SMART METERING USING GSM

by

Nurfarain Abu Bakar

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronic Engineering)

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Universiti Teknologi PETRONAS
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CERTIFICATION OF APPROVAL

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Approved by.

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Project Supervisor

Universiti Teknologi PETRONAS
Tronoh, Perak
DECEMBER 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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NURFARAIN BINTI ABU BAKAR

ABSTRACT

Recently, many engineers has discovered and attracted to Automatic Meter Reading (AMR) that said to be replacing the human operator meter reading in the future. AMR has many advantages over the traditional method which made it the preferred method in the residential distribution meter. Although AMR is not yet the dominant method, but with evolution of the technology and the subsequent research on various AMR medium this method with no doubt will be the common usage in the future. This paper discovered various advantages of this method and studied on one of the AMR medium that is using GSM (Global System Mobile) modem.

ACKNOWLEDGEMENT

I would like to take this opportunity to acknowledge and thank everyone that has given me all the supports and guidance throughout the whole period of completing the final year project. Firstly, many thanks to the university and the Final Year Project coordinators that have coordinated and made the necessary arrangements, especially in terms of the logistics, for this project.

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TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AMR	Automatic Meter Reading
TNB	Tenaga Nasional Berhad
PLC	Power Line Carrier
PLM	Power Line Modem
RF	Radio Frequency
SMS	Short Message Services
GSM	Global System Mobile
GPRS	General Packet Radio Service
MSB	Main Switch Board
LED	Light Emitting Diode
RAM	Random Access Memory
EPROM	Erasable Programmable Read-Only Memory

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Traditional meter reading is the most popular method in capturing or measuring the monthly billings of the consumers. Due to the rapid growth of population and technology, this method is however had been lagging far behind since the power electric consumption and number of utility consumers had increase rather quickly. Apart from its low speed [1] data collection, this traditional meter reading had difficulty in reading meters in rural area [1] or restricted area such as the power plants or the biohazard factories. Since this traditional reading is done by humans, they prone to get the incorrect reading whether unintentionally or intentionally [1]. This method had the limitation of the data profile [1] since it was done manually.

Recently, a new method had been introduced known as Automatic Meter Reading (AMR), to overcome the disadvantages of the traditional meter reading. AMR is believed to be replacing the traditional method and dominating the industry in the future for its advanced and flexible features [1].

1.2 Problem Statement

Meter reading conducted by human operator from house to house is the most dominant method of meter reading. This technique however consumed a large number of human labour and long working hours [2] to complete the consumers' data or billing retrieving. Hence, the effects are the increasing in operation cost and operation time as well as insufficient labouring. In some cases, the meter readers were banned from going inside the location area due to the

chemical hazard or other necessary reasons. Despite all the problems mentioned, the consumers' billings retrieved using this method is not hundred percent accurate since human labouring tend to make mistake or errors in reading. Consumers sometimes lost their own printed billings and had to go retrieve the billings at Tenaga Nasional Berhad (TNB) counters.

1.3 Objectives and Scope of Study

The objectives of this project are as follow:

1 To develop Automatic Meter Reading (AMR) using Global System Mobile (GSM) as an alternative method for traditional meter reading
2 To have billings that is based on the actual consumption of the energy rather based on estimation based on previous billing by the meter readers.
3 To construct a prototype of Smart Metering using GSM modem technology

This project will cover the research of the AMR on such medium that are available today such as power line carrier (PLC), radio frequency (RF), telephone line, SMS/GSM network and General Packet Radio Service (GPRS). All of these medium have their own pros and cons and this paper will further explain on the selected method.

CHAPTER 2

LITERATURE REVIEW

2.1 Electricity Meter

Electricity meter is like other mechanical or electric meter only to measure the amount of electricity consumption from users either in the residential area, business or industrial area. The measurement unit of this meter is in kilowatt hour which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. The other measurement is demand, measured in watts but averaged over a period, most often a quarter or half hour [6]. There are types of meter that can read reactive power which is measured in kilovar-hours. Inductive load, such as motor will have a negative reactive reading while capacitive load will have positive reactive reading [6]. The electricity meter can be divided into two types: (1) single phase meter and (2) three phase meter, like has been shown below:

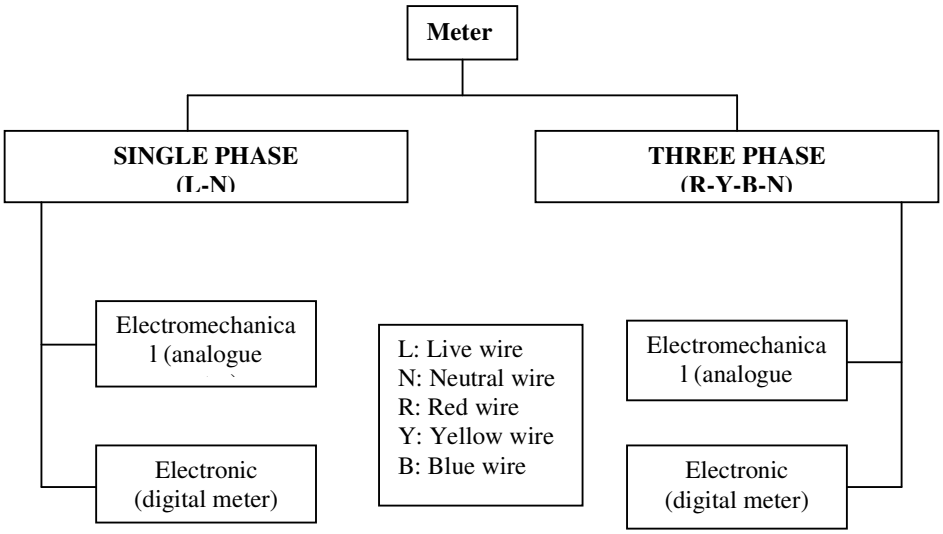

Figure 1: Block Diagram shows the types of electricity meters

Single phase and three phase meter differ from each other in terms of voltage carrier. For a single phase meter, since it only consists of two lines, live and neutral line, its voltage carrier is much lower than three phase meter which has four lines; red, yellow, blue and neutral. The current consumed for single phase meter captured is less than 100 A per phase. Both single phase and three phase meter has analogue and digital meter but the number of digital meter consumers keep on increasing every year since it is more accurate and has the temper detection function. This function has been added by the manufacturer to detect if any electricity been used illegally, and been preferred by Tenaga Nasional Berhad (TNB) to lower the risk of stolen electricity [6].

