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Simulation and Performance Analysis of Smart Meter

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ABSTRACT

Smart grid is an application of digital information technology to optimize electrical power generation, delivery and usage. Renewable generation, energy storage , demand response and electric vehicles introduce further complexity to system operation. Smart meter is an advanced energy meter that measures the energy consumption of a consumer and provides added information to the utility by using a two-way communication scheme. The objective of this paper is to extract useful information from smart meter data. This paper focuses on the measurement of energy consumption and for billing purpose. In this system, the energy measured in units and the software solution is provided to generate bill for energy consumption using Lab VIEW.

I. INTRODUCTION

A smart grid is an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.

Development of real time monitoring system under Smart Grid Environment, it presents a low cost, low power consuming system that can be used for quick and accurate power system parameter monitoring under smart grid environment. Real time monitoring of the power system is an important aspect of smart grid system. It involves measuring the voltage and current waveforms in real time and the detection of the power system disturbances occur during operation condition[1].In Performance Analysis of Smart Metering for Smart Grid to establish the better communication technologies & operate more efficiently. Artificial intelligent meter (AIM) based AMI network & energy management scheme. Real time data support and network communication/control functionalities for supervisory control and data acquisition [2][9]. In Design of a smart meter for the Indian energy scenario an advance features like two-way communication time of day tariff will be solved by smart meter techniques. Remote ON/OFF the supply and automatic cut off on theft detection and crossing the peak time energy consumption can be addressed. Using Zigbee with Wi-Fi, or wimax (or) mobile technology (GSM) to solved problem and server computer with graphical user interface front end designed using Lab view, receives this data and store database according to the meter ID. A detailed studied for statistical evaluation for Indian Energy Scenario would helpful for tariff system. [3]. A review of wireless Communications technology for Smart Grid to be implements in systemic way. It provides a dedicated utility communication in cellular network can ensure high quality for low cost maintenance, reliability with reduced operational cost and strong security [4]. In consumer energy measurement system integrate with smart meters to energy measurement to consumers in a smart grid. Smart meters are providing real consumption values as well as perform in-home energy management data to consumers. The distribution transformer allows load monitoring and power analysis in smart grid technology[5][11]. In Smart meter data analysis. An abnormal change in electricity consumption can alert consumers to take necessary action. Home energy management daily energy consumption pattern can be an important variable to monitoring and triggering customer action. Study carried out for smart energy meter measurement the methodology

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can be extended to other measurements such as SCADA and PMU measurement[6]. In Smart home communication technologies and applications. The home area network(HAN) communication technologies for smart home and domestic application integration. Home communication interface is analysed utilising as a key piece a gateway on machine to machine (M2M) communications that interacts with the surroundings environment. Fast progress and miniaturization observed in semiconductor technology resulting in a proliferation computing and electronic devices[7].

Grid computing technology enhances electrical power systems to implement the real time load balancing operates. The model infrastructure is combining power system via application interface with grid resources connected in a GC system which share processing power and data storage[8]

II. SMART GRID ARCHITECTURE

Information and communication technology of smart grid incorporates the future of electricity generation, distribution and consumption to minimize environment impact. This architecture is used for describing, discussing, analyzing and developing smart grid architecture and standards.

The consumer domain is used to generate, store and use the electricity. The operators and participants in the electricity are referred to the market domain. Bulk generation generate and store the electricity. Transmission transmits the electricity to distribution system and distribution distributes the electricity to the consumer.

