the Fastrack modem.

Table 2.2: Physical characteristic of Fastrack modem

Dimensions	98 mm x 54 mm x 25 mm (excluding connectors)
Overall Dimensions	110 mm x 54 mm x 25 mm
Weight	<130 grams
Volume	13.23 cm ³
Housing	Aluminum
Frequency Range	GSM 900/1800 MHz

To ensure proper operation of the Fastrack modem, the operating environment must be within a specific temperature range which is -20 0C to +55 0C for operating temperature range and -25 0C to +70 0C for storage temperature range. The Fastrack modem is permanently ON once the power supply cable is connected to a functional

power supply. Correct operation of the Fastrack modem has an optimum voltage range which is 5 volts to 32 Volts for operating voltage range and 0 volt for ground connection. The power cable connection of the GSM modem is as shown in Figure 2.11.

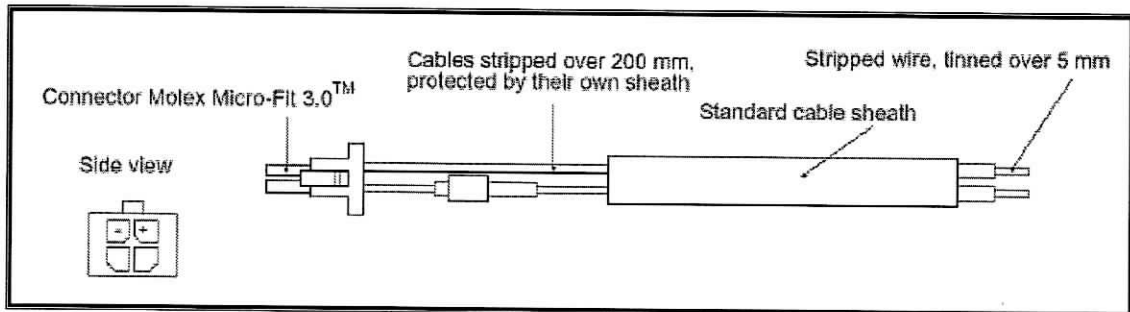


Figure 2.11: Power supply cable diagram

2.7.2 GSM features

Fastrack modem is awash with few interesting functions. As mentioned earlier, the Fastrack GSM modem used in this smart home module supports the transmission of data, voice, fax and also short messages. Following in Table 2.3, is the lists of the Fastrack modem feature.

Table 2.3: Fastrack GSM modem features

MODE	DESCRIPTION
Standard	Dual Band Extended GSM900 MHz Class 4 (2W) and GSM 1800/1900 MHz Class 1 (1W)
Interface	Serial interface RS232 V.24/V.28 Autobauding function AT command set based on V.25ter and GSM07.05 & 07.07

SMS	<p>Mobile Originated (MO) and Mobile Terminated (MT)</p> <p>Mode Text & PDU point to point. Cell Broadcast</p> <p>In accordance with GSM 07.05</p>
Data	<p>Asynchronous 2400, 4800, 9600 and 14400 bps.</p> <p>Transparent and Non Transparent mode</p> <p>In Non Transparent Mode only: 300, 1200, 1200/75 bauds/ Mode 3.1 KHz (PSTN) and V110 (ISDN)</p>
Fax	<p>2400/4800/7200/9600 bps</p> <p>GSM teleservice 62 in transparent mode</p> <p>Class 2</p> <p>Group 3 compatible</p>

2.8 Hardware interfaces

The hardware interfaces which exist for the Fastrack modem include the plugs, sockets, wires and the electrical pulses traveling through them in a particular pattern. The Fastrack interfaces include:

- LED function
- External antenna (via SMA)
- Serial and control link (via 15 pins SUB D)
- Power supply (via 4 pins Micro-Fit.)
- SIM interface

2.8.1 Connectors

Refer to the following Table 2.4, for the connectors that exist for the Fastrack modem. The antenna connection is as shown in Figure 2.12. The connection port for PLC communication is as shown and described in Figure 2.13 and Table 2.5.

Table 2.4: Fastrack connectors

Connector	Function
SMA	RF antenna connector
15 pins SUB D (high density)	RS232 link AUDIO link RESET
4 pins Micro-Fit.	Power supply connector
SIM connector	SIM card connection

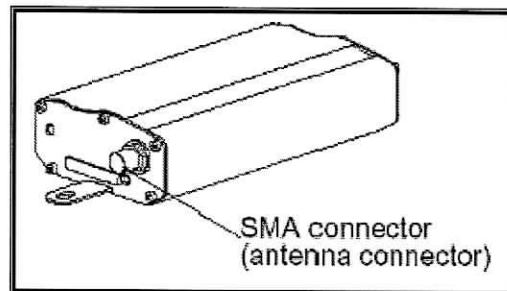


Figure 2.12: SMA Connector

2.8.2 SUB-D Connector

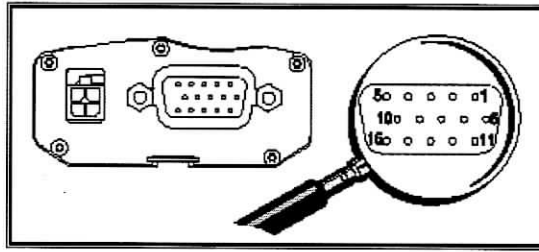


Figure 2.13: 15 pins SUB-D connector (high density)

Table 2.5: Pins assignment for 15 pins SUB D Connector

	PIN	EIA	CCIT	Designation
RS232	1	DCD	109	Data carrier detect
	6	RX	104	Receive data
	2	TX	103	Transmit data
	8	DTR	108.2	Data terminal ready
	9	GND		Signal ground
	7	DSR	107	Data set ready
	12	RTS	105	Request to send
	11	CTS	106	Clear to send
	13	RI	125	Ring indicator
Audio	4	Microphone (+)		
	5	Microphone (-)		
	10	Speaker (+)		

	15	Speaker (-)	
Reset	14	Reset	
	3	Reserved	

2.8.3 Power Supply Connector

Power supply connector is connected directly from 24 Volts from 12 to 24 VDC functional power supply. This power supply connector stands with 4 pins which functions for auxiliary, ground and supply. Figure 2.14 below shows the power supply Micro-Fit connector and it's description in Table 2.6.

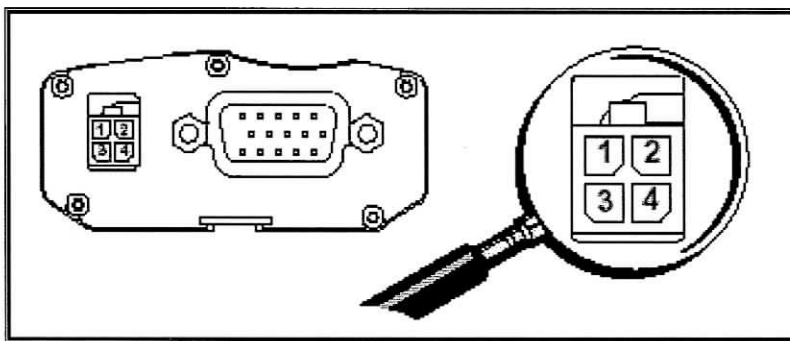


Figure 2.14: 4 Pins Micro-Fit Connector

Table 2.6: Pin assignment for Power Supply Connector

Connector	Pins layout		Comments
4 pins Micro-Fit 3.0.	1	V+ Battery	Power supply
	2	Ground	
	3 - 4	Auxiliary	NC

2.8.4 LED Functions

The Figure 2.15 below indicates the position of the LED on Wavecom Fastrack GSM modem used. The LED lights indicate the operational status of the modem. Refer to following Table 2.7 for a list of the LED states.