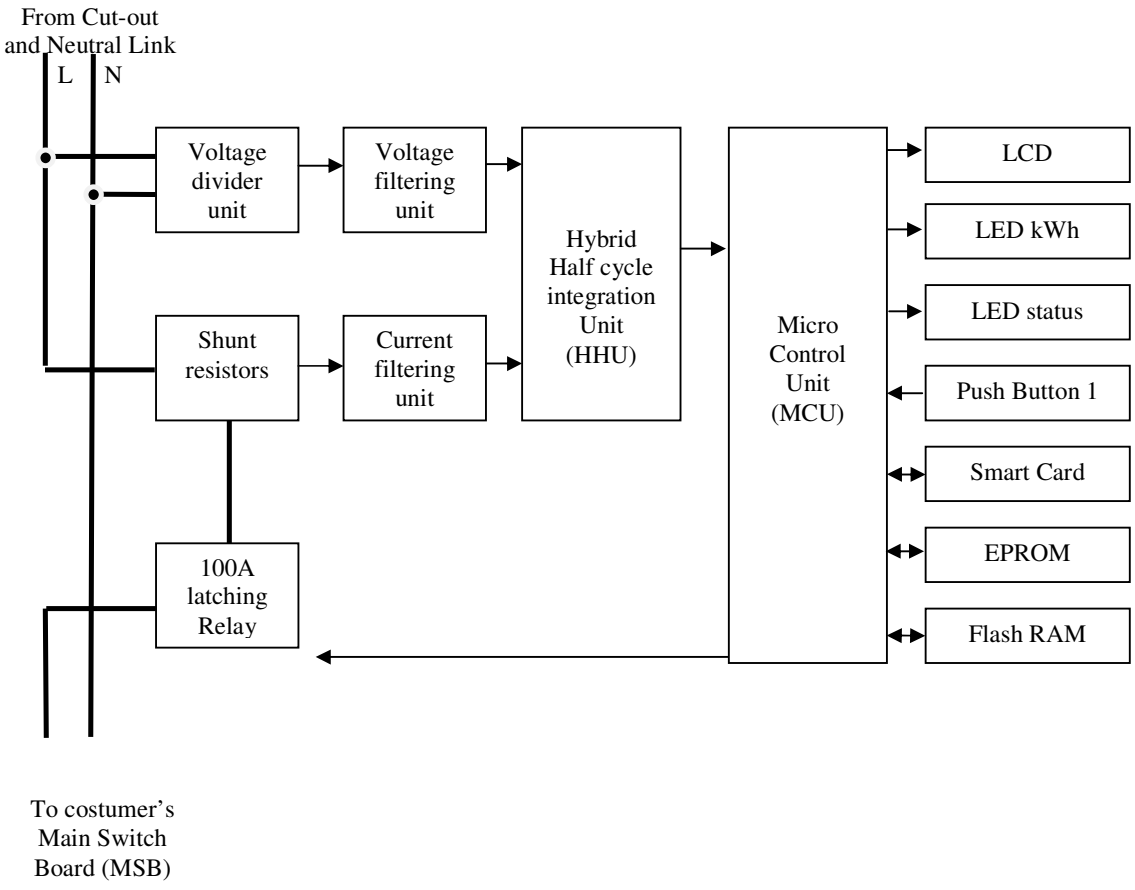

Figure 2: Block System of electronic single phase meter

Figure 2 summarized the operation of single phase meter. Single phase meter only involves two lines, live and neutral line. Live line can be tapped from either red line, blue line or yellow line. Both live and neutral line is needed to operate voltage divider unit in the meter. The function of this unit is to divide the primary voltage, 240V to other smaller value that is permitted in the circuit [6]. Voltage filtering unit on the other hand, is used to filter the voltage that is permitted [6] so that it can be processed by the Hybrid Half cycle integration Unit (HHU). Shunt resistor is needed to capture the current ampere and filter it through the Current filtering unit. HHU will then change the analogue signal from both voltage and current to a digital signal and send it to the Micro Control Unit (MCU). MCU acts as a brain to control and process the arithmetic data and the LCD screen. It executes the command from Erasable Programmable Read-Only Memory *(*EPROM) and identify if abnormality happen [6]. EPROM and Flash RAM are significant since it stores the data and the command that should be carried out by the MCU. This data will not loss if the supply to the meter is cut [6].

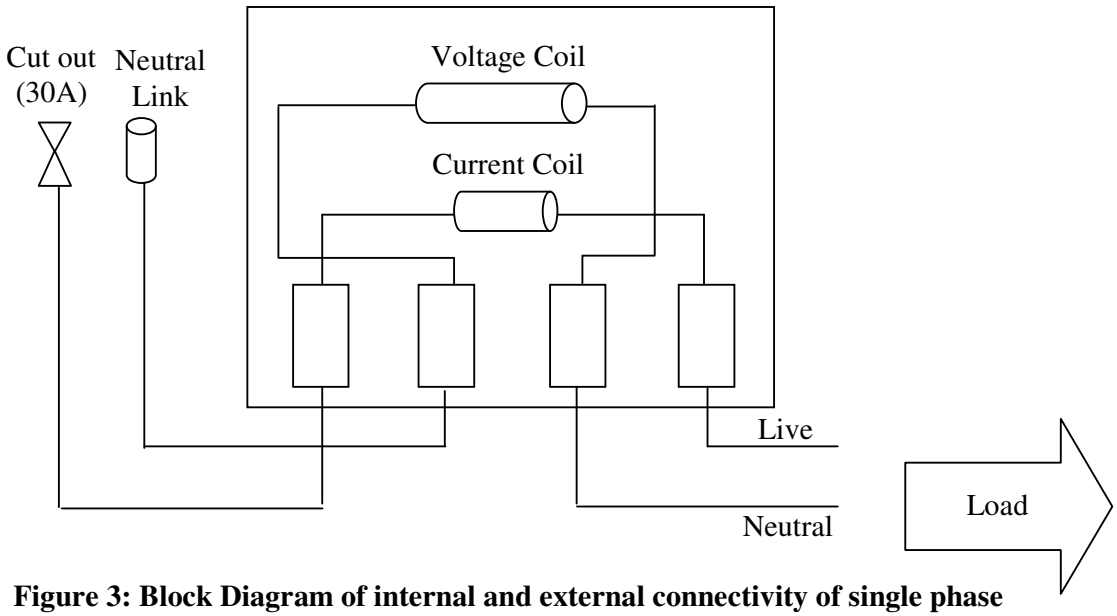

Figure 3: Block Diagram of internal and external connectivity of single phase meter

