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An Integrated Energy Measurement Technique for Smart Grid

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***Abstract*--- Smart grid is the integration of advanced information, communication and networking technologies in traditional electric grid to make it smarter and faster in making decisions. With the increase in population, there is increase in the demand for electricity. Nowadays we are generating our own power for home and industries. We can reduce demand by selling power to grid after our own usage. Cost can vary in proportion to the demand. In this paper, we explain to implement a smart meter to display power both EB & generated Solar power, and provide for the actual power consumption. By monitoring both EB cost and renewable energy cost is up a single energy meter both selling and consuming power from grid to home and vice-versa can be known using GSM methods through if it possible to intimate the consuming and selling power from grid to consumers through Messages and also to Electricity Board for government data. The monthly EB cost should be intimated through messages by calculating both real time and critical time cost and also selling power to grid and reduced to determine the actual power consumed. We propose to implement a smart meter to display power both EB & generated Solar power, and provide for the actual power consumption.**

***Keywords*---Micro Grid; DC-DC Converter; Full wave Inverter; Embedded System**

I. INTRODUCTION

Normally grids were designed for one-way flow of electricity, but if a local sub-network generates more power than it is consuming, the reverse flow can raise safety and reliability issues. The customer participation is increased by providing price for selling power to grid. Smart grid often replaces analogue meters with digital meters that record energy usage in real time. The digital meter normally read the watts usage from grid power. In this project, which designed meter can read both grid power and power feed from micro-grid at home. By using message service both usage and selling power can be intimated to the customer. Several works [1], [2], [3], [5] are done to increase the efficiency of micro grid. This paper focuses on hardware implementation of integrated energy measurement of smart grid.In the proposed design shown which in separate meter are merged as single integrated meter. Thus the power which export and import can be monitor in same single meter. The existing system is of high cost with less advantage.

In this report, we present the design and construction of the Energy Meter and describe few possible commercial applications of this meter. We studied existing methods of retrieving the data from the digital energy meter. They are Automatic Meter Reading [1]

Meanwhile, ARM is another method where an Energy Reader which each and every individual Energy Meter automatically regularly in order to get the meter reading of the corresponding households.

AMR is a mechanism whereby the Energy Meter sends the recorded power consumption of a household in the certain interval of time through wireless connected, which could be a personal computer (PC). In the case of AMR a person have to go each and every individual meter to take readings, so it only human man made mistakes but not human effort. On other hand APM send data to Bluetooth receiver mounted on nearer high voltage pole, and from there information send server of power supply company. In first system human have to go each and every individual household to take reading which is costly and time consuming. And APM have to create it‟s own network, which is costly to build and difficult to maintain.

Our proposed system overcomes both drawbacks. It doesn't need meter reader to go each and every meter to take readings, so it reduces cost. The meter sends information by SMS through GSM network. It depends on others network. So in this system power supply companies don't have to establish and maintain any network.

This metering system can only use in GSM network which send data from remote areas.

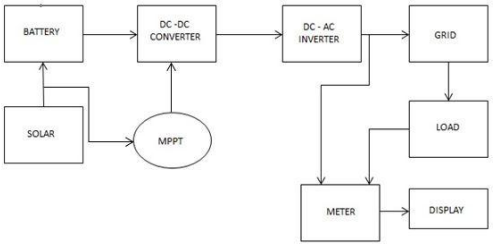
II. DESCRIPTION OF PROPOSED INTEGRATED ENERGY METER

The system we are implemented is simple and effective. Here a microcontroller will calculate load usage from main grid to home and also calculate selling power to

grid from micro grid. Then it displays the information in a LCD display that connected with microcontroller. Functional block diagram of proposed Integrate energy meter is shown in Figure 1. A GSM module is connected with the microcontroller through that information send to both customers and power distribution companies. A GSM network is chosen because suppose fault occurs in micro grid can be intimate through SMS to customer to recover hardware easily. The units used for home and selling power to grid are measured continuously in time interval and intimate to customer by SMS. By this we can know the usage of power to home and also selling power to electrical company frequently.

Technical specification of digital energy meter is given in Table.1. Presently use to make hardware.

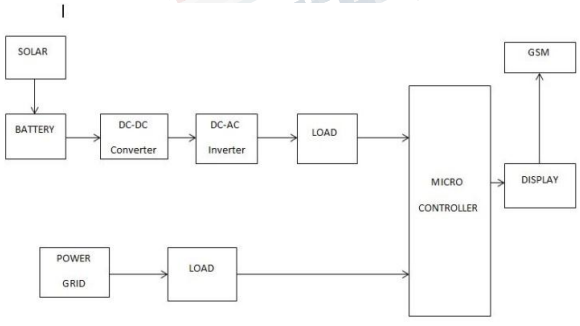
Fig 1: Proposed System of Integrated Energy Mete



III. DESIGN OF INTEGRATED ENERGY METER

In the proposed design shown which in separate meter are merged as single integrated meter. Thus the power which export and import can be monitor in same single meter. By this meter reading taken periodically and selling power price can get instantly.