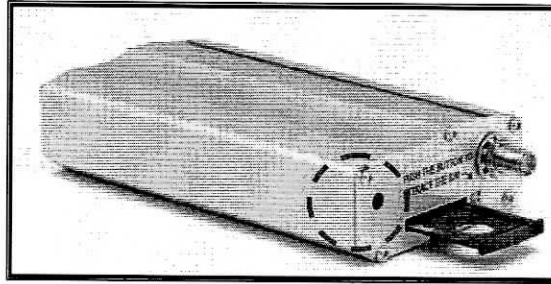


Figure 2.15: Position of Coverage LED

Table 2.7: Operational states of Fastrack modem

MODEM	LED light activity	Status of MODEM
ON	Flashing slowly	Idle mode & connected to the network
	Flashing rapidly	Transmission mode
OFF	None	Not connected to the network

2.8.5 SIM INTERFACE

The Fastrack GSM modem can be defined as a hand phone without keypads. Due to the functions of the modem similar to a hand phone, it has its own address or better known as a GSM number. Fastrack GSM modem requires a Micro-SIM card and supports 3 Volts and 5 Volts Subscriber Identity Module (SIM) cards. The SIM interface of the modem uses an extractible SIM card holder as in Figure 2.16.

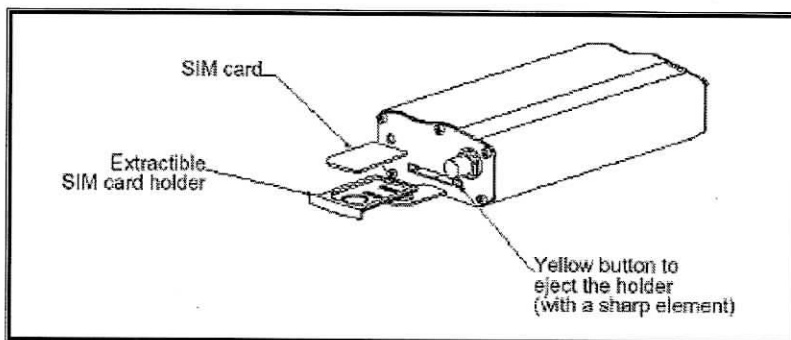


Figure 2.16: SIM card holder

2.9 External antenna

This module uses an external antenna connects to the modem via the SMA connector. The outlook of the antenna is as shown in Figure 2.17. This antenna is fabricated using the micro strip board and isolated with a highly water resistant material.

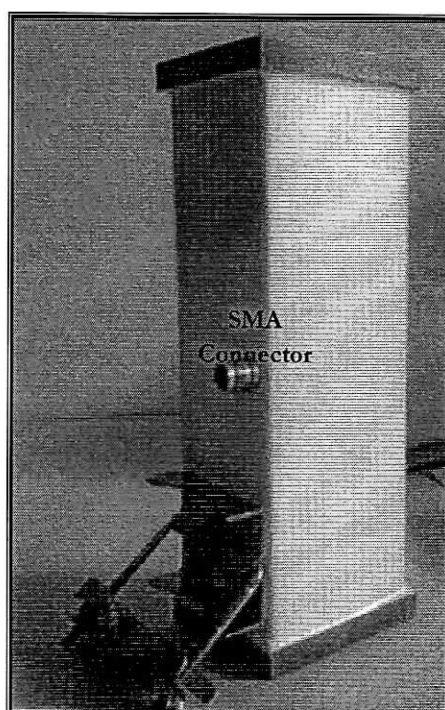


Figure 2.17: Smart Home Module External Antenna

This external antenna can be mounted even to a hard surface. This antenna is chosen since it has the capability of water proof. Using this advantage, the antenna can be placed on roof of the house without be anxious of the environment even during the rainy days. The antenna used is with the characteristics listed in following Table 2.8.

Table 2.8: External Antenna Characteristic

Antenna frequency range	Dual band GSM 900/1900 MHz
Impedance	50 Ω
Gain (antenna + cable)	0 dBi
VSWR (antenna + cable)	-10 dB

A complete smart home module is designed using these applications. Combination of these devices, various acts can be done according to the user. The best part of the system is that, in advance from the conventional way, the switching can be done via SMS and also preprogrammed schedule especially the house is left empty during vacations or business trips. This smart home switching module is also useful throughout the festive season when residents of a house are away to hometown or visiting. The electrical appliances mainly the lights can be programmed to be turned on according to user's necessities just to create a situation there are people in the house. At day time the system can programmed to turn off all electrical appliances and during the dawn, few lights can be programmed to be switched on with different sequence everyday. Indirectly, theft crimes can be minimized and the system give lend a hand to the police department as we are able to keep our much safer compared to the conventional way.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Project methodology

This project will involve four major phases which is literature review, software implementation, testing, and hardware development. Programming is the most imperative task in order to achieve a precise result out of this smart home switching system. A scrupulous research is done for devices and components used for tremendous application, to acquire a prevailing system.

3.1.1 Literature Review

An explicit and comprehensive study is made on the main unit of this system which is the PLC. Magnitude deliberation is given to the PLC since it should be capable of controlling all other devices absent with prerequisite applications. The applications required in this smart home module are remote switching, preprogrammed and also at the same time the conventional method of switching. The PLC is preferred by the scope of application in this system. The information's are gathered using internet, journals, project papers and also company catalogues. Once the PLC unit has been decided, the list of compatible devices for remote switching is done through the suppliers.

3.1.2 Software Implementation and Programming

The Zelio Telemecanique PLC is distinct as a smart relay due to its flexibility. As the controller is flexible, similar software is favored for this system. The programming software is ZelioSoft version 4.1. ZelioSoft also bestow a flexible medium for programming. This software is easy to employ for programming. The programming can

be done using preferred expertise where three different method of programming are competent by this software. They are programming using the ladder diagram, functional block diagram akin to icons and also electrical diagram.

The best fraction of ZelioSoft is that the view of programming method can be changed to either one of the three manner mentioned earlier at anytime during programming or after complete the programming. For an example lets say a user is programming by means of his proffered method which is the electrical diagram indoctrination. Once the program is completed or while programming, the user is able to view the same program inscribed in neither ladder diagram nor the Functional Block Diagram method. To program this smart home module, according to the knowledge and syllabus went through, the ladder diagram language programming been applied. Furthermore, using ladder diagram is much more reliable in structure and straightforward for PLC programming.

