

# Smart Home Appliances Based on Demand Responses with Load Fault Identification

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**Abstract**— HEMS utilize renewable energy effectively by visualizing load equipment information in the home such as water heater, storage battery, electrical vehicle (EV), and controlling it properly. In this paper a new approach of identifying the load fault with facilitation of house hold appliances connected to current transformer and scheduling of smart home appliances under hourly pricing and peak power limiting based on demand response (DR). This paper also presents automatic billing section. The simulation results are obtained from the data gathered from real appliances using software MATLAB simulink.

**Keywords**— HEMS, Smart Home, Demand Response (DR)

## I. INTRODUCTION

An electric power system is a network of electrical components used to supply transfer and use electric power. This system which is known as GRID and can be broadly divided into the GENERATORS that supply the power, TRANSMISSION SYSTEM that carries the power from the GENERATING CENTER to the LOAD CENTER and the DISTRIBUTION SYSTEM that feeds the power to homes and industries [1]. PIC microcontroller (16f877a), act as a major function in power system field. The microcontroller is used in this project is PIC series [2].

HEMS STRUCTURE is developed in order to identify the load fault and scheduling of smart home appliances by reducing total power consumption and also determining the automatic billing section [3]. PIC microcontroller is a first RISC (reduced instruction set computer) is a microprocessor that is designed to perform a small number of types of computer instruction so that it can operate at a higher speed, based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip with a small pin count [4].

The CMOS has immunity to noise than other fabrication techniques. GSM is connected with microcontroller. It is used for automatic billing section. Automatic billing section has been designed with help of hardware devices [5]. It uses current transformer, potential transformer, PIC, relay driver, LDR, LCD.3or t

Home energy management (HEMS) plays a vital role for the efficient and effective operation of such end user points coordinated by load serving entities (LSEs) under demand response.

## II. HEMS STRUCTURE

HEMS (Home Energy Management system) plays a vital role for the efficient and effective operation under demand

response. HEMS receives relevant input information (such as day-ahead, hour-ahead, peak power limits. In this HEMS structure we are connecting thermostatically load and non-thermostatically load in order to reduce total power consumption.

In this HEMS structure we are using lamp and tailoring motor as a load. The lamp load is merely the total amount of power used by all the lamps plugged into a given outlet or power source. The load should be less than or equal to the rating of the supply. It acts as a load because it consumes energy causing a potential difference (voltage) between its terminals and has a given internal resistance determining the current through it.

Tailoring motor acts as a load it has a constant speed. These motor that are designed to operate at difference but fixed speed and it do not require a very high starting torque.

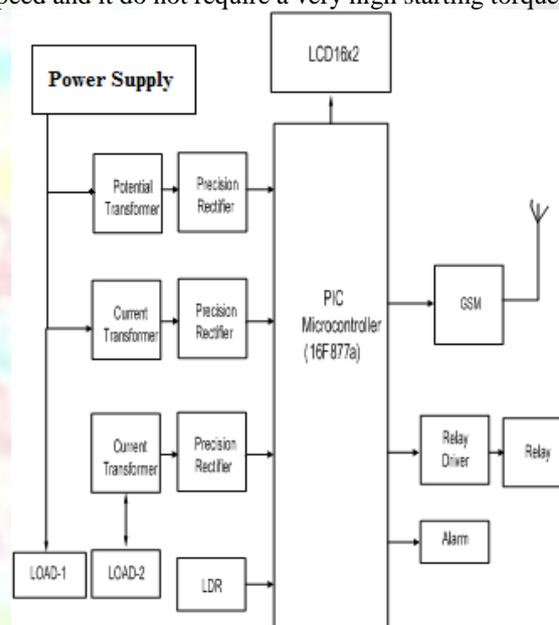


Fig. 1: Hardware Description.

Current transformer is commonly used in metering and protective relay in the electrical power industry. In this HEMS structure current transformer is used to measure current from the load up to 5V.

