Full Paper

Development of a remote Accessible Electrical Power Measuring System for Domestic Customer

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Graphical abstract
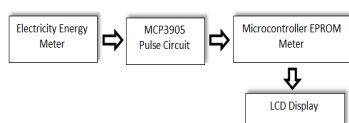
Block diagram of the system

Abstract

Tenaga Nasional Berhad (TNB) is a power utility company in Malaysia that performs three main thrust in the electricity sector. One of which is the distribution sector. The distribution sector involves other activity associated with the customer. Many initiatives have been introduced by TNB to satisfy all its customers. This research introduces a method of reading electric meter without sending meter readers to the premises of the customers. This method was introduced to large power customers (LPC) to ensure total consumption recorded is accurate. Since 2005, remote metering reading project has been using global packet radio service (GPRS) technology as a medium of communication. However, GPRS communication system at that time has not been widely used. Use of electronic meters is introduced to LPC because this meter can provide current information about electricity consumption. A total of 45,000 users of LPC involved in the installation of electronic meters and global system for mobile communication (GSM) modem in which this system can determine the amount of electric current consumption compared to manual meter reading is applied. In this project, the *XBee* radio module is used to send data to a GSM modem. From GSM modem, users can get the total electricity consumption through the SMS (short message service) system in their mobile phones. This project aim is to facilitate the customers so that they do not have to waste time going to the *Kedai Tenaga* (electricity payment counter) to find out the amount of energy consumed during the period. TNB can also collect the metering details without sending personnel to produce monthly bills.

Keywords: Electricity consumption, remote metering reading, electronic meter, XBee radio module, GSM Modem

1.0 INTRODUCTION

An electricity meter or energy meter is a device that measures the amount of electrical energy consumed by a resident, business, or an electrically powered device. Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) and finding the product of these to give instantaneous electrical power (watts) which is then integrated against time to give energy used.

Sometime consumers have problem with energy meter reading because the reading has been taken by authorized meter readers. The bills also given based on the reading that they took and consumers did not know the method and how to read the electricity meter. The problem is the bill also unexpected and sometimes gets high and sometimes low.

Due to the tight daily reading schedule and bad condition of meter, it may give wrong reading because of human error. For old-type and special houses, the meter does not face the road. The meter readers have to take estimation reading for the electricity consumption. Therefore the customer's bill is not an actual consumption. In terms of cost, it has also resulted losses to TNB. This is due to failure of collecting outstanding electricity bills and costs of operation. The operation cost is affected because the TNB staffs need to revisit for doing the task.

The objectives of this project are to develop a remote accessible power measuring system for domestic consumer by using GPRS modem and *XBee* radio module as a communication medium. Secondly, is to design the components for measuring the electrical power consumption for domestic customer (Ordinary Power Customer).

2.0 SYSTEM DESIGN

The technique of data signalling function for a cellular mobile phone has been proposed since1970's [1]. The technique is much improved until this decade by utilizing global system for mobile communication (GSM) [2].

There are two basic elements involved in the construction of this research work, which are to develop of hardware and software part. In hardware construction, energy meter reference design, namely MCP 3905 circuit is built based on the purpose of this project. This project is designed to measure, record and display the electric power consumption. This device measures the power consumption usage by detection the blinking from the energy meter reference. Then record the data of power consumption usage based on hourly basis for seven days continues. Lastly this device displays the power consumption usage every 7 days continuously [3-4].

In software programming, a flow chart is used as a guideline so that the software development is more easily to be understood. The MPLAB XIDE V2.00 Software is used to make program to the microcontroller [5].

The component involved in this project are the GSM module, SIM card, AVR IC Microcontroller, *XBee* radio module as a universal asynchronous receiver transmitter (UART), and energy meter reference design circuit; MCP3905, respectively. In addition, the UART module interface used for troubleshoots the system by monitoring the programming or testing the GSM module whether working properly or not at the Hyperterminal software using personal computer/laptop [6-7]. This service maintenance can be done by the authorized person only. The block diagram of the whole system is shown in Figure 1. Electricity energy meter is connected to MCP3905 circuit which measuring the energy usage indicating by blinking LED. The microcontroller (EPROM) acquires the reading from the energy meter through MCP3905

circuit and displays the reading on the LCD and save the reading/data in memory.

The detail flow chart of operational process of the system is briefly explained in the Figure 2.

To build the programming of the system, the MPLAB IDE V2.00 software was used and implemented on ATtiny2313 IC Microcontroller. This software program was chosen because it is suitable with the project and not too complicated to build the programming compared to other software program. Hence, debugging and compiling the hex file programming is much easier. The picture of complete component of the system is showed in Figure 3.
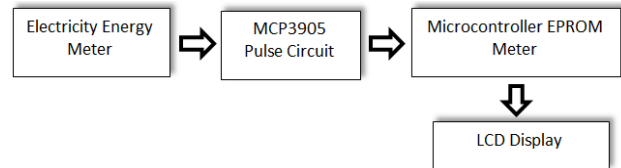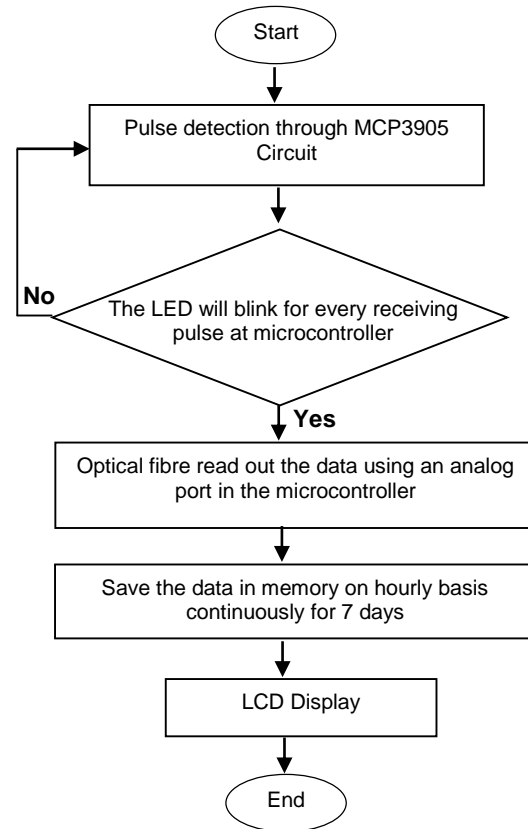