3.1.3 Testing

Testing the system plays a main role. Since a new approach is applied for this system, numerous technical errors might occur might be in program itself or implementation of the applications. Throughout testing, errors are patterned and rectified for astonishing outcome from this smart home switching module. At the same time, the testing of the system before implementation provides a circumstances to incise unnecessary processes during the execution. Two partition of testing is done over this system. First testing is done once the module is fabricated or congregated and after the program is done according to the application craved. This testing route comes with a troubleshooting procedure to point out faults in the module. The blunders are later being made to order and there comes the final testing procedure. In case of any errors later, the process of first testing is carried out for the best outcome.

3.1.4 Hardware Development

Development of hardware is also done for this system. Since most of the devices used for this application are purchased, for further application and features added into this system needs hardware fabrication. As mentioned earlier, the application on temperature sensing need a supporting circuit to make it perform compatible with the PLC used. At the same time, in order to upgrade the existing idea, a fault detection circuit is planned to be operating by the PLC. This fault detection circuit hardware is fabricated to detect failure on electrical appliances especially mounted on lights to alarm the user remotely via SMS. This application is still under research and being expected to produce better demand for this smart home switching module. This circuit will be implemented to alert the user about the faulty in case the house is left empty. When the alert has notified the user, immediately through SMS, the light is capable to be switched off remotely. This is because a malfunction on electrical appliances left switched might cause conflagration especially it is important when everyone is away from home. Relying on this fact, fault detection circuit is being researched to be implemented.

3.2 Expected Outcome

All the input (switches and sensors) are connected to the PLC for manual switching purposes. The electrical appliances or load is connected at the output of the PLC. Since the output is directly controlled by the PLC, the device now is capable of switching the load manually, preprogrammed and remotely.

The output port of the PLC can be both in DC and AC supply. Where by if it's a high load (above 6 Amps) then an external relay is used for this purpose. The PLC has a built-in relay to contact the output DC. The electrical appliances connected to the PLC output need minimum current of 6 Amp to utilize. Concerning this specification, external relay is used for certain application on switching the electrical appliances.

3.2.1 Manual Switching

For manual switching, the user has to switch ON or OFF the electrical appliances. This system is well known as the conventional method of switching. Currently, the conventional method of switching is being replaced with the smart switching technique. Here, either one of the technique can be implemented. With the existing technology implementation, the smart switching is done using Radio Frequency (RF) module or Wireless touch screen. This PLC Smart Home Module creates a platform where both conventional method and Smart Switching system can be used.

3.2.2 Preprogrammed Switching

The preprogrammed switching is done automatically by the PLC as been programmed by the user. The real time PLC works according to the time frame specified in the programmed. This method enables the system to interact with the electrical appliances without the help of humans in any condition.

3.2.3 Remote Switching Using GSM modem

Remote switching is an alternative method of accessing to the electrical appliance using a hand phone. By sending a SMS command to the GSM modem attached to the PLC, the device will be able to react according to the send commands. This system also enables the users to interact to the system at any point of time to control and monitor the status of the electrical appliances.

A Subscriber Identity Module (SIM) card which is a removable smart card for mobile phone is inserted in the GSM modem. The remote switching is done by the user via the number provided to the GSM modem by SMS. The SMS command is referred to the standard messaging command according to the GSM module. For an example,

“12341234!Light1=1” command from the user will switch the specified output of the PLC. To monitor the current status of the appliances, the same authorization code is used by same individual for example “12341234!Light1?”. The GSM modem endows with high security features where by only authorized mobile users programmed in the GSM module is able to communicate for switching and monitoring purposes. At the same time, the GSM modem can be programmed to alarm a number of multiple users with limited access on the modification of the system and status of the electrical appliances. Figure 1.3 and Figure 1.4 shows the command used to trigger Light1 as well as to monitor the status of Light1 each.

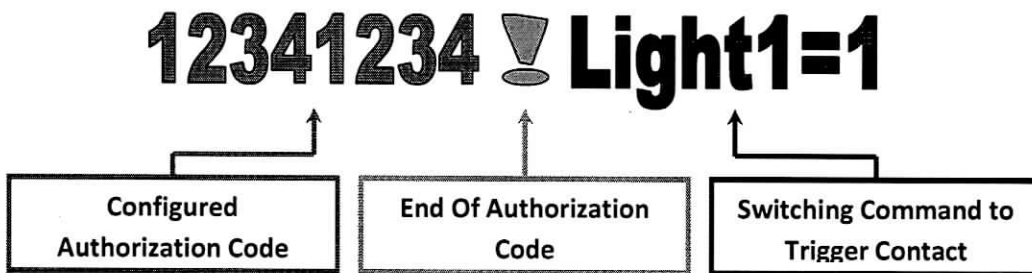


Figure 3.1: Remote Switching of Light1

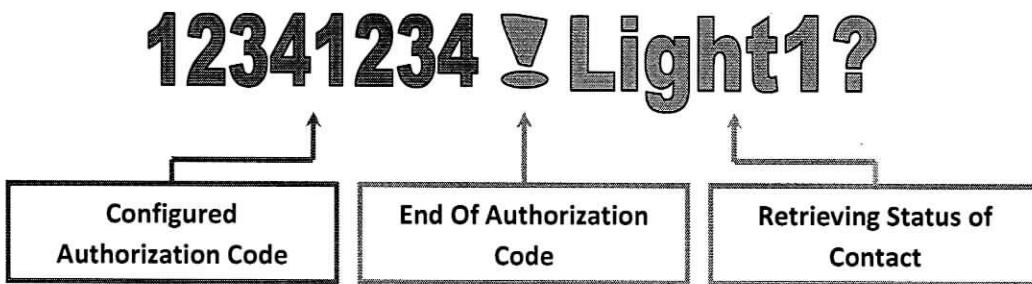


Figure 3.2: Monitoring Status of Light1

3.2.4 Error detection System

To set up a preeminent scheme, the Smart Home Module has been attached with an error detection system which is capable of detecting the defect of the electrical appliances. For an example, this error detection system has been mounted to an electronic light; A SMS message can be assigned to the user informing the faulty faced.

CHAPTER IV

RESULT

The Figure 4.1 below is the expected outcome of the project. Real time PLC is connected to the Communication Interface using the provider's standard cable. The GSM modem is connected to the Communication Interface using a RS232 cable. Communication between real time PLC, Communication Interface and the GSM modem is a one way communication while the link between the hand phone, transmitter and the GSM modem is a two way communication. Two way communications provide a medium for the user to monitor the status and modify the status of the electrical appliances.

As can be seen on the functional block diagram, the switches of the electrical appliances are connected to the PLC input. Four switches are connected to the PLC input in order to control four output electrical appliances. Due to the appliances connected to the PLC output need minimum current of 6 Amps to utilize, external relay is used in between the electrical appliances and the PLC output. The electrical appliances, light, fan, air conditioner with automatic temperature sensor and error detection system.