Fig 2: Functional Block diagram of Integrated Energy Meter



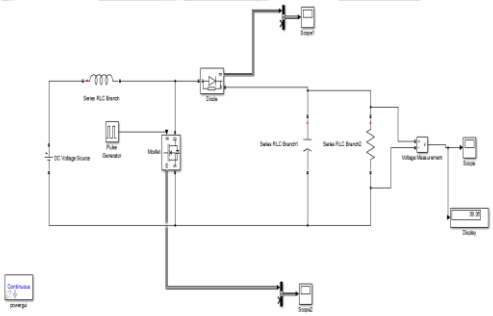
This part of the paper discusses the code written for PIC16F1877A using C language. The Components used in the project are listed in tabulation which used to build micro grid. The micro grid is main part in this paper used to sell the producing power using renewable resources. The power from the renewable energy should tie up with grid power. So the impedance should match correctly and harmonic distortion of the inverter should be less. By below methods, micro grid designed part by part to ensure that output toke using MATLAB SIMULINK. The output for DC-DC Converter should be determined as 230 V.

Table I: Technical Specification Of Integrated Digital Energy Meter

Sl No	Parameter	Specification
1	Battery	12v
2	Inverter	230V
3	Micro Controller	
4	GSM module	SIM900
5	Display	16x2 LCD display

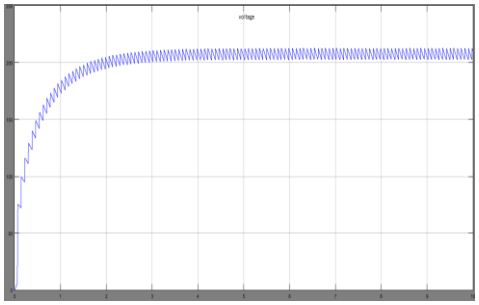
A. DC – DC Converter

Fig 3: MATLAB SIMULINK Diagram of DC-DC Converter



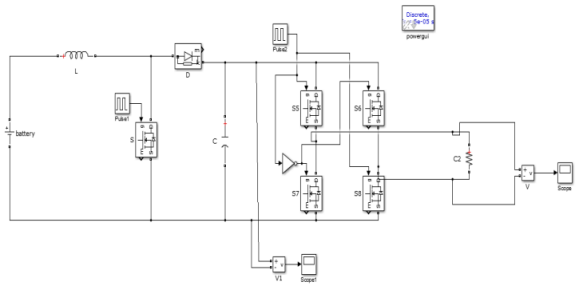
The components used in the DC-DC Converter circuit are designed using mathematical modeling of DC-DC Converter using reference. [1]. The output of DC-DC Converter between Voltage and Current using MATLAB SIMULINK.

Fig 4: Output of DC-DC Converter



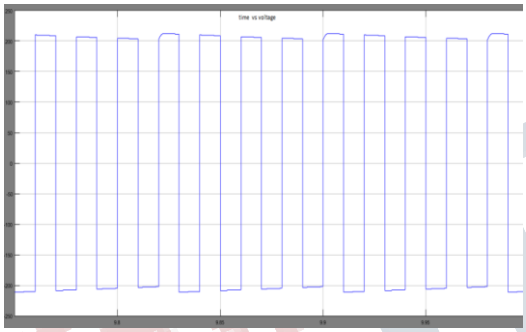
B. DC –AC Inverter

Fig 5: MATLAB SIMULINK of DC-AC Inverter



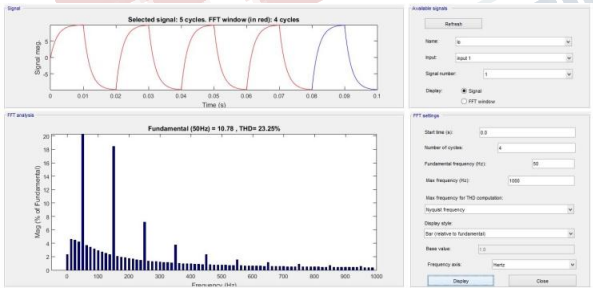
The components used in the DC-AC Inverter circuit are designed using mathematical modelling of DC-AC Inverter using reference. [1]. The output of DC-AC Inverter between Voltage and Current using MATLAB SIMULINK.