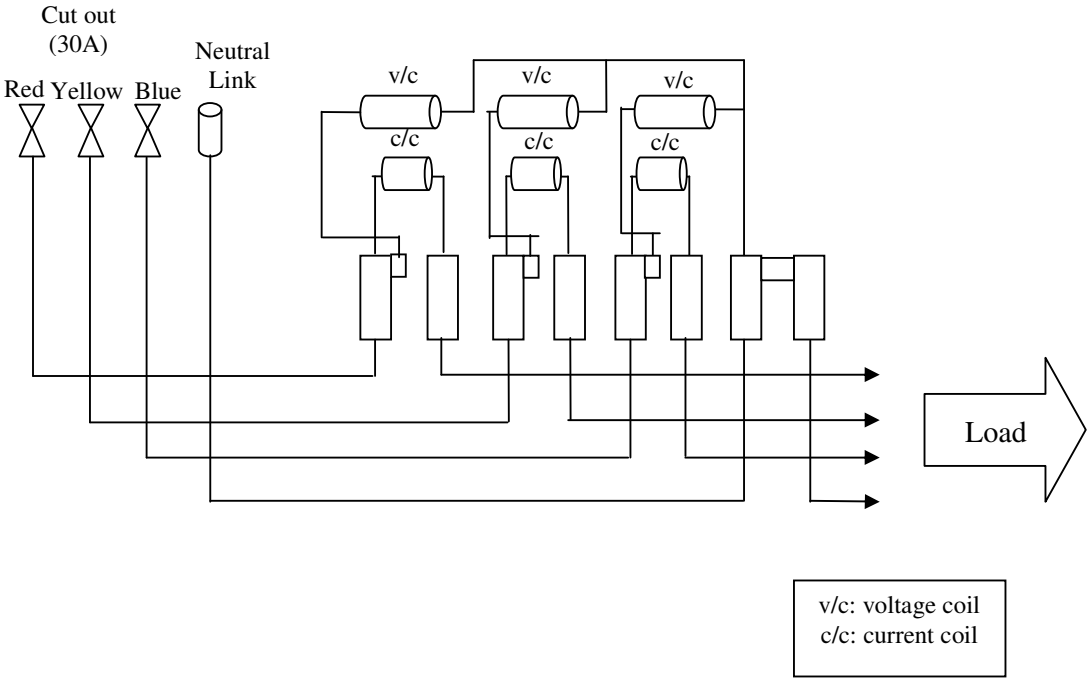

Figure 4: Block Diagram of internal and external connectivity of three phase meter

Figure 3 and Figure 4 above show the simple internal connectivity as well as external connectivity of single phase and three phase meter. Voltage coil and current coil are both present in either single phase meter or three phase meter. Voltage coil carry the voltage value for measuring purposes and has more windings compare to current coil. Current coil on the other hand, carry the current value for measuring purposes [6]. Voltage coil is connected parallel with the load while current coil is connected in series with the load. The cut out fuse in both meter acts for safety purposes for the meter such if the current exceeds the rated fuse value, the fuse will blow.

For this project, single phase meter is chosen over the three phase meter since it only has the real reading of the meter. Despite that, the meter must be a digital meter because the component used to capture the reading can only capture the pulse which is present only in the digital meter. Since single phase

digital meter is most preferable meter among the consumers (refer to appendix III for the survey), this project still beneficial to the industry if it success.

2.2 Automatic Meter Reading

AMR is an alternative means of meter reading that allow substantial saving through the reduction of meter re-read, greater data accuracy, improved billing and customer services, hence better deployment of human resources [2]. This method had provided various advantages on the effectiveness of the meter reading. Apart from its high speed data transmission, this method had improved the load profile of the consumers and had turned the printed billings into the automatic billings invoice [1] that the consumers can access via internet. AMR provide the real time energy cost, load management and tamper detection [1] to avoid the illegal possession of the electric by the consumers. The effectiveness and reliability of the AMR had introduced many means of this new technology, such as via power line carrier (PLC), radio frequency (RF), telephone line, SMS/GSM network and General Packet Radio Service (GPRS).

2.1.1 AMR via Power Line Carrier (PLC)

PLC communication is a built-in Power Line Modem (PLM), which sending and retrieving the data via the power line [3]. The rate of the transmission is set to 60 bps, to reduce the noise (transmission error) and to ensure the communication network over a long distance transmission [3]. The advantage of PLC communication is that it is a low cost technology which can achieve the nominal speed of transmission [4]. However, this method has its own weakness that it tends to lose the data during the transmission. Hence, it has higher error rate levels [4].

2.1.2 AMR via SMS/GSM network

Global System Mobile (GSM) has a vast coverage over the nationwide that has advantage of easy billings and meter reading since the consumers' data can be transferred wirelessly. Storing and forwarding function of the Short Message Services provide the flexibility of meter reading during the poor signal of GSM [2]. Using this system, the terminals is divided into three sections: sender, SMS center (SMSC) and recipient [1]. This can be clearly seen in the figure below.

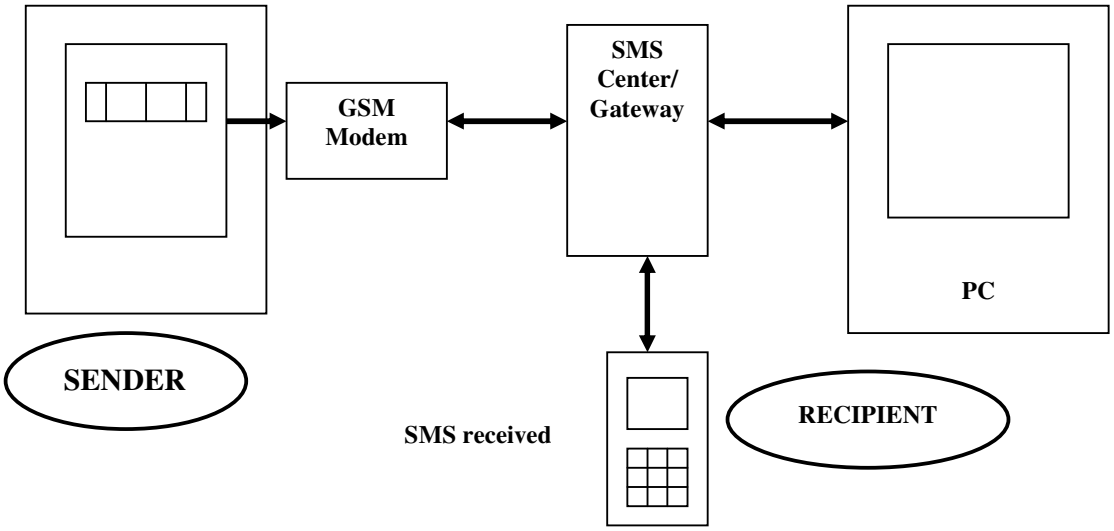

Figure 5: Block Diagram of AMR via GSM network

Meter here act as the sender which send the consumers' data to SMSC via the GSM modem. SMSC will then stored the data and only send it to the recipient (mobile phones or PCs) upon their request.