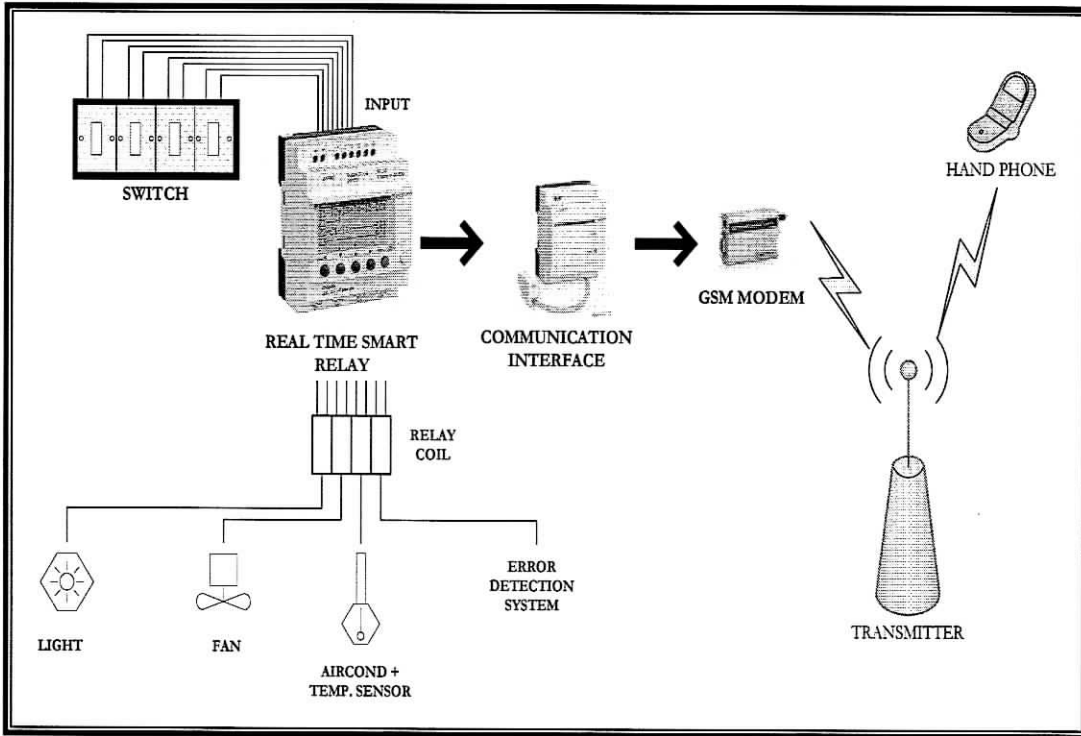


Figure 4.1 : Full functional block diagram

4.1 Results

The exact design of the Smart Home Module is as shown in Figure 4.1 above. This system provides an accurate and ideal outcome. This system has been tested for one week to observe its genuine productivity. As expected, this Smart Home System endow with a stable utility. The results of this system are categorized into 4 different sections which is the conventional method, preprogrammed schedule, remote access and last but not least the error detection system to illustrate the real time concept. The error detection system provides a structured approach of the electrical appliances and can be assigned to any electrical devices in order to detect defects or malfunctions.

A program is premeditated using the zeliosoft software and uploaded into the PLC. The program of the smart home system is as shown in Figure 4.2 below.

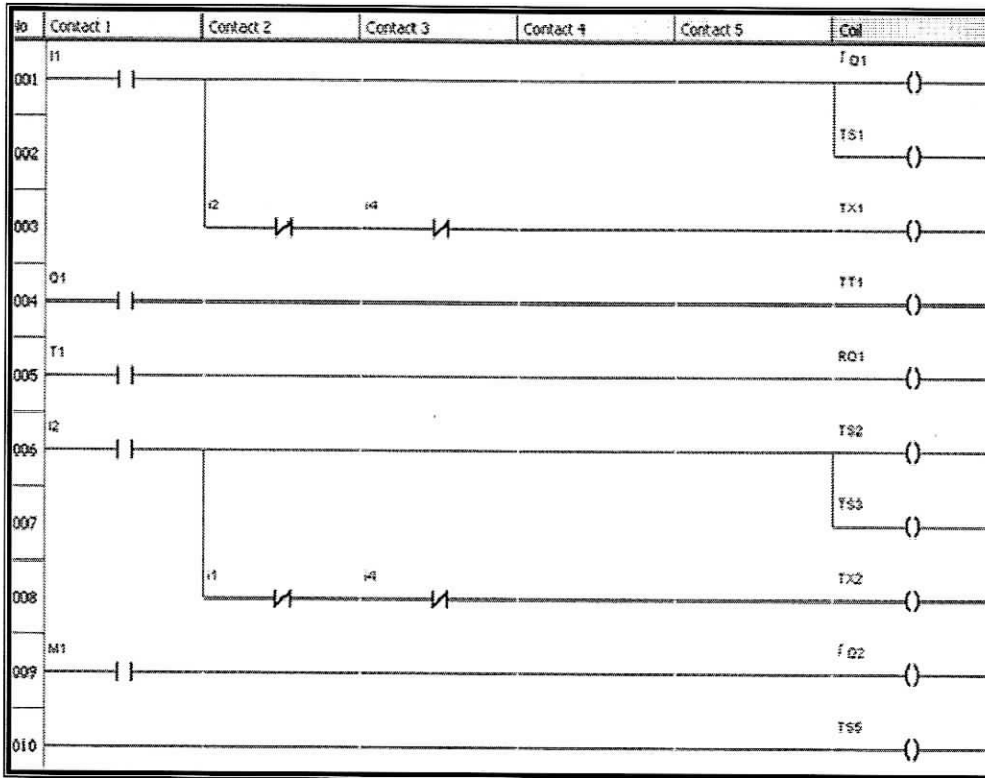


Figure 4.2: Smart Home Module Complete Program

4.1.1 Conventional Method Switching

Conventional method of switching refers on turning on or off a switch. This is the normal accessible structure used at home to control manually the electrical appliances. Generally this existing scheme is updated into an automated switching using a RF technology or wireless expertise where either only one of the manual switches or smart switching can be used. This designed Smart Home Module using the PLC is capable of producing both concepts above. The main aim of this product is to increase the flexibility in switching. The appliances can be switched using a switch manually at home or remotely when away home. This is one of the specialties generated by the PLC for a perfect and stable structured approach.

The conventional method technique is designed by the inspiration of two-way switching where normally used on staircase light. This system uses two switches connected to one appliance where each switch works proportional the other way around. The appliance can be triggered using both switches. Using this concept, the conventional method switching is designed. One switch is replaced with the PLC. The PLC maneuver as a switch. When the first switch is pressed manually, the conventional way of switching is done while triggering the appliance using a SMS is where the remote switching takes place. The real time feature from the PLC plays its role on switching the appliance remotely via SMS. The design and implementation of the two-way switching are as shown in Figure 4.3 below.

