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Modeling of Three Phase Energy Meter Using Matlab/Simulink

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A B S T R A C T

Energy demand is expanding due to increase in population and development of several industries. In the present scenario the target of Electricity Board is to meet out the Energy demand in consumer end. Hence the most important solution is the consumer has to realise their maximum power utilization and utilization cost in order to avoid the wastage of electricity. In this proposed system, we have implemented a three phase energy meter in simulation model using MATLAB Tool. So that without any hardware the consumer can know their major electrical parameters like voltage, current, active power and power factor based on their power utility.

Keywords: Three phase Energy Meter, Simulink, Matlab.

1.Introduction

Smart meter is developed energy meters that measures the energy utilization of a consumer and ensure the information of their Dailey consumption. Now a days many type of energy monitoring system developed in real time using advanced wireless technology. The conventional Energy Meter Reading was not convenient for the consumers as it spends much human and material resource. It brings the problems in calculation of readings and billing by manually. At Presently an important task of power maintenance, the operator goes to the consumer's house and produces the bill as per the meter reading. If the consumer is not available, the billing process will be pending and the operator again needs to reevaluate. If any consumer did not pay the bill, the operator needs to go to their houses to disconnect the power supply. These processes are taking more time consumption and difficult to handle.

Hence the billing system can become inaccurate and inefficient. Smart meters are widely used in power grid, which plays an important role in building the smart power grid and its stability is the key to stable operation of the grid. However, the reliability prediction of the smart meters is difficult to be performed due to its huge number and it cannot be tested one by one.This paper presents the Energy meter model using Matlab/Simulink tool. The measured active power between the simulation model and active power calculated by two wattmeter methods. To improve the energy efficiency, consumers need to be more aware of their energy utilization. So that the consumers can be reduce the electricity billing by display the power consumption per hour, week and also can estimates the energy usage per day.

2. Modeling of Three Phase Energy Meter

The simulation was studied on three phase energy meter using Matlab Simulink software. The performance of three phase energy meter was analyzed with different types of loads. This simulation model of three phase energy meter helps to provide awareness to the consumer towards consumption of energy by showing their energy pattern of their daily utility. This can access and calculate anywhere at anytime. So that the consumer could save the energy by reducing their unwanted energy consumption. Fig.1 shows the flowchart for modeling energy meter using MATLAB / Simulink Software. The voltage and current were measured for different loads like R load, R-L load andR-C load. This system used to measure the energy consumption by the consumers.

The value of voltage and current depends on the load used. The system will find the phase angle difference between the voltage and current in order to measure the power factor. The phase angle difference of the system will not be satisfied, the system will measure the voltage and current again. The power

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factor can be measured based on the phase angle difference. Then the energy consumption was generated. The measurement of the energy consumption can be seen in term of graphical display of the different load used.