2.1.3 AMR via GPRS

The development and revolution of the mobile communication has lead to the better of the GPRS system since it been widely used [5]. Apart from that, the advantages that can be gained from this technology; it is always on-line and it has high speed transmission over a long distance [5]. However, it still will charge according to the amount of the transmitted data. This service can build outdoor, wide-range Multipoint-to-Multipoint data transmission channel, hence satisfy the need of data transmission speed of automatic system of reading digital meter [5].

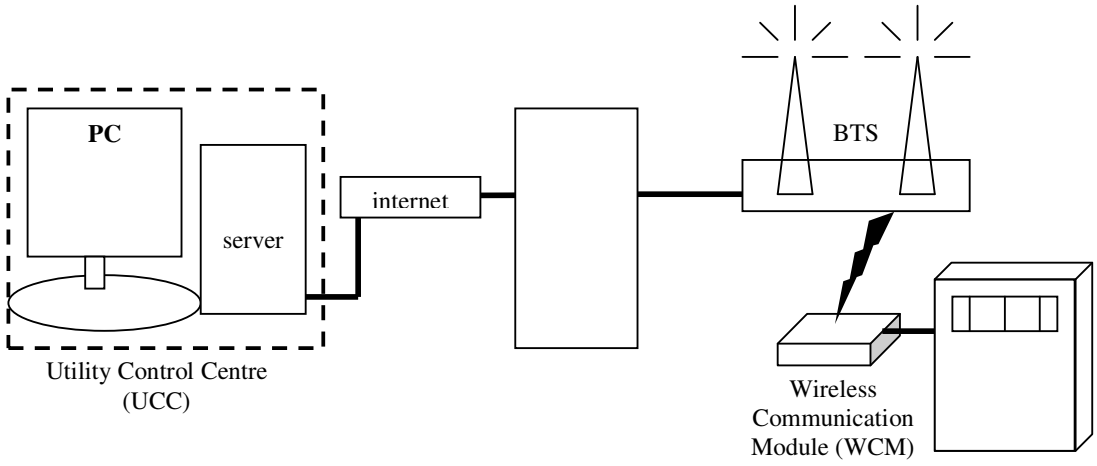

Figure 6: Block Diagram of AMR via GPRS

Table 1: Comparison of AMR medium: PLC, GSM Network and GPRS

Medium	PLC	GSM Network	GPRS
Coverage	-	wide	Wide
Transmission speed	slow	medium	High
Cost setup	low	medium	High
Error rate	high	low	Low
Reliability	low	medium	High

Based on table 1, GSM Network and GPRS both have wide coverage transmission since both are wireless communication. In term of speed, GPRS has the fastest transmission speed compare with the other two medium since GPRS is the latest technology among them. PLC has the lowest setup since the cable line is already there. The cost for cable line is lower compare to wireless module present in GSM Network and GPRS. For reliability, GPRS is the most reliable since is has low error rate and its transmission speed is the fastest over a long distance although the cost for its setup is quite high.

CHAPTER 3

METHODOLOGY

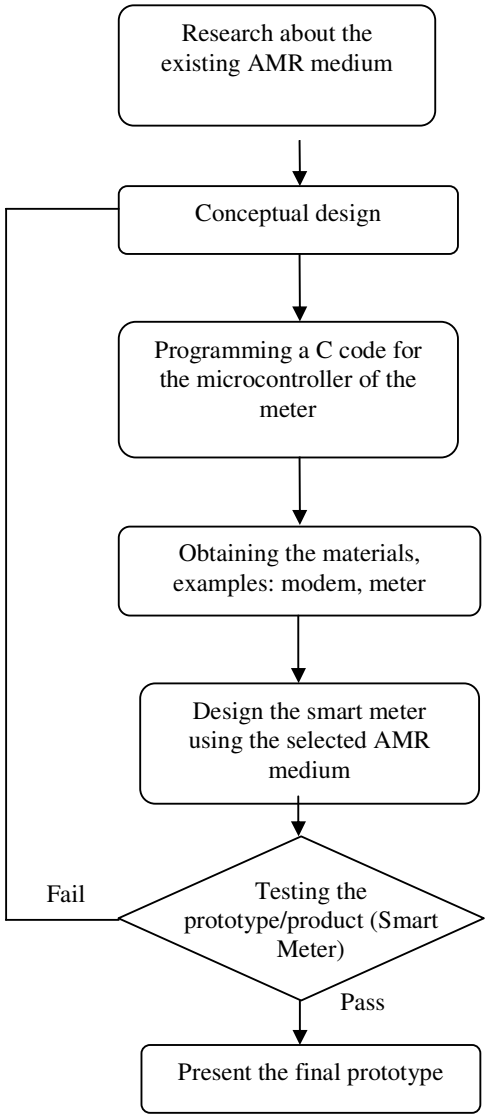

Figure 7: Flow chart of project methodology

3.1 Project identification:

1) Research/ literature review of the AMR medium

This is the first step of this project which is to research on similar project that had been done before and improved the project outcome.

2) Programming C code

Construct and program a C code that can capture the pulse of the meter to read as the output of the meter. This can be done using the simulator ide68k and be implemented in the microcontroller. The output of this code is actually the consumers' meter reading at that instant.

3) Construction of the prototype

Construct the AMR model using the desired media. This prototype can is designed base on the simulation of the C code.

4) Testing and troubleshooting

Test the prototype to see its efficiency and the outcome of the reading. If the reading received on the PC (laptop) is not the same as the reading on the meter, thus the prototype needs to be re-examined.

5) Presenting the working prototype

After the troubleshooting has passed, the prototype can be consider as success and the operation and the costing of the working prototype and troubles that been encountered during the implementation on this project will be present at the end of Final Year Project 2. Then, the dissertation of this project will be followed shortly after that.

3.2 Tools and equipments:

The tools and equipments for this project can be divided into two groups:

1) Software

IDE68k

This is a simulator for the coding that captured the LED pulses of the meter to display it as the reading of the consumers'. It is capable of simulating the outcome of the LED pulses

2) Hardware

Single phase digital meter

This is the single phase digital meter that been used through out the project. The meter must be a single phase digital type meter since the use of microcontroller at one of its output can only captured the real kWh only.

PIC16F877A

This is the microcontroller used to capture the LED pulses of the meter and stores them temporary. If the data is inquired by the user, the microcontroller will send it to the user via the GSM network.