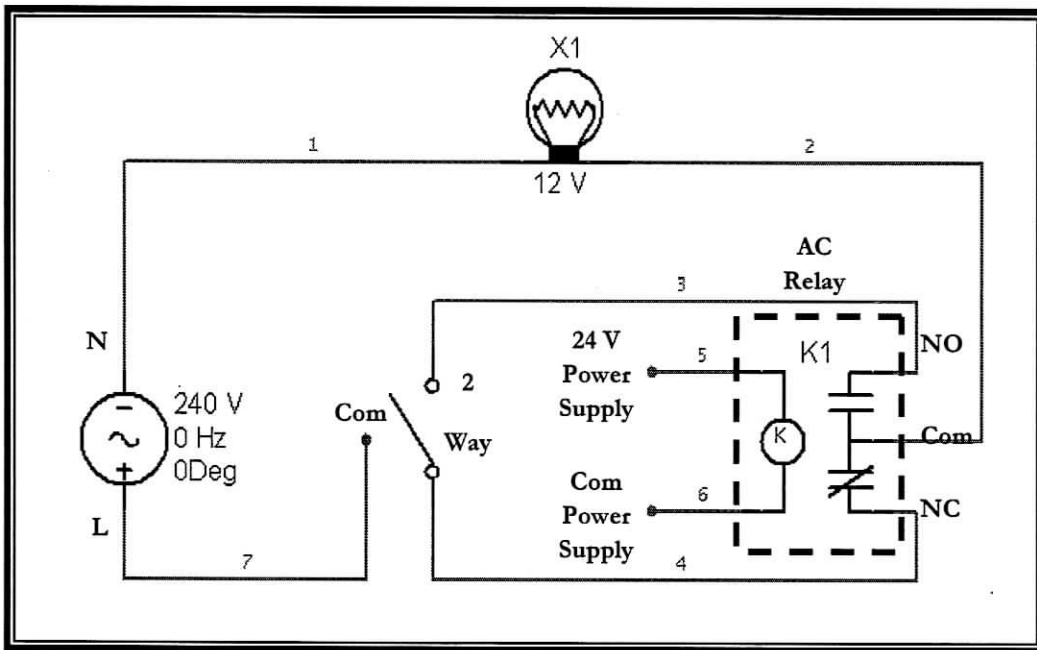


Figure 4.3: Conventional Method Smart Home Connection

This concept works when a light is switched ON at home using the 2 way switch manually. Later on, the light overlooked and has been forgotten to switch OFF. Here is where the PLC plays its role. The light can be switched off using the remote triggering.

4.1.2 Preprogrammed Switching

The preprogrammed switching is done automatically by the PLC as been programmed by the user. The real time PLC works according to the time frame specified as programmed. This method enables the system to interact with the electrical appliances without the help of humans in any condition. The PLC clock has an internal memory clock which can last up to 12 years upon one programming. This clock is the main aim of this product for preprogrammed switching. The clock are able to be programmed according to the GMT time doesn't matter in which country, the time can be programmed. Furthermore, the existence of the clock provides a flexible conception into the Real Time system. Figure 4.4 below shows the setting of a preprogrammed based schedule into the system.

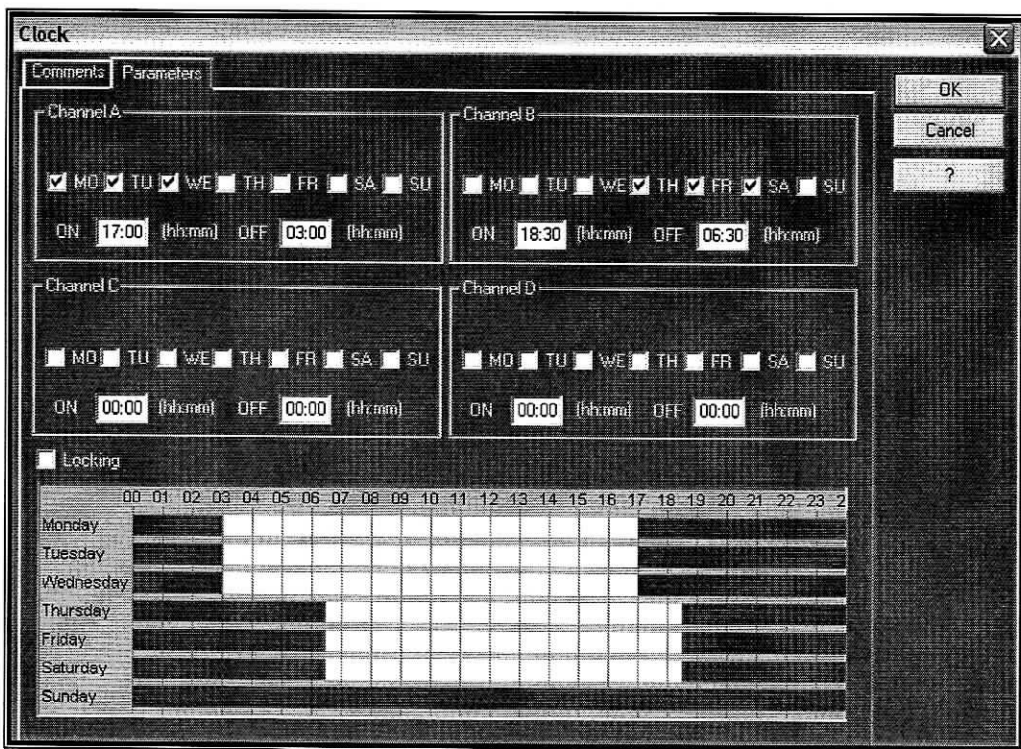


Figure 4.4: Preprogrammed Schedule Setting

As can be seen on Figure 4.4, the time to trigger ON and OFF the appliance at the same time the day according to channel can be programmed into the system. This Real

Time PLC will switch the appliance referring to the time base programmed. Figure 4.5 below shows the programming of the scheduled switching.

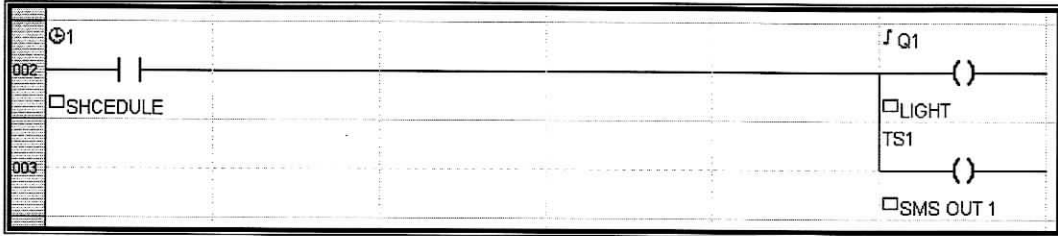


Figure 4.5: Ladder Diagram of Preprogrammed Schedule

4.1.3 Remote Switching via SMS

Remote triggering is commonly an existing concept. This concept is used to trigger a relay which activates an appliance at home but programming base of C language or PIC is done. This system relies on the programming. The disadvantage of this system is that once an automated system is mounted to the system, the conventional method of manual switching cannot be applied at the same time. Furthermore, it requires a desktop computer or a laptop computer to be always resting on the system. To overcome this problem, a more reliable structure has been designed using the Real Time PLC. With Real Time PLC, both conventional method and remote triggering can be used instantly and the transmission to trigger on an application is approximately 25 seconds. Figure 4.6 below shows the ladder programming for remote switching.

