Implementation of Automatic Meter Reading (AMR) Using Radio Frequency (RF) Module

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Abstract—**Automatic Meter Reading (AMR) aims to move away from the traditional method of manual reading of electricity meters in which a meter reader who visit every meter location periodically and read the meter value manually. AMR by using radio frequency (RF) is the remote collection of consumption data from customers' utility meters using radio frequency technologies. This system provides electric utility service company (TNB) the opportunity to increase operational efficiency, improve customer services, reduce data-collection costs and quickly gather critical information that provides insight to company decision-makers. The existing digital electric in the marketing is upgraded by adding RF module to provide remote communication capabilities. At the same time, the receiver module unit interfaced directly to a computer/laptop to display all necessary details.**

Keywords-component; AMR, RF module, electricity meter,remote.

INTRODUCTION

Electricity meter is an instrument used to measure the electricity usage by the customer. The amount of electricity consumed is represented in term of kWh. Usually the amount charges depend on the unit used which had to be collected from the meter in each customer residence [1]. This manual procedure has to be repeated every month by the authorities of Tenaga Nasional Berhad (TNB) representatives. These traditional and manual ways of collecting data cause problems to both sides: the TNB management side to the consumers. By introducing automatic meter reading, collecting data can be much easier, controllable and monitored thus reducing the problem associated with meter reading.

This system is divided into two main sections which are hardware section and software section. The hardware section is divided into two which are one for customer unit and another one for the TNB management unit. The software section is mainly for TNB management unit to record, control and monitor the consumer electricity usage.

HARDWARE DESIGN

Automatic meter reading is designed based on the actual digital electricity meter available in each consumer residential. Figure 1 show the basic block diagram of the whole automatic meter reading system. Basically, this system using existing one phase digital electricity meter in consumer residential. The digital electric meter will display the amount of energy consumed by the consumer based on daily usage. At the digital electric meter the build in liquid crystals display (LCD) will display the energy consumed according to the number of pulses generated by the LED blinking. Therefore, the numbers of pulses generated by the LED are the proportional amount of energy used by the consumer[6].

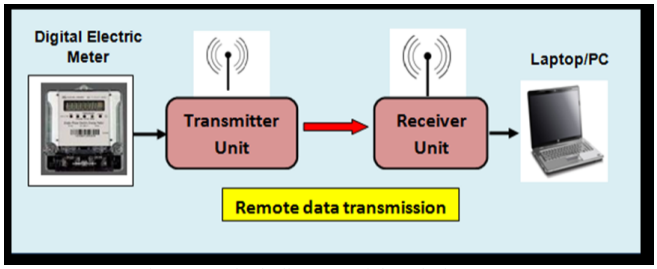

Figure 1: Block diagram of the whole system

The transmitter section consists of transmitter module, microcontroller PIC16F877A, LCD display, Real Time Clock (RTC), digital electricity meter and load. The pulses from meter are given to the microcontroller via optocoupler. The transmitter sends the amount of energy consumed in unit to the receiving end through RF module. LCD display is used to display the unit value, time and date.

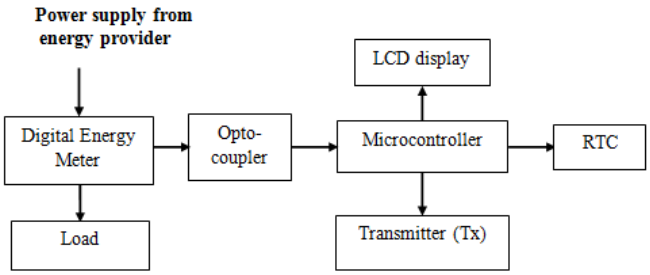

Figure 2: Transmitter block diagram

At the receiver end the data is received by a receiver module and the microcontroller will display the data over the LCD display. The LCD at receiver side also displays time, date and unit value. The PIC transmits these data to laptop/PC by connecting MAX232 as an interface between the controller and laptop/PC

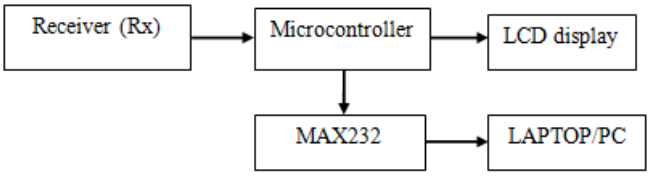

Figure 3: Receiver block diagram

SOFTWARE DESIGN

The programming was developed by using PicBasic PRO compiler. For software design, flow chart is constructed as it will give a better idea about the operation of the project. The main purpose of software design is to build the programming code for PIC16F887A microcontroller at transmitter and receiver units. Apart from that, Visual Basic (VB) is used to design the output interface in order to display the value of unit, time and date. The program flow chart for the transmitter and receiver units are shown in Figure 4,5 and 6 respectively.