GSM modem

This type of modem was chosen to be used in the prototype implementation due to its feasibility and reliability for the project.

3.3 Project block layout:

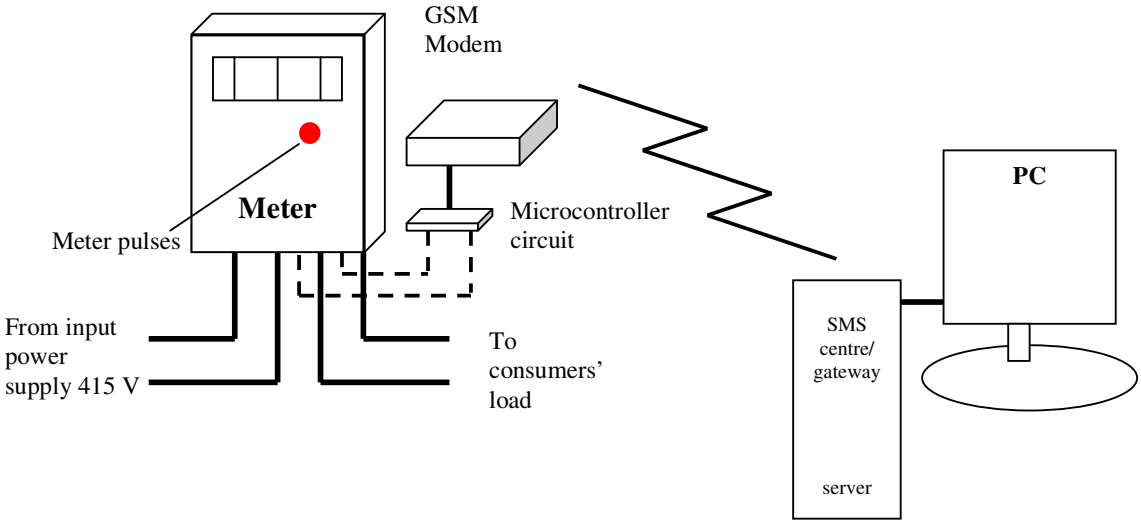

Figure 8: Smart Meter block layout

CHAPTER 4

RESULT AND DISCUSSION

4.1 Major Components of the project

Major components for this project are:

1. Microcontroller
2. GSM modem
3. Meter

All are important and significant due to their availability, reliability and cost.

PIC16F877A microcontroller was chosen since it is widely used and easy to program. It is a Reduced Instruction Set (RISC) where the instructions are much more linear compared to other microcontrollers. PIC microcontroller is more accessible and cost efficient compared to others.

GSM modem is needed in order to have wireless communication link between the digital meter and the PC or laptop (user interfaces). This communication differs from various AMR medium and its link is being established via data cable.

Single phase digital meter is chosen since the microcontroller in this project only read the real reading of the meter. Therefore, three-phase meter is not applicable for this project because it has both real value and reactive reading. On the other hand, analogue meter is not suitable for this project since the microcontroller can not capture the reading because it does not emit pulses.

4.2 Interface between microcontroller and electricity meter

Output from electricity meter is in terms of pulses that is in the form opt coupler with a maximum rating of 24 V voltage and 20mA current. These pulses can be retrieved using wires at the pulse output terminal mounted on the meter terminal block, right under the terminal cover as shown in Figure 9 and connected them to the microcontroller circuit to be processed before sending to the GSM modem.

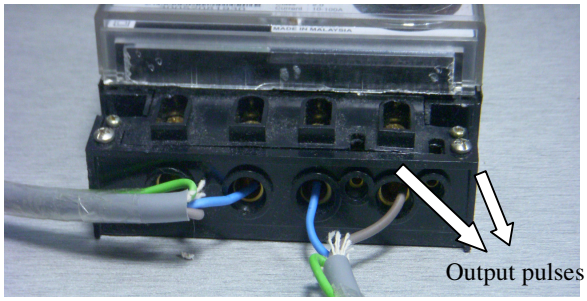

Figure 9: Output pulses from electricity meter

These output pulses is equivalent to the consumers' load at the rate of meter constant and been produced by the action of opt coupler. The contact of opt coupler will be closed every time a unit of power have been measured by the meter. Hence, a pulse is produced as there will be a square wave of output as in Figure 10 due to the open and close of the contact.

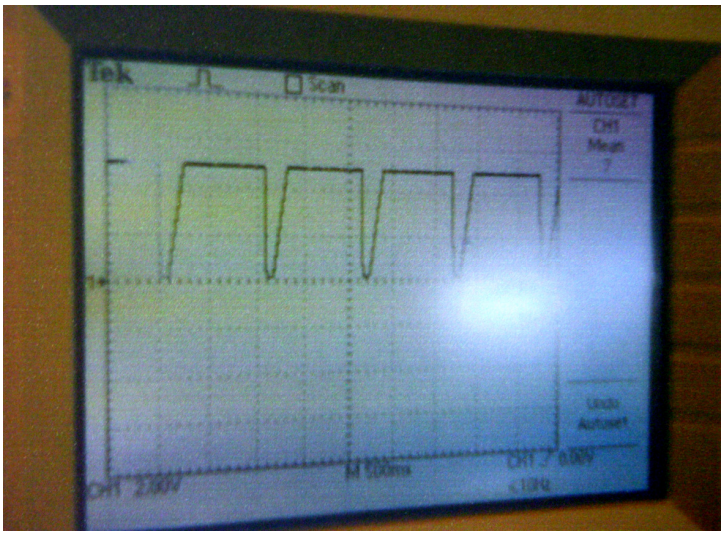

Figure 10: Signal waveform of the output pulses

The quantity of the pulses measured is corresponding to the quantity of energy, and Tenaga Nasional Berhad (TNB) will charge consumer for every 1000 Watt they have used as being display on the electricity meter as 1 kWh.

1 pulse = 1 W
1000 pulse = 1 kWh

Thus, by taking the pulses directly from the electricity meter, we can estimate the users load and electric bills on the electricity meter. In fact, this method is reliable to other type of meter since every meter regardless of model and type will have output pulses as a basic requirement for digital electricity meter.

4.3 Interface between microcontroller and GSM modem

4.3.1 Programming and simulation on IDE68k

The programming of the C code had been developed and tested on the simulator IDE68k. Figure 11 shows the ASCI code of the program that had been run on the simulator.