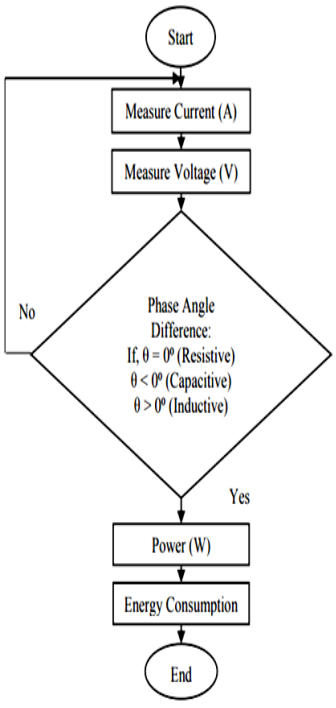

Fig.1 Flow Chart for Modeling of Energy Meter

3. Matlab/Simulink Design

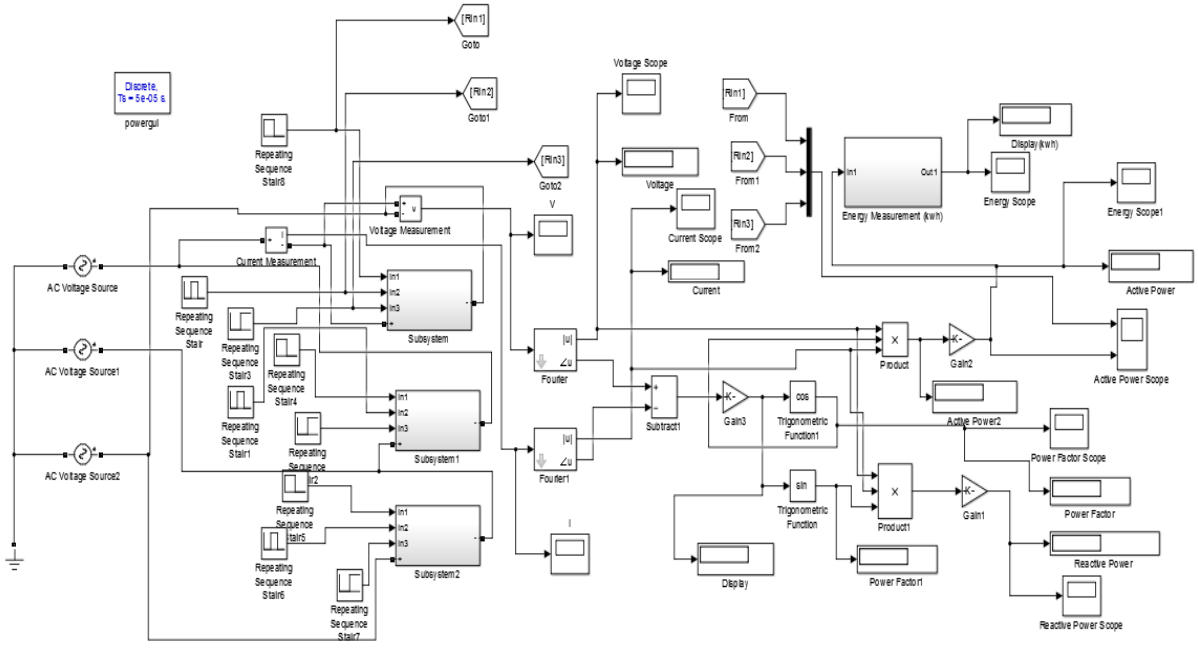

Fig. 2. Three Phase Energy Meter Circuit

Mathematical Modeling

The equation (1) represents the active power for the three phase energy system.

$P = \sqrt{3}IV \cos\theta$ (1)

Where,

V – Measured voltage in Volts

I – Measured Current in Amps

$\cos\theta$ – power factor

This energy meter model involves the following blocks.

Input Blocks:

Voltage: Voltage to be provided using this **voltage block** as per the source we required.

Load : Using this **load block** we can change over the load like R, RC, RL also vary the range of load as per the appliances we used.

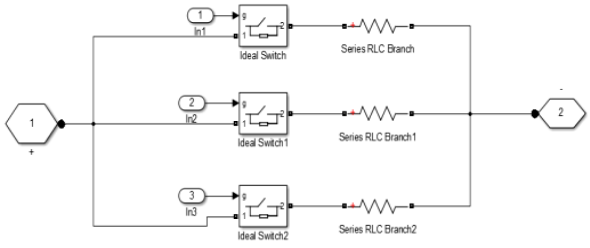

Fig.3. Subsystem For Load Block

Output Blocks:

Current: According to input voltage and load what we used, the current will appear in this current block.

Power Factor : The power factor is calculated from the phase angle difference of voltage and current and it is designed to show in this power factor block.

Real Power: The real power is calculated from the formulae of VICOSØ which is made in the real power block itself.

Reactive Power: The reactive power is calculated from the formulae of VISINØ which is made in the reactive power block itself.

Energy (final no. of unit): The final value of kWh. i.e., number of units what we consumed that will appear in this Energy Block.

Fig.4 Subsystem For Energy Measurement Block

4. Results and Discussion

Measurement of active power by simulation andcalculated value of active power with RL load is given in the Table 1.

Table 1. Real time value and simulated result comparison

Sl. No	R load (Ω)	L load	Simulated Active Power (W)	Calculated Active Power (2 wattmeter method) (W)	Energy (joules)
1.	100 Ω	1 mH	903.3	902.6	0.9033
2.	100 Ω	1.5 mH	884.9	886.0	0.8849
3.	100 Ω	2 mH	859.4	858.5	0.8594
4.	100 Ω	2.5 mH	827.0	826.39	0.8270
5.	100 Ω	5 mH	787.9	786.9	0.0134

Resistive loads are the loads consisting of any heating element. In fixed resistance value and different inductive load values were connected to three phase energy meter which are from 100 ohms in various inductive load . The readings and measurements of the energy meter were taken and recorded in Table 1. The graphical behavior of theenergy meter was recorded.

It observed that the voltage for the entire resistance constant as the value of resistance increases. This satisfies by using the Ohm's Law states that the current is directly proportional to the voltage and inversely proportional to the resistance. In the energy meter system, as the resistance increases, the current flow become lower and the voltage does not change.