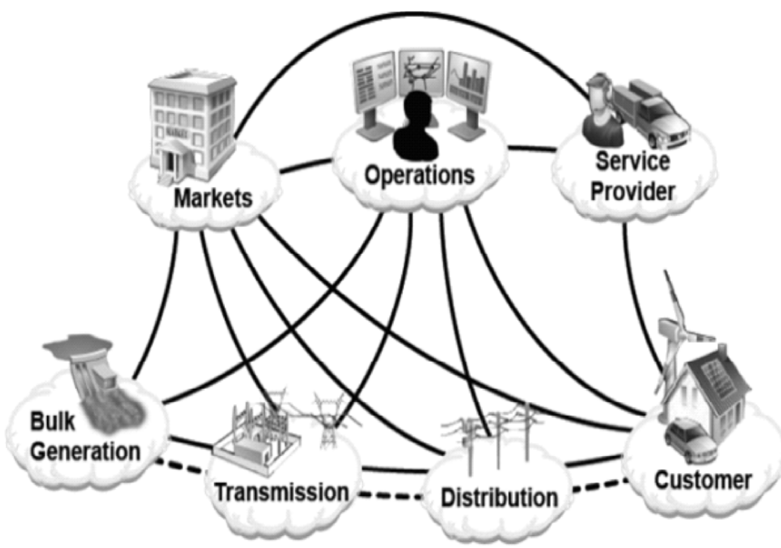

Figure 1: Architecture of smart grid

III. ENERGY MANAGEMENT SOFTWARE

The electricity bill will reduce immediately by giving proper direction. Power provisioning and green engineering are improved.Continuous monitoring of power quality.Speed and efficiency are increased.Specific building beforehand possibilities are saved and planning energy consumption

In this paper Energy meter will be simulated by using LABVIEW and power and energy waveform will be produced. Here Active power and reactive power are calculated by using the formula,

$$\text{Active power KW} = VI \cos\Phi \quad (1)$$

$$\text{Reactive power KVAR} = VI \sin\Phi \quad (2)$$

IV. PROPOSED SYSTEM

Block diagram representation for smart energy meter is shown in fig. 2. It consists of electric devices, interfacing bus, second and hour calculation logic block, total power consumption, total electric bill calculation, price unit and debit card system.

According to the electricity load turn on in the lab view software in switch. Available price will be decided according to user requirement like money top up. Price/unit will be increased or decreased according to general hours, peak hours and demand requirement given by electricity board. Hours and second can be formulated in a logic block, each electrical load power can be increased or decreased depends upon electrical consumption attached in table. According to electrical input load can be increased or decreased then the power consumption will be increased or decreased then the total units will be increased or decreased. Total cost block in lab view software can be varied according to the load variations When smart meter electrical bill will be reduce according to actual price. When load increase according to the power consumption increase the electricity bill will be increase. According to the electricity bill total amount will be reduce like prepaid system.

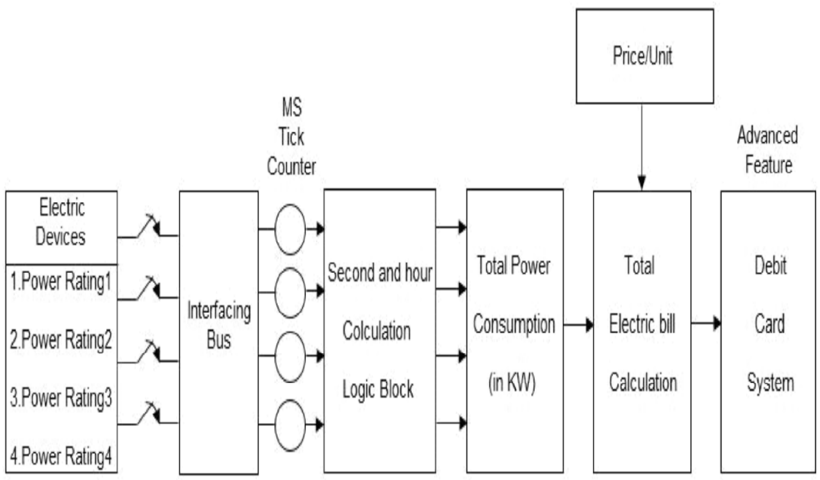

Figure 2: Smart Energy Meter

Rating of power consumption for house hold appliances is shown in fig 3, Electrical energy consuming for unlimited household components. Large amount of energy is saved by efficient utilization of devices.