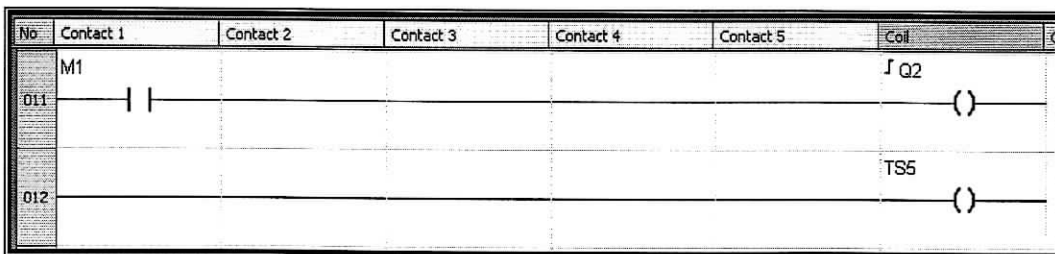


Figure 4.6: Ladder Diagram of Remote Switching Concept

The program shows the contact *M1* activates the output *Q2*. This *Q2* is connected to an electrical appliance. The *TS5* is the message sent to the PLC to trigger contact *M1*. Once contact *M1* is triggered by sending a proper command, the appliance will be switched ON or OFF. The best part here is that upon every switching done, the PLC will send a status monitoring SMS to the user alerting on the current status of the appliance connected. Figure 4.7 below shows the variable modification settings where a user is defined to the PLC by hand phone number. Only individuals with the specified number and definite password are able to do the variable modification or remote switching.

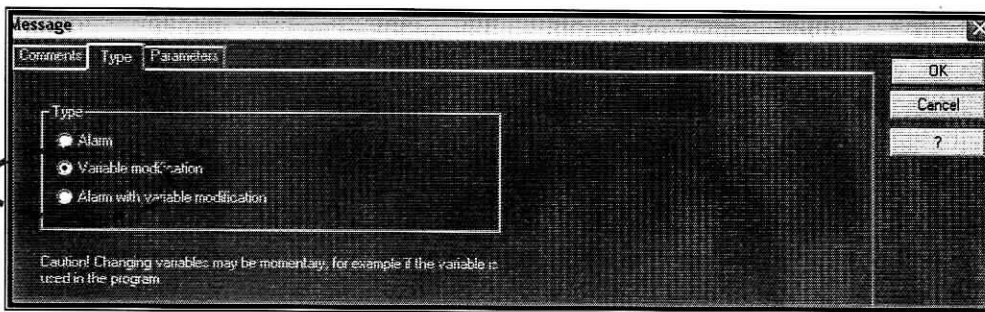


Figure 4.7: Variable Modification Setting

After this setting is done, the user and hand phone number have to be specifically programmed into the ladder diagram with the password. Figure 4.8 below shows the user identification configuration.

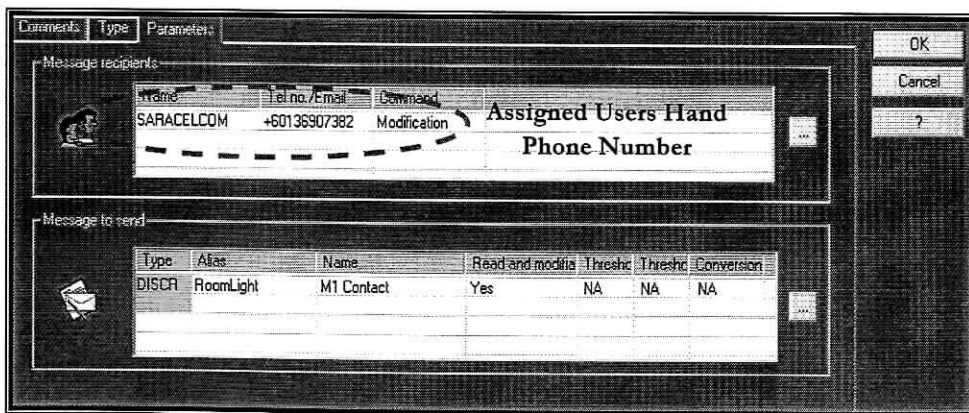


Figure 4.8: User identification configuration

As highlighted in Figure 4.8, only user "SARACELCOM" has the authorization to make the changes on electrical appliances. This user should send a command consists of the password and also the contact name to the remote station of the GSM modem. The password or authorization code is default of '00000000' ahead changes from the user. This code can be changed anytime upon downloading the program into the PLC. The contact name for this appliance is programmed as *RoomLight*. Figure 4.9 below shows the message command should send by the user SARACELCOM with mobile number +60136907382 to the remote station +60136907328.

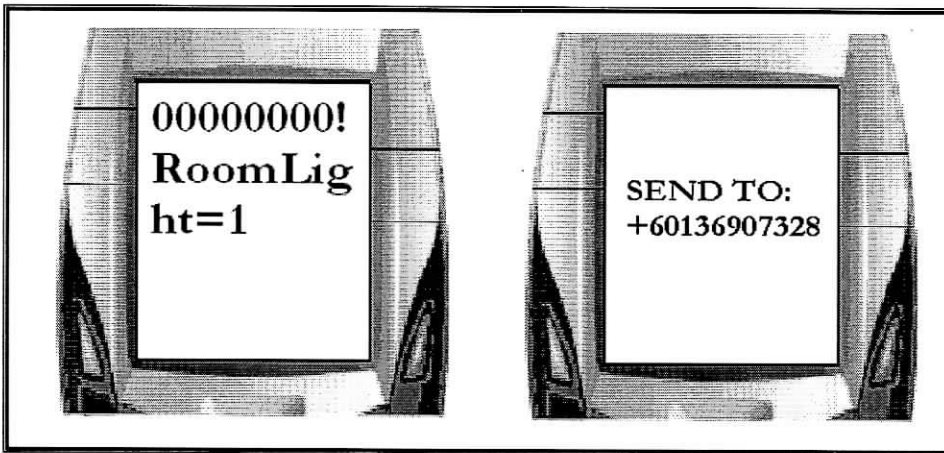


Figure 4.9: Remote Switching Command

The command should not have any space upon typing. The name of contact *RoomLight* is case sensitive where the switching might not take place if the command is wrongly typed. In case a wrong command is sent to the remote station, the PLC will trigger a error message to the user saying the command sent contains error as shown in Figure 4.10. The error word will indicate which field the defect takes place.