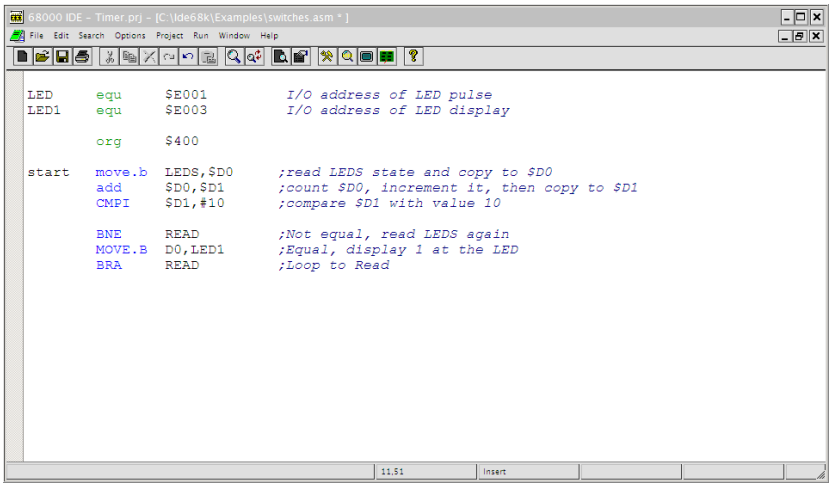

Figure 11: ASCI code of IDE68k

First, before starting, the input of both LEDS and LED1 are being initialized and set to the appropriate addresses. Then, the status of the LEDS is being read and saved into another address and being incremented right after that. Its value will be compare to 10 (as for 10 pulses). The value 10 here is chosen to shorten and cut the simulation time. By right, it should be 1000 since 1000 pulses equivalent to 1 kWh on the meter for the real case. Finally, for the case value equal to 10, then the LED1 will display 1 on the LED while for the case value not equal to 10, it will loop and read the LEDS status again. The result has been display on the 7-segment display of the simulator as in Figure 12

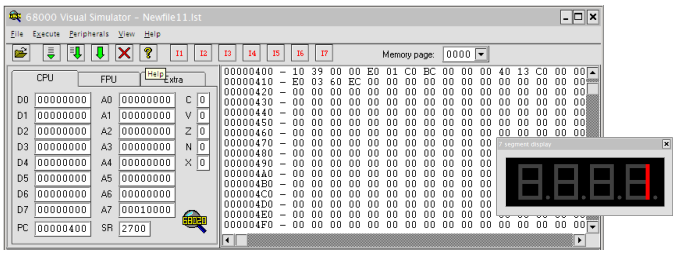

Figure 12: Simulation result on the visual simulator of IDE68k

4.3.2 GSM modem hardware setup

GSM is used in this project is type Q24 (serial) modem from mobitek sdn, bhd. This type of modem is preferred than the converted mobile type of GSM modem since there is certain limit of application for mobile type modem and in terms of transmission speed, mobile type of modem only support the slowest speed for transmission.

Before MS HyperTerminal is being used to configure modem command, the hardware part of GSM modem must first being setup. The valid sim card that has subscribed to the GSM service of a wireless network operator is inserted into the slotted card of the GSM modem. The modem needs to be powered up by the AC adapter and connected to a computer using RS232 cable. The corresponding wireless modem driver is set on the computer through the installation CD driver.

4.3.3 Configuration on GSM Modem

GSM modem usually works with the GSM wireless network that most likely behaves like a dial-up modem, only that GSM modem received and sending data via radio waves rather than a fixed-telephone line. Hence, the configuration must be made on the GSM modem to avoid data collision between other wireless devices that were using the same wireless network. GSM modem uses MS HyperTerminal software to configure the modem command or works and establish interface between PC and GSM modem. GSM modem also needs a SIM card for it to work.

MS HyperTerminal is a handy tool in testing GSM device. The GSM device needs to be tested first before starting to ensure the devices are working properly. The main reason for this is that when the problems occur, it is very hard to determine whether the cause is from the programming, GSM modem or the SIM card.

The parameters in MS HyperTerminal are set according to the supported GSM speed and bandwidth. After the hardware part of GSM modem is setup, a new connection on MS HyperTerminal is created to set the interface between the GSM modem and the PC. The port of which the GSM is connected is specified in the setting. The GSM is then ready to be controlled using the AT commands in the HyperTerminal window.

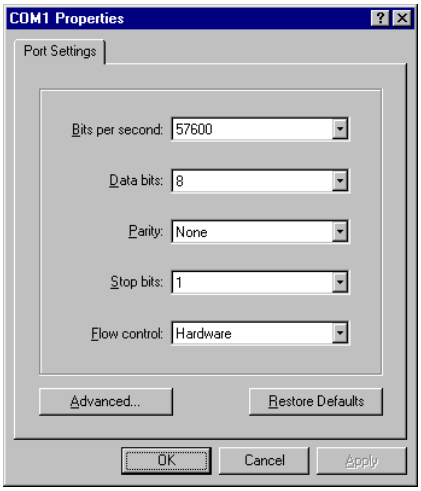

Figure 13: Setting of GSM modem on HyperTerminal

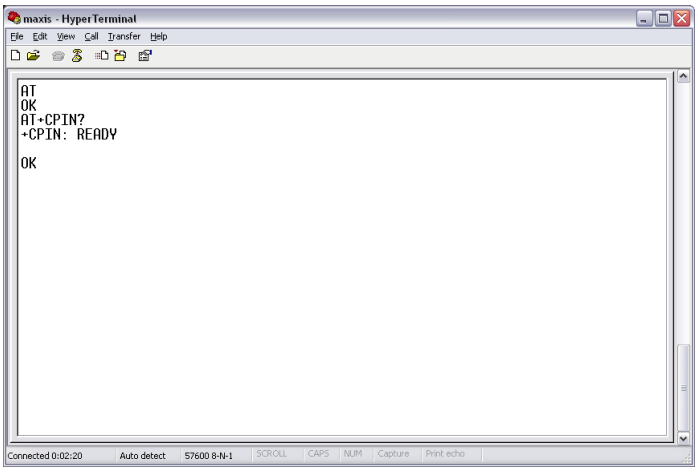

Figure 14: AT command on the HyperTerminal

AT command is used to control the receiving and the sending of data from GSM modem. The modem needs to be checked for the status of the PIN and the SIM card first before being ready to be used with the AT command. Few of the list of the AT commands used in sending and receiving the data are listed in Table 2.

Table 2: AT commands used in sending and receiving data

AT command	Description
+CMGS	Send message
+CMSS	Send message from storage
+CMGW	Write message to memory
+CMGD	Delete message
+CMGC	Send command
+CMMS	More message to send

4.3.4 Hardware interfaces between GSM modem and microcontroller

For this project, SK40B board from cytron is used as part of microcontroller circuit. The reason is to simplify the programming of microcontroller. SK40B is designed to offer an easy start for PIC MCU family to be programmed and applied on the real project using different input and output interface on the board. Since it offers plug and use for the user, it usually dependable especially in the case of serial communication between microcontroller and other device, in this case, GSM modem.