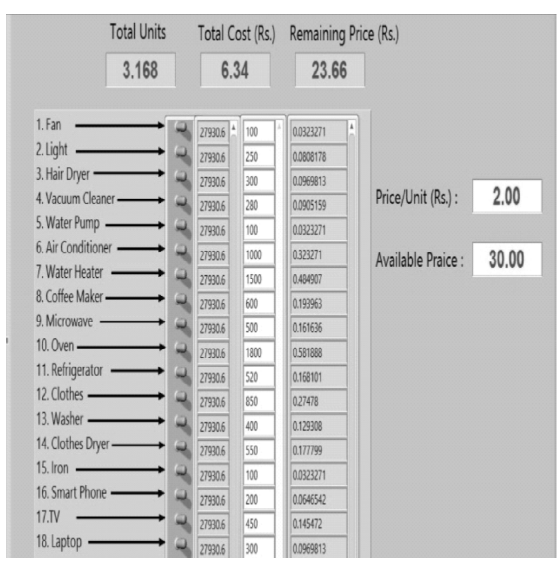

Figure 3: Rating of Power consumption for house hold appliances

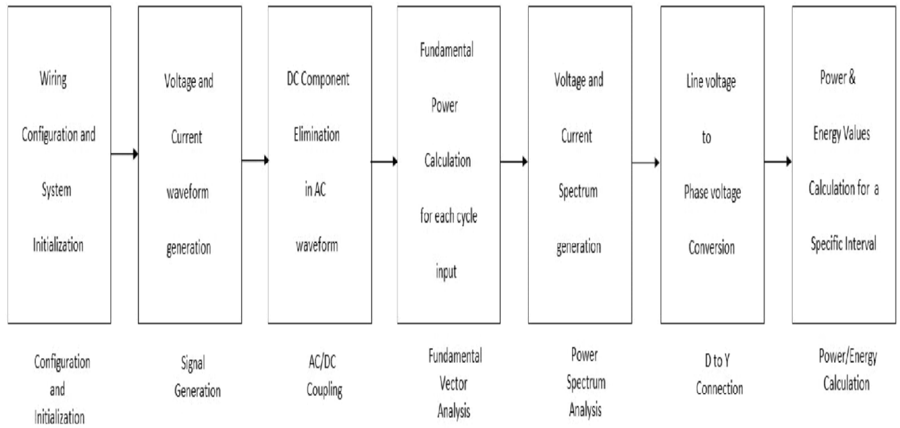

Figure 4: System Block diagram

Here Actual price will be always more than 21. Price/unit will be more than 2. Switch on individual load like fan, light. Power watts value will be give minimum 100, 1000, 150, 2000 type. Switch on the load. Run the program. According to load price will be reduce, power and power/unit will be shown.

The Block diagram consists of configuration and initialization, signal generation, AC/DC coupling, fundamental vector analysis, power spectrum analysis, D to Y connection and power/energy calculation. System can be initialized and configure according to power requirement (either single phase or three phase system).Signal can be generate in a form of voltage and current in sine waveform. In sine waveform DC compound will be elimination in AC waveform. Fundamental power calculation can be done for each input cycle as per formula. Voltage and current spectrum analysis can be done by formulated block as per formula developed. Line to phase voltage conversion factor is done according to formula (Delta to star formula was developed in the block).Power and energy calculation has done for specific interval as per load.

V. SIMULATION RESULT

In this section simulation results are shown for current and voltage waveforms. In this First block is initialize system VI; it specifies the basic configuration of the load.