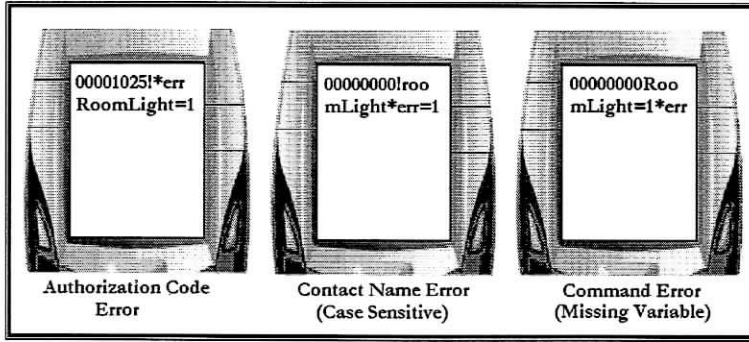


Figure 4.10: Remote Switching Command Errors

This system is as elastic as a rubber band where status of the appliances can be monitored anytime by the authorized user. The command to monitor the current status of the appliances is almost the same and differs only with one character. Although status is sent upon every switching is done, human nature competent on forgetting or careless always exist. In this case, this feature is useful to the user. At the same time, those users configured a preprogrammed switching at home might wanted to know the status of the appliances at home are able to use this concept. The area of expertise of this system is that the remote switching can be done from all around the world even using the roaming service. An external antenna capable of 800 MHz to 1900 MHz is used to strengthen the coverage of the GSM modem. This antenna is weather proof where it can be mounted at the roof of the house. Figure 4.11 below shows the command to derive the current status of the home appliance.

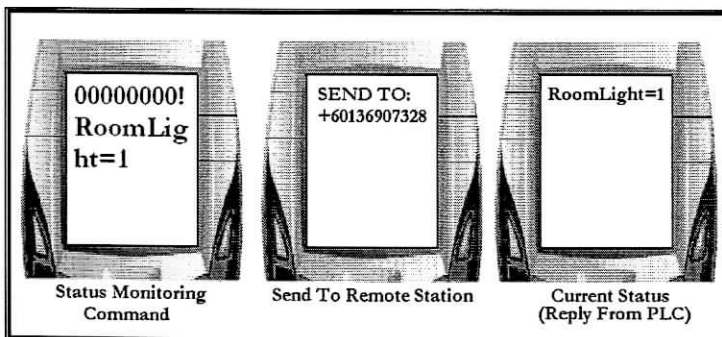


Figure 4.11: Remote Access Status Message

4.1.4 Error Detection System

Error detection is a system that designed for safety purposes. This error detection system is an additional concept intended into this system as proposed in future development of previous section (PSM I). As planned, this system turn-up precisely according to preferred manner. This error detection system design for temporary scheme as to be mounted to the light in Smart Home Module which consist of AC Relays with 24 Volt Contact. The AC Relay are connected to the PLC and as well as to the appliance consecutively to detect any defects of the electrical appliance.

This is consider as a precaution step taken in case of implementing the Remote Switching Concept or Preprogrammed Schedule technique at home while a user is away from resident. A light with defect has a malfunction may carry a short circuit if left turned on for an extensive period. This short circuit can cause fire. Realizing these facts, error detection system is implemented into this module where if there is any malfunction to the system, immediately a signal is sent to the PLC. This signal is programmed to send an alert to the user regarding the defect. Here, the user are recommended and given a chance to turn off their appliance to avoid any consequences. The design of the error detection system is as appended in Figure 4.12 below.

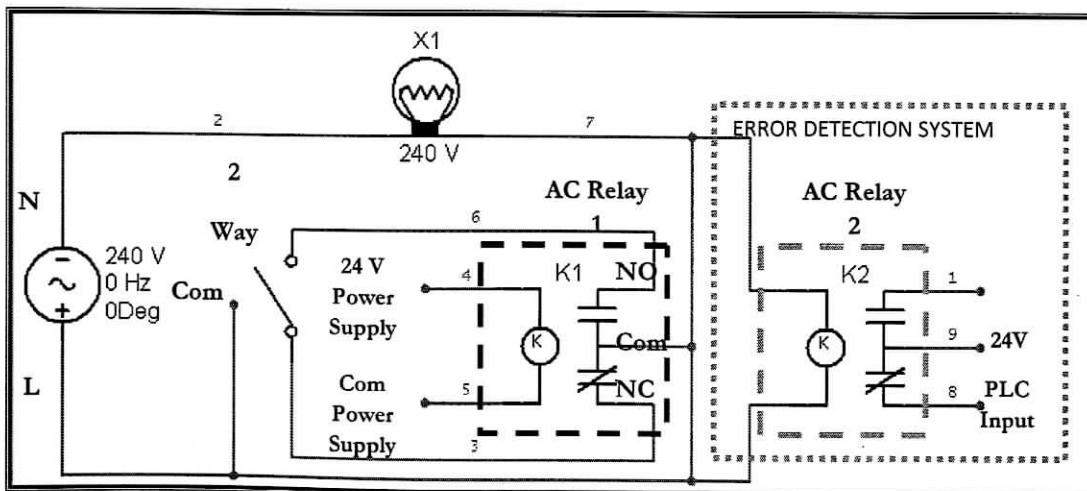


Figure 4.12: Error Detection System

When the light *X1* is switched, AC Relay 2 will trigger the 24V contact from Normally Close (NC) to Normally Open (NO). In the sense if the filament of the light burn, bulb *X1* will not function. This situation will not energize the AC Relay 2 coil to trigger from NC to NO. When the coil maintain its condition on NO, a signal is sent to the PLC (NO connected to PLC input) to send the alert to user regarding this defect.

4.1.5 Temperature Sensor

In order to prove the ability and flexibility of this Smart Home Module, a automated sensor is designed to detect the temperature in a room to activate the air conditioner. To trigger ON the air conditioner, the temperature should be 31 °C and to deactivate the air conditioner, the temperature should be 28 °C. A transistor is used to send a pulse to the PLC which will later control the air conditioner. The circuit is as shown in Figure 4.13 below.

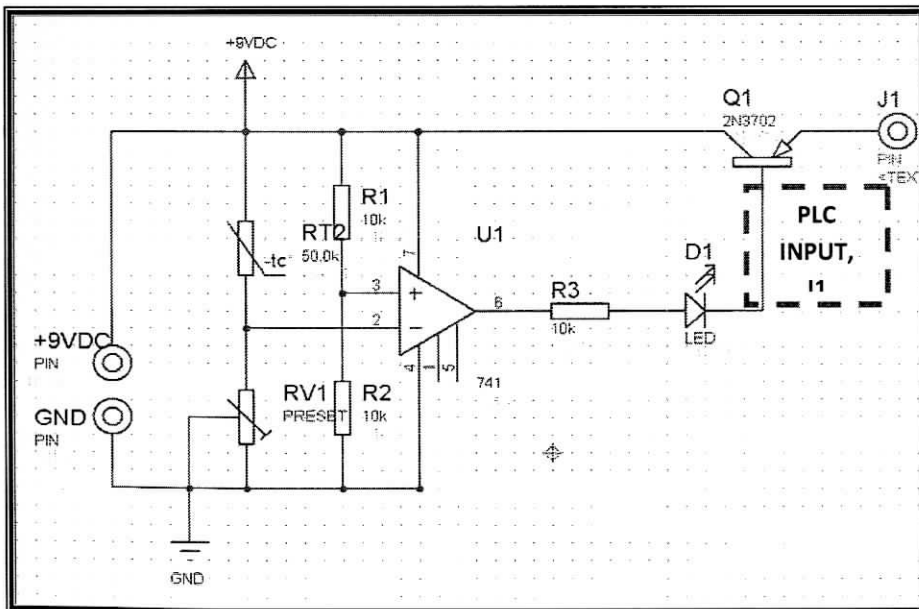


Figure 4.13: Temperature Sensor Circuit

When the cut-off temperature is detected by the temperature sensor (NTC), the operational amplifier will give a signal to the transistor (base) which turns the LED. When base is energized, automatically current from collector will activate the transistor which triggers a 12 Volt signal to the PLC input through *J1* to control the air conditioner. Once the room temperature is reduced up to 28 °C, the signal to PLC will be terminated by the operational amplifier and the air conditioner stops functioning in delay of 10 seconds as assigned to the PLC. The transistor functions as a switch for this application. The air conditioner can even be switched manually while the cutoff temperature also can be varied at any time.