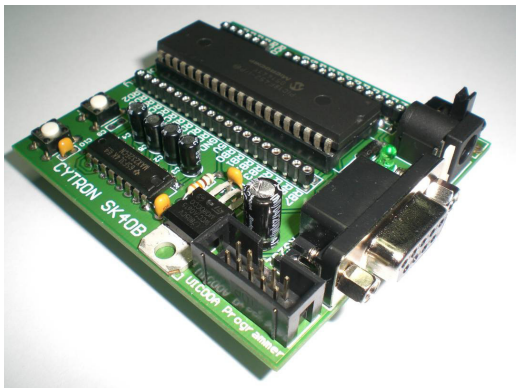

Figure 15: SK40B board from cytron

Serial communication usually involves the USART (Universal Synchronous/ Asynchronous Receiver Transmitter) as asynchronous serial communication. The basic concept of this serial communication is to load the parallel data into a shift register, as in this case is the microcontroller, and later shift it out as a serial data stream. This serial data stream has to be converted first into a specific format that is RS 232, using the RS 232 protocol, before being transmitted on a communication link such as wireless link.

SK40B board has a built-in RS232 connector that deal with the RS232 protocol. Thus it is much easier in terms of coding to handle the communication protocol. For microcontroller, PIC16F877A, the assigned RS232 port uses pin C6 of the microcontroller as a transmitter (TX) and pin C7 as a receiver (RX). GSM modem is connected to the microcontroller, PIC16F877A through RS232

connector of SK40B board. The circuit to capture the pulses and transfer it to the microcontroller is shown in Figure 16 below.

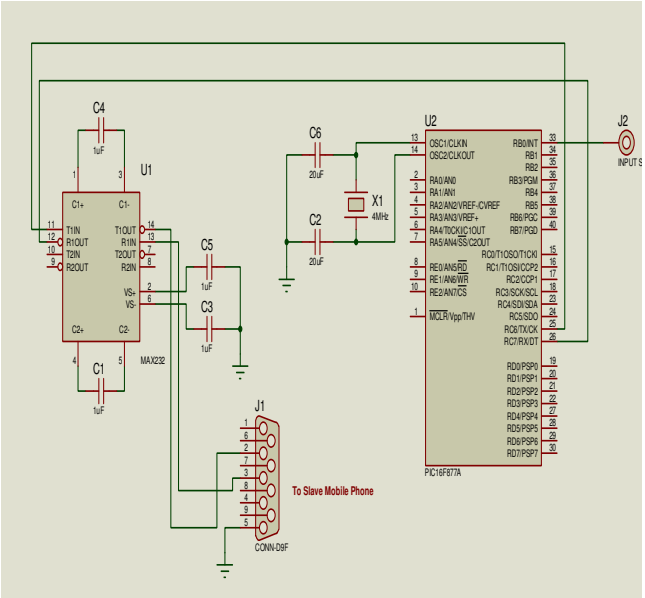

Figure 16: Schematic of PIC16F877A pulses capture circuit and RS232 connection

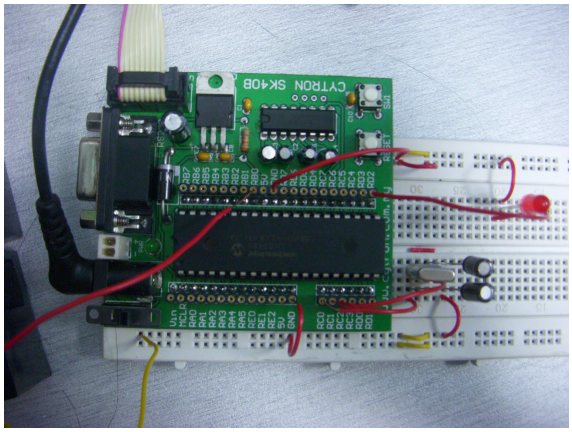

Figure 17: Circuit of 16F877A pulses capture and SK40B input/output interface

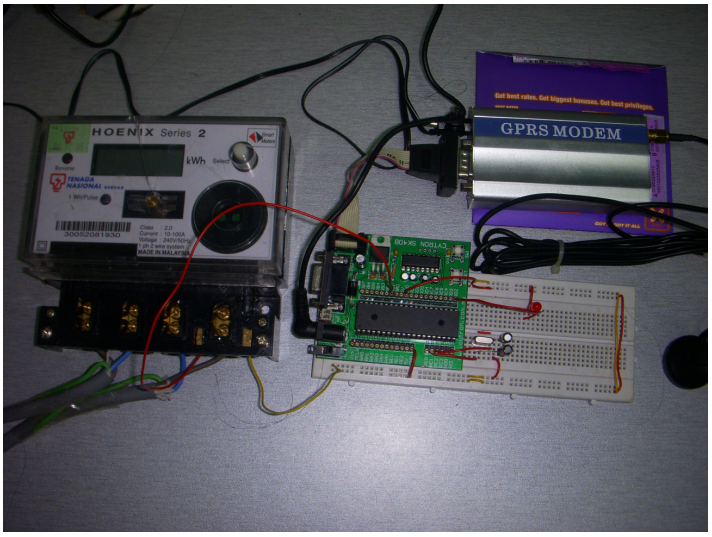

Figure 18: Interfaces between meter, microcontroller and GSM module

4.4 Interface between computer and GSM modem

For the interfaces between GSM modem and Personal Computer (PC), the GSM software has been installed in order to connect to the GSM network. The sending and receiving data still uses HyperTerminal as the platform to receive the input from microcontroller. Every time microcontroller receives a command from the pc, it would translate it and reply by sending the stored data in the memory register. The output will be read as hexadecimal by the pc and displayed on the HyperTerminal.