Fig 6: Output of time and voltage



The harmonic distortion for Inverter calculated using MATLAB tool by square wave. Using Filter circuit in the end of the output can reduce the harmonics distortion which designed using reference [3].

Fig 7: Total Harmonics Distortion of Inverter



IV. HARDWARE DESIGN AND IMPLEMENTATION

A. BATTERY

For hardware requires external 12V Supply as input. So battery 12V/1.3Ah to giving input power supply to the Converter circuit.

B. DC-DC Converter

In DC-DC Converter circuit the step up transformer is used with 120µf capacitor to increase the voltage. MOSFET acts as switch can be charging the capacitor by closing switch and dis charge by open the switch frequently. MOSFET time interval can be drive using SG 3525 Voltage mode PWM IC.The maximum power point tracking is essentially a load matching problem. A DC to DC converter is required for changing the input resistance of the panel to match the load resistance by varying the duty cycle.

As shown in the Output window (figure 4)the voltage increased from 12V to 230V continuously using the circuit derived by the model. The derived model used to inverter from DC-AC Inverter.

C. DC-AC Inverter

The proposed Inverter circuit modelled by mathematical calculations using reference papers and improved the output. In this circuit, the input which given from the DC-DC Converter can be inverter into square wave as per the time interval which we required. In Inverter circuit consist of 4 MOSFET'S which are used to converter in to sine wave. Two number of IR2110 RECTIFIER IC's are used to drive MOSFET parallel in circuit. Using PIC 16F877A IC are used in inverter circuit.

Fig 8:Hardware Model of Micro Grid

By this output shown the hardware model of micro grid which connected to grid for selling power.The simplest type however, in situations where sensitive appliances like the computers are used these inverters are not desirable because of their other disadvantages such as low efficiency The design advantage is to low cost to implement high selling power to grid.

For this project the output connected to main grid is not possible. Because the main grid connected project should get permission from electricity board, other than its offence. So we connected load to be imagine as main grid. For load we used 40W bulb to calculate the power.

D. Integrated Energy meter

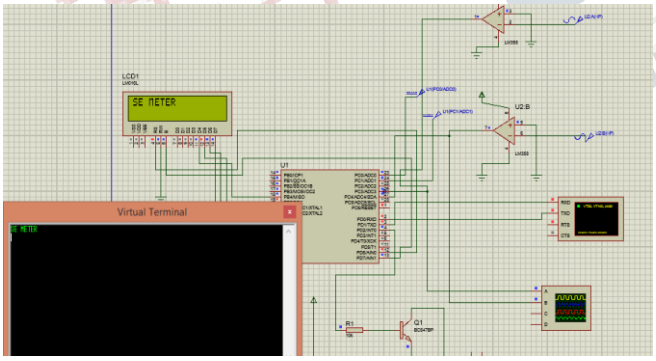
In this paper, the main concept is too measure both micro grid and main grid using load and intimate to customer side as well as electric company. The meter also programmed to display the temperature of solar panel, date

and time, voltage drop in main grid supply and two readings in units (KWH). The temperature dropped to certain value means SMS send to customer side to replace the fault. The power from the inverter supply cut off or battery drained means message intimate to customer side. The selling power to grid and receiving power for home from grid also intimate in units to customer through message by certain days. Thus the integrated measurement are calculated and displayed in screen for several times. The integrated energy meter hardware are shown below as Figure 9.

Fig 9: Hardware implementation of integrated energy meter

Figure 10 shows the code was simulated in Proteus ISIS professional before implementing in the hardware and in functioned accordingly once programmed into the PIC.

Fig 10: Simulation of integrated energy meter in Proteus ISIS Professional



GSM module is used to send SMS because it can easily connected to microcontroller using serial connection and response on AT commands.

V. CONCLUSION

We have designed and demonstrated an Integrated Energy Meter system to read the energy of both micro grid to main grid and main grid to load in home. It is proposed and implemented in the targeted applications of Automatic Meter Reading. The design is based on PIC16F877A microcontroller energy meter to build an inexpensive.

We have successfully implemented the Integrated Energy Meter for several advantage of reading the electricity consumption through GSM technology. It will help to save cost and time as compared to the existing method. The selling power to grid in farming land by installing solar and wind are available nowadays. But periodically reading noted for selling power is great dis advantages to customers. By this integrated meter reading taken periodically and cost of selling power can be reduced in actually bill and more than cost means grid company provides unit cost as per the norm to the customers. By this proposal the customer participation will be increase and reduce tension in power grid.

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