A. Transmitter Unit

1) There is four push buttons in transmitter side, which is used for different purpose. When transmitter module detected the push button is pressed:
   a) If hour button is pressed, increase hour value by 1. When hour reached to 24 it is cleared to zero.
   b) Else if minute button is pressed, increase minute by 1. When minute reached to 60 it is cleared to zero.
   c) Else if reset count is pressed, count will reset and store in EEPROM.
   d) Else if reset unit is pressed, unit will reset and store in EEPROM.
2) Interrupt will occur once the system detects meter pulse. If pulse detected, system increase the pulse value by 1 and store it into internal EEPROM. Else if pulse more than 9, system increase unit value by 1 and reset the count value. At the same time, it stores every unit value into internal EEPROM.
3) LCD will display time, date, count and unit values.
4) Send signal to receiver side.

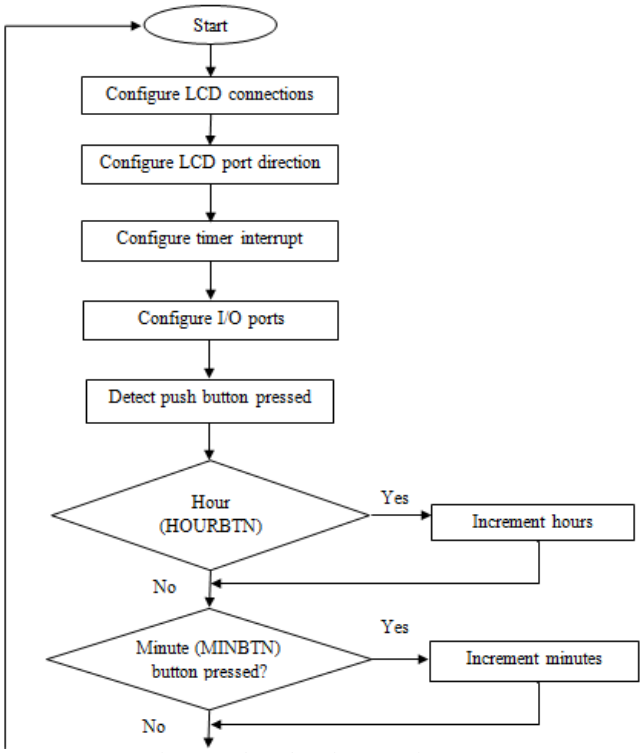

Figure 4: Flow chart for transmitter

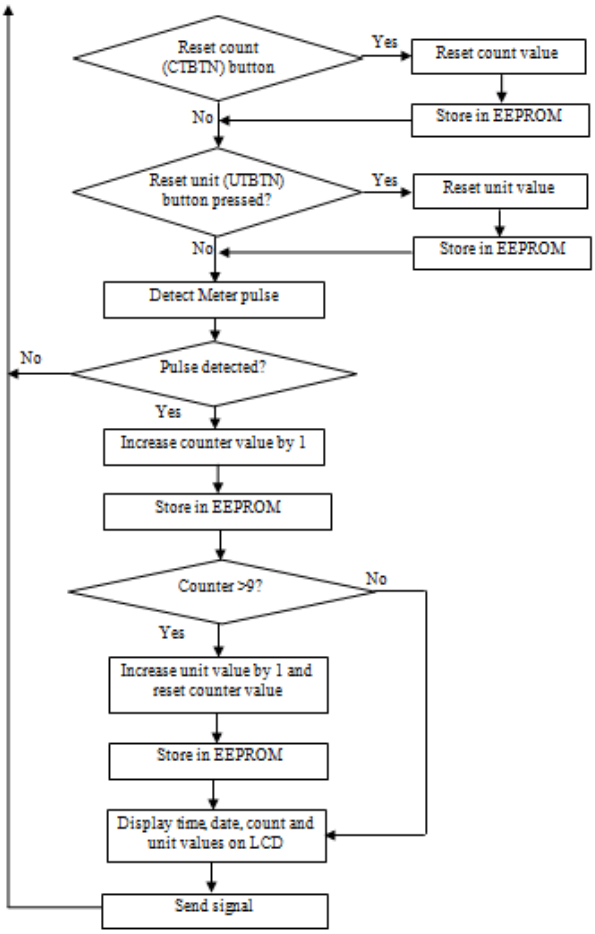

Figure 5: Flow chart for transmitter (continue)