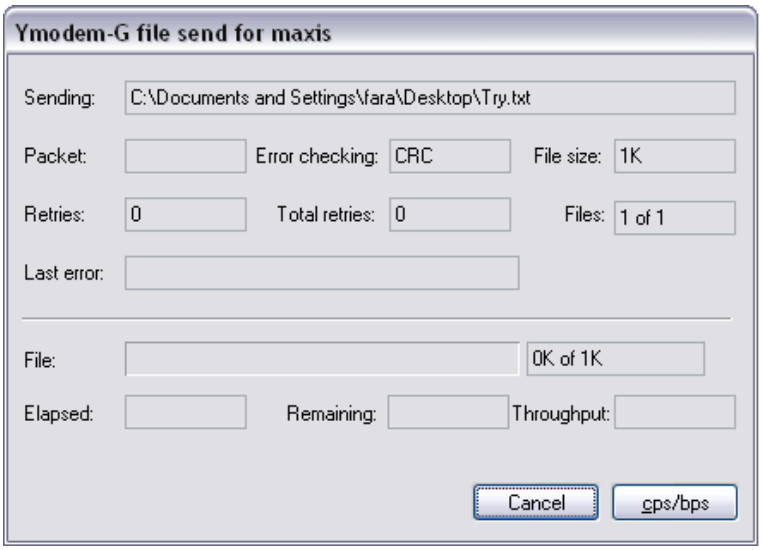

Figure 19: The sending and receiving of data on the HyperTerminal

4.5 Discussion

For this project, the meter model used is Pheonix Series 2, Single Phase meter. This meter will only produce pulse whenever the load is connected to it. In order to produce pulse, the high power electrical appliance was used as the load. This project has used iron as electrical appliance to produce the pulse on the meter. The pulses captured is measured in terms of voltage usage, thus there will be no effect in the meter reading whenever the current is changing. Electrical appliance, iron used is a heat produce application, and because of that the run time for the prototype is cut short to avoid the overheating from the iron. Therefore the prototype only being programmed to capture 3 pulses to represent 1 kW reading on the meter.

There were several problems aroused during the completion of this project. In the beginning, the ASCI coding developed is not applicable when converted into the C programming, thus making harder to reprogram the microcontroller. The C programming is then developed before converted it to ASCI coding in order to run it on the simulator IDE68k.

After the coding has been developed, the microcontroller circuit to capture the pulses is then developed and tested later with the GSM modem. After troubleshoot the circuit several time, another problem arouse, that is RS232 protocol. RS232 connection involves complex protocol and harder in terms of coding. For solution, SK40B board is used to cater the program and the protocol problems.

For the GSM modem, the SIM card needs to be programmed in order to be use with the GSM network. SIM card should be upgraded to a 3G card and configured to the GSM setting. There are a lot of problems aroused after the activation of the 3G card and some solutions have been taken to cater that.

There were some other problems that were difficult to detect due to the hardware interfaces and the setting of the computer. A lot of troubleshoot have been done throughout the completion of this project.

CHAPTER 5

CONCLUSION

5.1 Conclusion

Smart Metering is used with the GSM technology in order to retrieved and request reading wirelessly. Hence, the job of the meter reader will be a lot faster and more systematic billings will be produced. The billings will also base on the actual consumption since the reading is retrieved intelligently by the microcontroller. The reading can be retrieved by the meter reader as long as there is a GSM coverage and the electronic device that support GSM applications. GSM network also support Short Message Services (SMS), hence, it will be easier for the consumers to require and track their monthly billings status through the simple SMS. The services will be charged as per text message.

5.2 Recommendation

This project is aimed to design an Automatic Meter Reading (AMR) Electricity meter using GSM modem. The meter used in the project is a single phase digital meter. In the real world, there are also single phase analogue and three phase digital and analogue meter exist in the consumers' premise. Hence, there should be another study to implement this AMR meter on those different types of meter.

Additionally, this project is only focusing on retrieving data from one meter. For the real life applications, there would be hundreds of meter to be retrieved at a time from the specific consumers' premises. Thus, the improvement of efficiency on retrieving data from multiple numbers of meters could be done in the future.

This project used an external microcontroller as an intelligent device to read and retrieve the reading from the meter through the output pulses. It will be more effective and accurate if the reading can be retrieved directly from the internal microcontroller of the electricity meter. Hence, the size would be more compact since the wireless module will be communicating internally.

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APPENDICES

Appendix I: Gant Chart of the Final Year Project 1

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Selection of Project Topic															
2	Research Work (Literature Review)															
3	Submission of Preliminary Report				●											
4	Seminar 1 (optional)															
5	Project Work															
6	Submission of Progress Report									●						
7	Seminar 2 (compulsory)															
8	Project work continues															
9	Submission of Interim Report Final Draft														●	
10	Oral Presentation															●

Mid-semester break

● Suggested milestone

Process

Appendix II: Gant Chart of the Final Year Project 2

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Project Work Continue	■	■	■					Mid-Semester Break							
2	Submission of Progress Report 1															
3	Project Work Continue			●	■	■	■	■								
4	Submission of Progress Report 2															
5	Seminar (compulsory)									●	■	■	■			
5	Project work continue									■	■	■	■			
6	Poster Exhibition															
7	Submission of Dissertation (soft bound)													●		
8	Oral Presentation														●	
9	Submission of Project Dissertation (Hard Bound)															●

● Suggested milestone

■ Process

Appendix III: ASCI coding of IDE68k

```
LED    equ    $E001          ;I/O address of LED pulse
LED1   equ    $E003          ;I/O address of LED display

       org    $400

start  move.b      LEDS,$D0        ;read LEDS state and copy to $D0
       add         $D0,$D1         ;count $D0, increment it, then copy to
$D1
       CMPI        $D1,#10         ;compare $D1 with value 10

       BNE         READ            ;Not equal, read LEDS again
       MOVE.B      D0,LED1         ;Equal, display 1 at the LED
       BRA         READ            ;Loop to Read
```

Appendix IV: C programming on 16F877A

```
#include <16f877a.h>
#use delay (clock=20000000)
#fuses HS, NOWDT
#use RS232 (baud=115200, parity=N, xmit=PIN_C6, rcv=PIN_C7,
ERRORS, stream=pc, bits=8)

int count1;
int count2;
int countee;
char price;

void main()

{
char price;
set_tris_b(0xFF);//input
set_tris_d(0x00);//output

output_d(0x00);
output_b(0x00);

while(1)
{
If(input(PIN_B0)==0)
```

```
{
  delay_ms(23);
  count1=1;
  while(count1==TRUE)
  {
    if(input(PIN_B0)==1)
 {
 count1=0; //clear register count1
 count2++; //add to reg=1

if(count2>5) //if reg count2=10
 {
 count2=0; //clear register count2
 countee++; //add 1 to reg countee

 }

 else
 count2=count2;

 output_D(countee); //output to led
 }
}
}

 else
```

```
count1=count1;

        if(kbhit(PC)) //get char from pc
        {
         price=fgetc(pc);
        if(price==’meter price’) //if ‘ meter price’ press
        {

        put(countee); //display current value inside register countee
        }
 }
}
}
```

Appendix V:

Datasheet of 16F877F microcontroller

Appendix VI:

Datasheet of GSM Modem

Appendix VII:

Datasheet of SK40B board