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Microcontroller Based Single Phase Digital Prepaid Energy Meter for Improved Metering and Billing System

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Abstract

This paper presents a single phase digital prepaid energy meter based on two microcontrollers and a single phase energy meter IC. This digital prepaid energy meter does not have any rotating parts. The energy consumption is calculated using the output pulses of the energy meter chip and the internal counter of microcontroller (ATmega32). A microcontroller (ATtiny13) is used as a smart card and the numbers of units recharged by the consumers are written in it. A relay system has been used which either isolates or establishes the connection between the electrical load and energy meter through the supply mains depending upon the units present in the smart card.Energy consumption (kWh), maximum demand (kW), total unit recharged (kWh) and rest of the units (kWh) are stored in the ATmega32 to ensure the accurate measurement even in the event of an electrical power outage that can be easily read from a 20×4 LCD. As soon as the supply is restored, energy meter restarts with the stored values. A single phase prepaid energy meter prototype has been implemented to provide measurement up to 40A load current and 230V line to neutral voltage.Necessary program for microcontrollers are written in c-language and compiled by Win-AVR libc compiler.

Keywords*: Energy meter IC, Microcontroller, LCD, Relay control unit, Smart card.*

1. Introduction

The present system of energy metering as well as billing in Bangladesh which uses electromechanical and somewhere digital energy meter is error prone and it consumes more time and labor. The conventional electromechanical meters are being replaced by new electronic meters to improve accuracy in meter reading. Still, the Indian power sector faces a serious problem of revenue collection for the actual electric energy supplied owing to energy thefts and network losses. One of the prime reasons is the traditional billing system which is inaccurate many times, slow, costly, and lack in flexibility as well as reliability [1].

Meters, in the past and today in a few countries, were electromechanical devices with poor accuracy and lack of configurability. Theft detection was also a challenge.Recent developments in this direction seem to provide opportunities in implementing energy efficient metering technologies that are more precise, accurate, error free, etc. [2].

A Prepaid Energy Meter enables power utilities to collect electricity bills from the consumers prior to its consumption. The prepaid meter is not only limited to Automated Meter Reading but is also attributed with prepaid recharging ability and information exchange with the utilities pertaining to customer's consumption details. The use of electronic token prepayment metering has been widely used in UK for customers with poor record of payment [3]. A paper suggests a design of a system which can be used for data transmission between the personal computer and smart card [4]. Another paper suggests making use of state of art technologies like WiMAX in Prepaid Energy Meter owing to the idea of centralized accounting, monitoring and charging [5]. Polyphase prepaid energy metering systems have also been proposed and developed based on local prepayment and a card reader [6]. Wireless prepaid energy metering sytem has been proposed which incorporate RF based system [7]. Digital energy metering system as an alternative for the clectromechanical system has been proposed and developed with the Peripheral Interface Controller (PIC) and necessary software [8]. Due to the low cost of microcontrollers, Prepaid Energy Meter has been developed using a microcontroller from the Microchip Technology Inc. PIC family [9].

In this paper, we have proposed a microcontroller based single phase digital Prepaid Energy Meter using two microcontrollers from the Atmel AVR family because of its performance, power efficiency and design flexibility and an Energy Meter IC. In this paper a credit card is used which is capable of communicating with both the distributor unit from where the credit card have to be recharged and the energy meter to which the number of recharged units to be laoded. An electronic circuit called USB burner circuit is used to load the recharged units both in energy meter and smart card. Softwares have been developed in c- language and compiled by Win-AVR libc compiler. The proposed enrgy meter has been implemented in the laboratory and finally results obtained have been presented and compared with electromechanical energy meter.

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