The structure used for this block is conditional disable structure. The use of this structure is to disable specific sections of code on block diagram based on some user-defined condition The second block returns

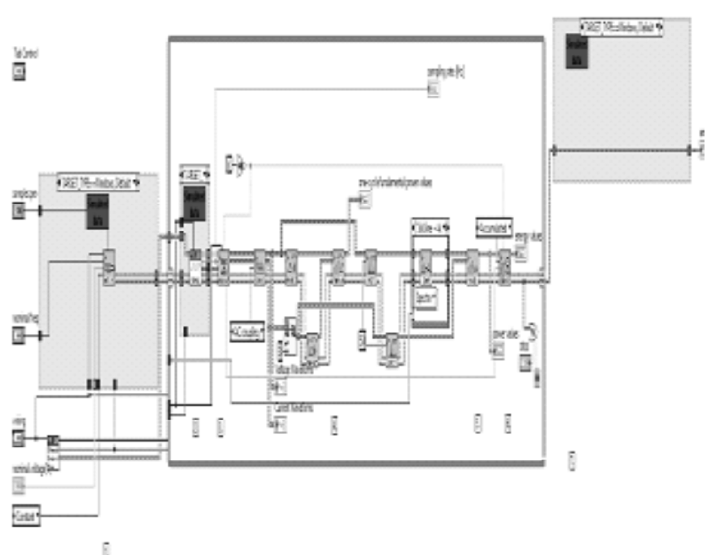

Figure 5: **Labview Simulation**

simulated waveforms for windows system and reads data from the FIFO for real time systems. The while loop structure is used for convert data to waveform VI, AC DC coupling VI, Fundamental vector VI, Array subset function, Fundamental power values VI, Spectrum VI, D to Y conversion VI, Power values VI, Energy values VI and OR function. While loop repeats the code within its sub diagram until a specific condition occurs. A while loop always executes at least one time. The third block is convert data to waveforms VI, converts resample voltage and current waveforms. This VI also arranges the order of the elements in the waveforms for further measurements. Next is Ac Dc coupling VI, it eliminates the Dc component of a voltage and current waveforms. In this block voltage and current waveform specifies voltage and current waveforms. Each array elements represent in one phase. Here t0 – specifies the start time of waveform, dt - specifies the time interval in seconds between data points in the waveforms and y – specifies the data values of waveform. Voltage and current waveforms out specifies voltage and current waveforms after coupling. Here t0 – returns the start time of waveform, dt – returns the time interval in seconds between data points in waveform and y – returns data values of waveform. Fundamental vector VI block calculates vector for each cycle contained in input waveforms. Array subset function block returns a portion of array starting at index and containing length elements. The fourth block is fundamental power values (1 cycle) VI, it calculates fundamental power values from voltage and current spectra for a single cycle block. This VI returns fundamental apparent, active and reactive power values. Spectrum VI block computes the FFT spectra of input waveforms This VI returns FFT spectra as complex spectra of voltage and or current upto a specified maximum harmonic order with a frequency resolution around 5 HZ, which is the fundamental frequency divided by 10 or 12. D to Y conversion VI block converts line to phase voltage, this VI calculates an approximate value for the phase voltage in an unbalanced system. Fifth block is power values VI, it calculates power values from voltage and current spectra. This VI returns apparent power, active power, reactive power and power factor. The sixth block is energy values VI; it calculates energy values for a specified length. This VI returns apparent, active and reactive energy values. The seventh block stops the simulated generate signal.