Potential transformers are used to step down or step up the AC voltage level. Here we use the potential transformer to measure the voltage level of the AC line this potential and current transformers are working with the concept of mutual inductance.

The microcontroller that has been used for this project is from PIC series. PIC micro controller is the RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of

program and data memory. The CMOS has immunity to noise than other fabrication technique. Flash is the most recently developed technology that used in PIC 16f877a.

PIC devices are popular with both the industrial developers and hobbyists due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, serial development tools and programmable flash –memory capability. All RAM locations function as register as both source and destination

A relay is a switch worked by an electromagnet. It is useful if we want a small current in one circuit to control another circuit containing a device such as a lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously.

When the controlling current flows through the coil, the soft iron core is magnetized and attracts the L-shaped soft iron armature. This rocks on its pivot and opens, closes or changes over, the electrical contacts in the circuit being controlled it closes the contacts. The current needed to operate a relay is called the pull-in current and the dropout current in the coil when the relay just stops working. If the coil resistance  $R$  of a relay is  $185 \Omega$  and its operating voltage  $V$  is  $12V$ , the pull-in current  $I$  is given by:

$$I = V/R$$

$$I = 12/185$$

$$I = 0.065 \text{ amps}$$

Relay driver circuit is used for on / off control of relay, it acts as a switch, normally open relay is used. Relay function is derived by controller unit. Relay working current is  $40 \text{ mA}$ .

#### A. Billing Segment

Automatic billing section can be done by using GSM. GSM is used to send the message the Owner and EB office regarding the billing information. If they didn't pay at the correct time. EB office sending message to cut the supply. GSM (Global System for Mobile communications: originally from Group Special Mobile) is the most popular standard for mobile phones in the world GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—macro, micro, Pico, feta and umbrella cells. GSM networks operate in a number of different frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G). Most 2G GSM networks operate in the  $900 \text{ MHz}$  or  $1800 \text{ MHz}$  bands. Some countries in the Americas (including Canada and the United States) use the  $850 \text{ MHz}$  and  $1900 \text{ MHz}$  bands.

### III. HARDWARE RESULTS

A single phase ac supply is given as an input supply. Voltage is measured with the help of potential transformer. It will convert main supply voltage to low voltage DC. This DC voltage will be rectified with the help of precision rectifier. This rectified output will be given to the microcontroller.

Current will be measured by current transformer. The shunt resistor will convert current into voltage. This DC voltage will be rectified with the help of precision rectifier.

This rectified output will be given to microcontroller through AD converter. This AD converter converts the input analog signal to corresponding digital signal which is given to microcontroller. The microcontroller is flash type programmable.

LDR is used sense the day and night to use under hourly and peak power limiting.

GSM will send the message the owner and eb office regarding the billing information.

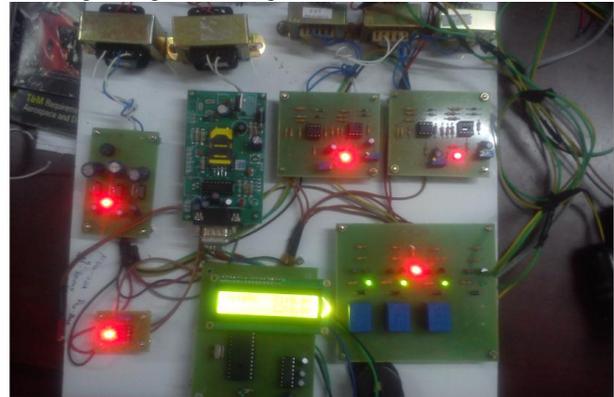


Fig. 2: Hardware module

Potential transformer =single phase AC supply 226v

Load current 1 (c1) =0.28A

Load current 2 (c2) =0.17A

Energy consumed =9KW/HR

Amount=56 rs

### IV. CONCLUSIONS

HEMS structure has been described where thermostatically and non-thermostatically controllable loads were explicitly modelled using MILP (mixed integer linear programming). Automatic billing section was done by using GSM. Based on simulations conducted, the occurrence and effect of fault in the load can be identified.

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