Figure 1 Block diagram of the system

Figure 2 Flow chart of operational process of the system

Note that each electrical energy meter must be calibrated using voltage divider circuit going into channel 1 of the energy meter reference design MCP 3905. A known power is supplied to the meter (e.g. 1000W) and an expected output frequency is the goal (1000imp/kWh). Start with the higher values resistor using its respective shorting jumper. If the output

frequency is too high, remove the shunt. Continue testing each resistor short until all jumpers are tested once.

Figure 3 Actual picture of the completed system

3.0 RESULTS AND DISCUSSION

The load is measured at the energy meter reference design MCP3905 circuit. A known power is supplied to the meter (e.g., 1000W), and an expected output frequency is the goal (1000 imp/kWh). In this work, the LED glows blinking when two bulbs of 18W are ON. The load is measured in watt second (Ws).

In recording operation process, microcontroller (EPROM) has been programmed to record the power usage based on pulse from the energy meter. A microcontroller is a single chip device that contains memory for program information and data. The data of power usage is recorded based on hourly basis for 30 days continuously. All the data measured and recorded is displayed at GSM *XBee* monitoring circuit. The LCD displays the consumption of power usage every 30 days continuously. All the data are sent to the LCD in a real time. Figure 4 shows the example of typical power consumption display of the system.

By utilizing GSM technique, the customers may check the power usage by using their mobile phone. The users only send "METER" through SMS system and the GSM Modem will receive and send to GSM *XBee* monitoring circuit. The GSM *XBee* monitoring circuit will display "MESSAGE RECEIVED". At that time the user will receive from GSM Modem the power consumption via SMS. Figure 5 shows the demo of using GSM in a mobile phone. The electrical consumption reading can also be monitored at personal computer/laptop *XBee* monitoring circuit. The example of electrical consumption reading display at PC/Laptop is shown in Figure 6.

The overall system evaluation of this project from designing, developing and testing, the energy meter reference design circuit running well and successful as expected. The reading operation done by the system is equal as desired but sometimes the reading measure operation or SMS status received by user was delay for a several minutes depending on data traffic density on the network operator.

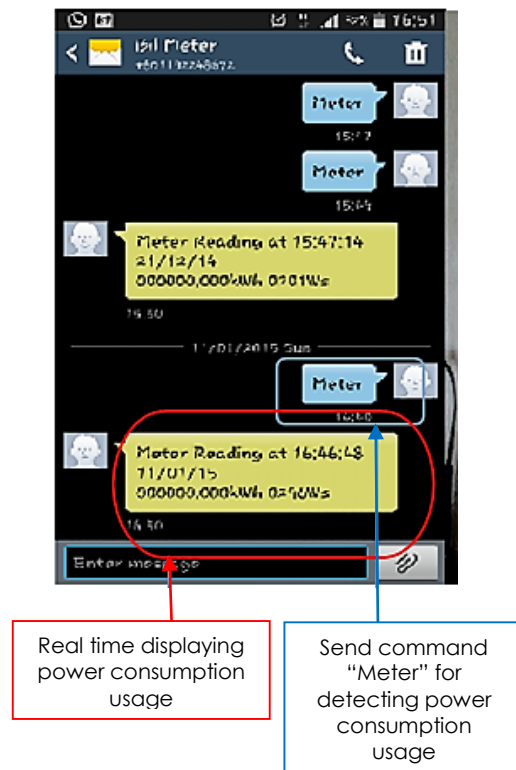**Figure 4** Electrical power consumption display at reference energy meter

Real time displaying power consumption usage

Send command "Meter" for detecting power consumption usage

Figure 5 Electrical power consumption display sent through SMS
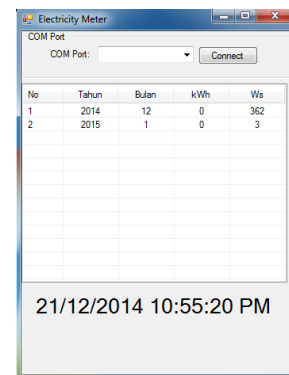

Figure 6 Electrical power consumption display at personal computer/laptop through XBee monitoring circuit

4.0 CONCLUSION

In this research work, the development of remote accessible power measuring system for domestic power has been successfully performed. There are a lot of advantages if this project is applied in domestic system. This is a new approach for TNB to record and measure the power consumption at customer meter. It will improve the method to manage and monitor power consumption.

SMS-based remote control for measured power consumption is beneficial because mobile telecommunication is used to facilitate meter reading. From the outcome of this project, a new method to read power consumption could be implemented and extended at any electrical utility company. The old method like sending meter reader to customer premises can be replaced with this project development.

The income losses involving error reading by meter reader can be avoided. By using this design, the reading of electrical energy consumption can be remotely obtained. Therefore, the job becomes much easier and safe. Productivity can be increased and it will increase the trust of the consumers toward TNB. This is because responsibility of TNB can be done efficiently and in time.

Acknowledgement

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