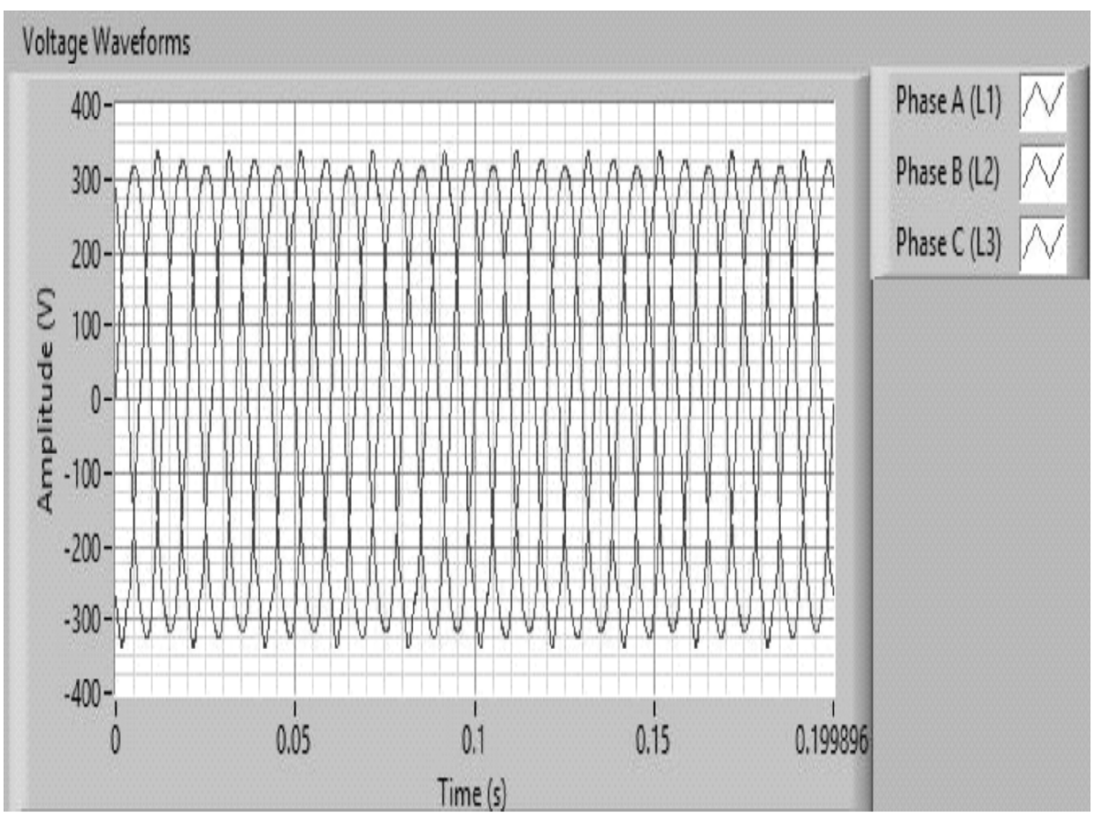

Figure 6: **Voltage Waveform**

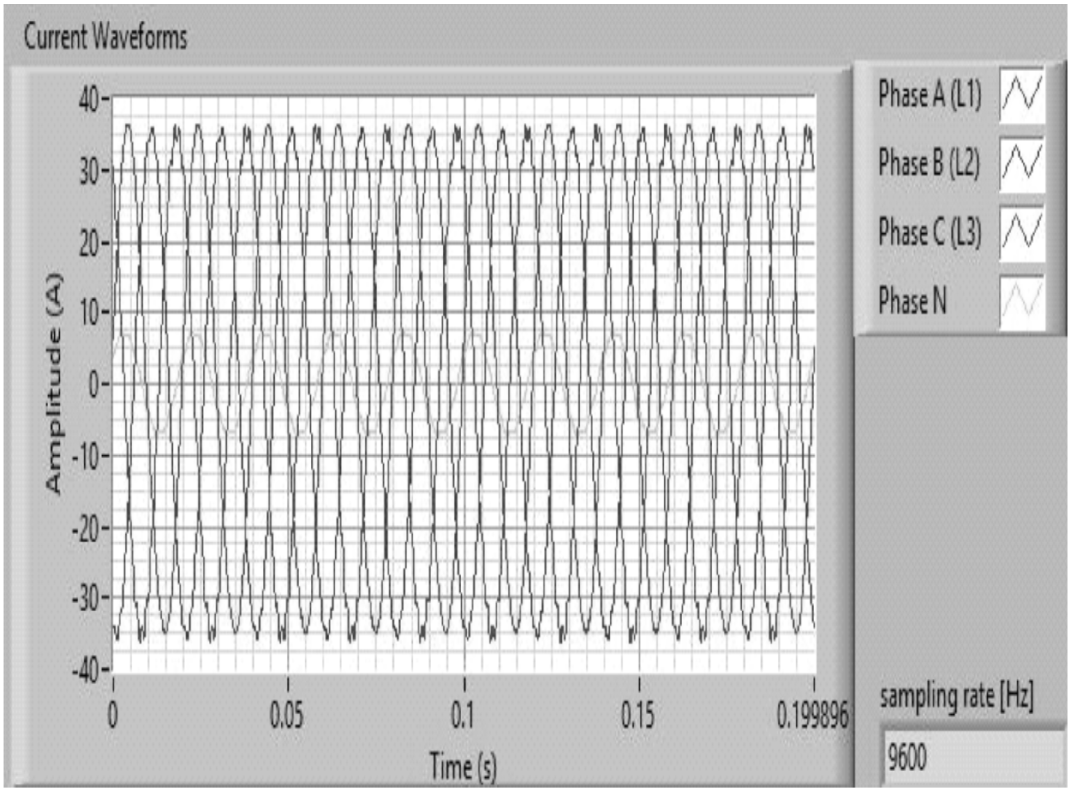

Figure 7: Current Waveform

Figure 6 and Figure 7 Shows voltage and current waveform for energy and power measurement. Three phase voltage channels and four current channels (3xUph+4xI) are used for wiring. The nominal frequency used here is 50HZ. Nominal voltage used here is 230. The samples per cycle range used here is 192.

Variable measurement is shown in Fig. 8. It shows time stamping, one cycle fundamental Energy values and power values.