B. Receiver Unit

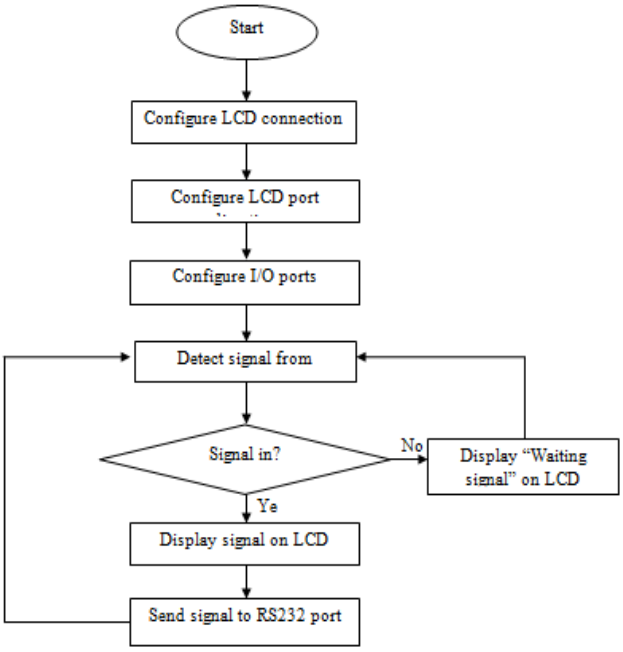

Figure 6: Flow chart for receiver

1) Receiver module detects signal from transmitter. If signal detected, display the signal on LCD. If no signal the display will show "Waiting signal" on LCD.
2) Send the signal to laptop/PC through RS232 protocol.
3) The VB interface will display the time, date and meter reading based on the data received.

C. Working Operation

Most of digital electric meter functions controlled by a specially designed IC called ASIC (Application Specified Integrated Circuit)[3]. The 'Input Voltage' is compared with a programmed 'Reference Voltage' and finally 'Voltage Rate' will be given to the output. This output is then converted to 'Digital Data' by the analog-digital converter (A/D converter) present in the ASIC. The digital data is then converted into an "Average Value". Average value per mean is the measuring unit of power.

The output of ASIC is available as "Pulses" indicated by the LED placed on the front panel of meter. These pulses are equal to Average Kilo Watt Hour (kWh or unit)[8]. Different ASIC with various kWh are used in different meters. For this system, digital electric meter used is from Series DDS228 electronic single-phase two wire watt-hour meter which has characteristic of 1000 pulses/kWh. This meter is chose as many consumers at residential house in Malaysia install this kind of meter.

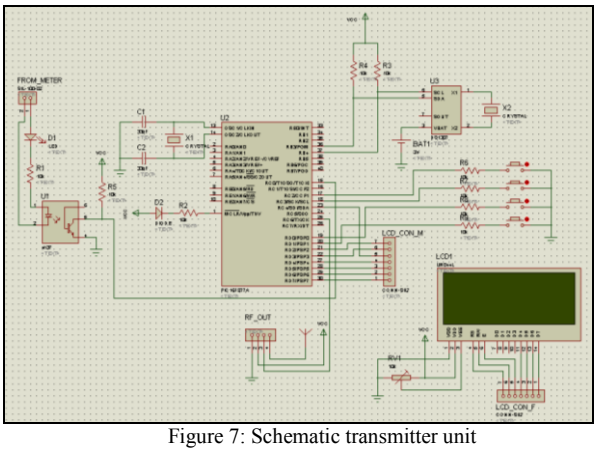

Figure 7: Schematic transmitter unit

This output from energy meter for each unit being consumed is taken by the microcontroller at pin no.15 (Port C 1st pin) through a optocoupler (4N37). Optocoupler provides the electrical isolation between circuits and it allows signal transfer without coupling wires, capacitors or transformers. The optocoupler also consist of an internal LED and a phototransistor. When interrupt comes, triggers the LED of the optocoupler. When the LED glows the light will falls on the base of the phototransistor turning it on. The optocoupler output will be 1 in presence of interrupt again to logic 0 in the absence of an interrupt.