Finally, can be concluded that, the Multiple Switching module shows a good result where desired output observed accurately. The two way communication between end users and also the module enable a safe and flexible switching method intelligently. The final prototype of the Multiple Switching Module is as appended in Figure 4.14 below.

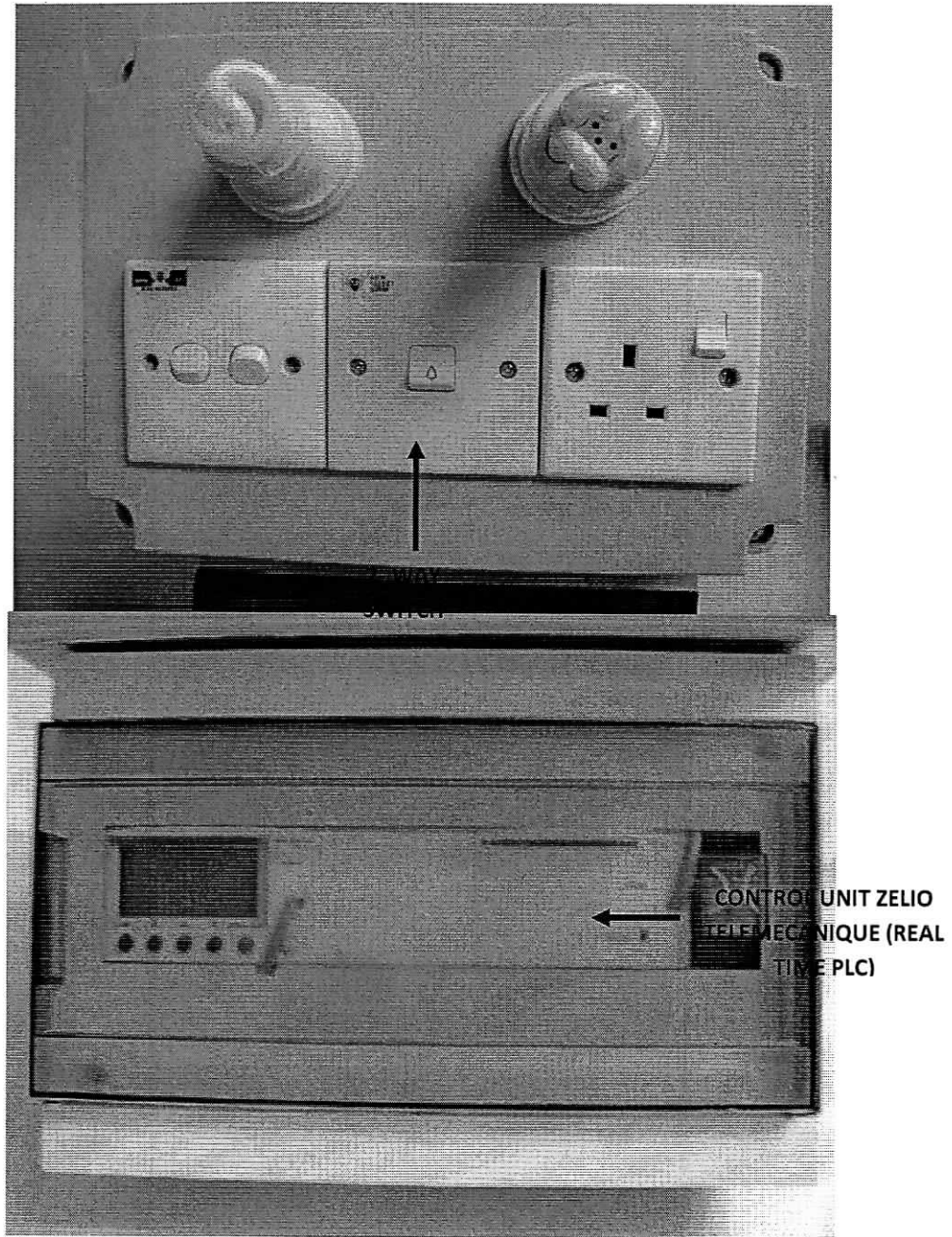


Figure 4.14: Finished Prototype

CHAPTER V

SUMMARY & CONCLUSION

5.1 Conclusion

With the infant Multiple Switching and other associated high-technology markets changing so rapidly, any predictions for their future are highly uncertain. Nevertheless, this research does identify reasons to be optimistic that a mass consumer market for Multiple Switching type technology could develop if the market grows and prices fall appropriately.

There appears to be significant consumer interest in the concept which could be unlocked at the right price. Unsurprisingly, the Multiple Switching idea is most attractive to more pro-technology consumers, including the so-called 'early-adopters' vital to the early development of high-technology markets. But, in addition, the Multiple Switching also could appeal to a broader range of consumers because of its potential safety and security benefits.

If a market does develop, it seems less likely to come from impetus in the building, construction or property sectors. The greater opportunity for growth in the use of Smart Home technology appears to be from its addition to the burgeoning array of consumer electronics and initial demand from the more technology-literate early-adopter households.

Can be concluded here is that this smart home switching system is operating as desired according to the program uploaded. Looking at this fact, this system is able to problem solve the existing conventional way of switching and able to achieve the objective of this submission. In the future, improvement on this project can be done by individual algorithm required. Further improvements will enable this project to bring benefit to mankind.

5.2 Suggestion

The Multiple Switching system is not only a home automation application. This module can be used at industrial sites, hospitals and also office lots for manual, preprogrammed switching and also remote switching via SMS. It also can be operate to other system such as security system. The remote switching can be also switched into a PSTN network whereby switching is done using a house phone. This application is available by just replacing the existing GSM modem with a PSTN modem. Therefore, the smart home switching module designed to operate in any attach sensor to according to user's needs and demand. Nothing mush need to be replaced but the just the devices and program based on requirements.

Further research and development on this Multiple Switching Module will be emphasized more on security for the authority departments such as police and fire department on dealing with their job more drastically. At the same time, implementation of touch screen with this module widens the usage of this system. Using touch screen enable a main control unit always by the side all the time. This system is considered more efficient compared to the RF remote control.

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