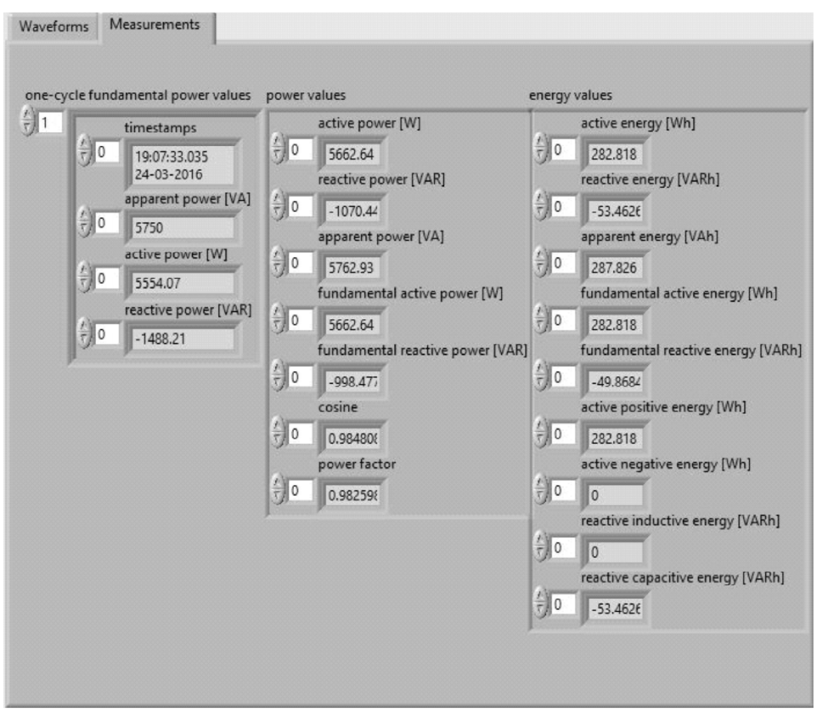

Figure 8: **Variable Measurement**

VI. CONCLUSION

Increasing the efficiency of energy consumption and billing information by using Lab view software. The Voltage and current waveforms are simulated using Lab view and the measurements for power Values and Energy values are displayed . In the future work real time smart grid and flexible substation AMR system with embedded real time controller will be developed which provides good solution for processing data and handling multiple tasks.

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