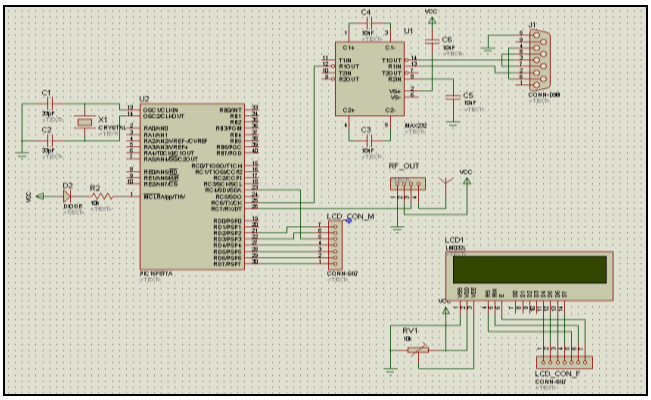

Figure 8: Schematic receiver unit

The cathode of the meter's LED connected to the Pin 1 of the optocoupler (4n37) through resistor and LED and the other end of the meter's LED (anode) connected to the Pin 2 of the Optocoupler. The output of optocoupler is connected to the pin 15 of PIC16F877A microcontroller. Microcontrollers recognize the interrupt and it execute the interrupt service routine. Here the PIC counts the number of interrupts (each interrupt is represented as a count), where in normal case 1000 counts is equal to one unit. For convenience 10 counts has been considered equal to be one unit. When it reached 10 counts, the unit at meter will increment by one.

RESULTS

Figure 9 show the overall hardware for this system. Testing is done to ensure the system operate well and the integration between transmitter and receiver working properly.

The important part of this system which is the transmitter is successfully sends the data to the receiver and from this receiver send to the microcontroller. The microcontroller then converts the data into readable form and displays the data which are the date, time and energy usage to the LCD. The output can be also display using VB interface via computer or laptop for easy measurement energy reading and monitoring by the authority.

Figure 9: Overall hardware setup

Figure 10 shows the measurement for energy usage at certain date and time via VB interface in laptop. The total amount of energy usage can be easily recorded and monitor at the meter reading column. This data can also be converted to notepad or excel application for the TNB to analyze any abnormalities or for monitoring purposes.

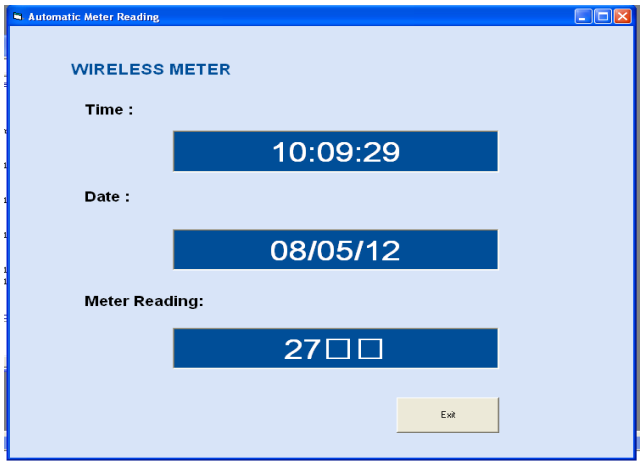

Figure 10: Output of measurement data using VB interface

CONCLUSION

Since the majority of electricity meters in Malaysia are installed inside the customer residential, the approach of conventional data reading is by entering private zones and read the meters. This approach faces problems such as collecting data from door to door and includes inconveniences to the customers. Applying AMR by using RF module can solve the problems and improves electric utility service performance, moreover it increase customers' satisfaction.

To make the receiver module communicates with the transmitter module, RF module is used and this task is successfully achieved. Overall, the system functions as expected even though the RF module having problem in capturing data being send and receive due to the sensitivity of the RF module itself. Further work can be done to replace the RF module with other wireless communication media in order to ensure the sending and receive data is 100% accurate and can be transmitted in longer distance.

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