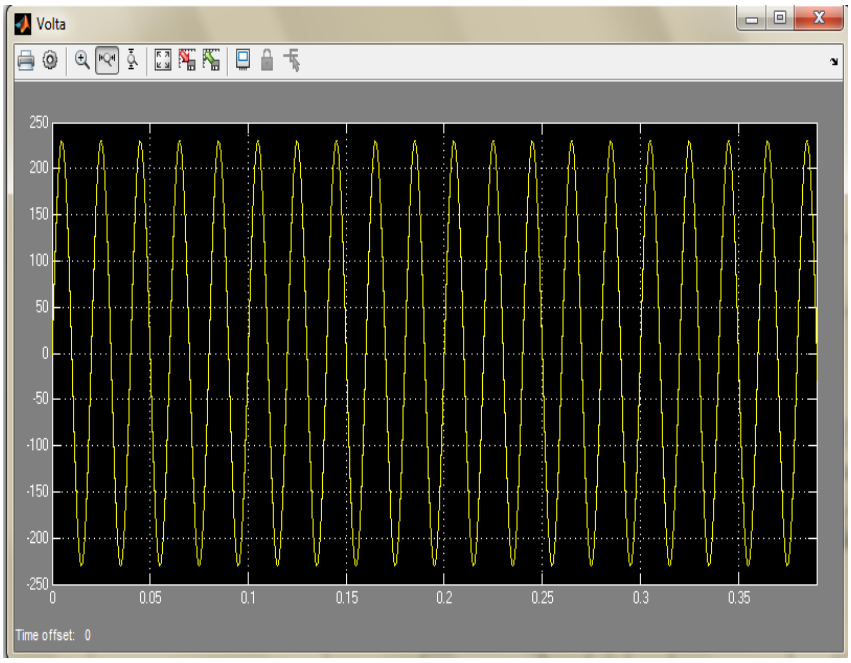

Fig.5 Voltage Waveform

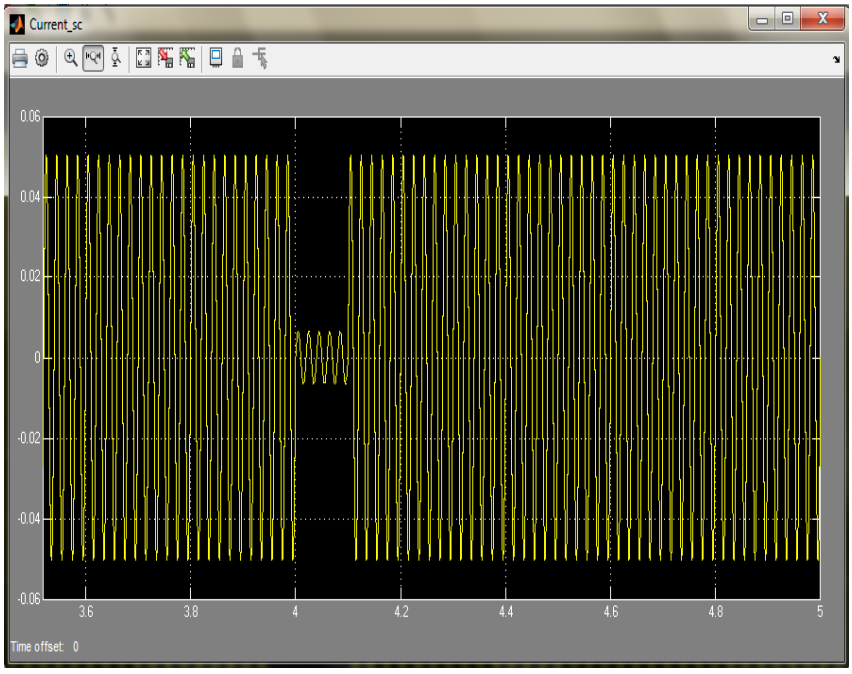

Fig. 6 Current waveform for R Load

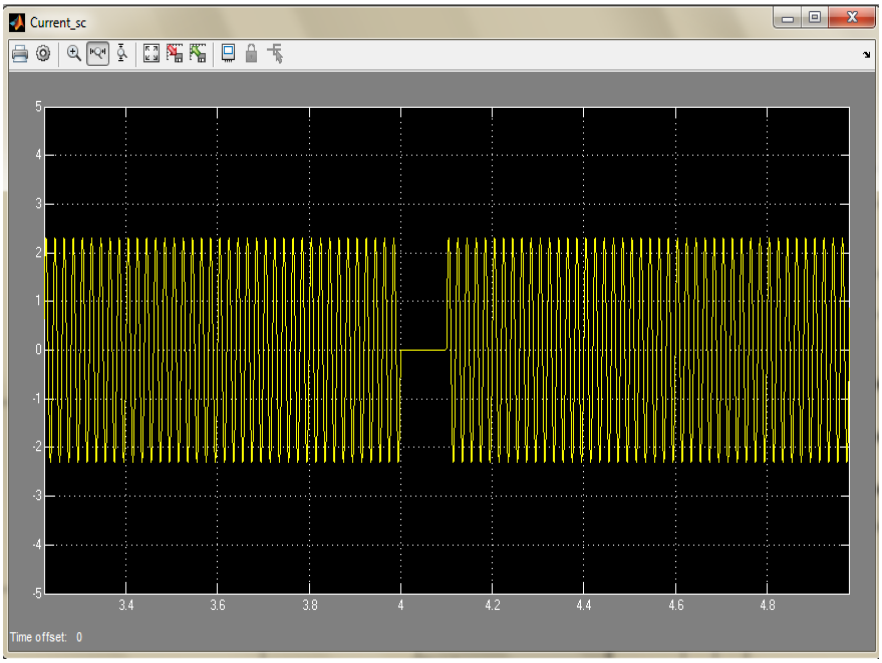

Fig. 7 Current waveform for RL Load

Capacitive load is the dual of the inductive loads. Normally, if the load draws current along a sinusoidal pattern that peaks before the voltage sine which is the current waveform leads the voltage waveform, the load is known as the purely capacitive. Many of the loads have capacitive elements, they are generally come from the additive of resistive and inductive load.

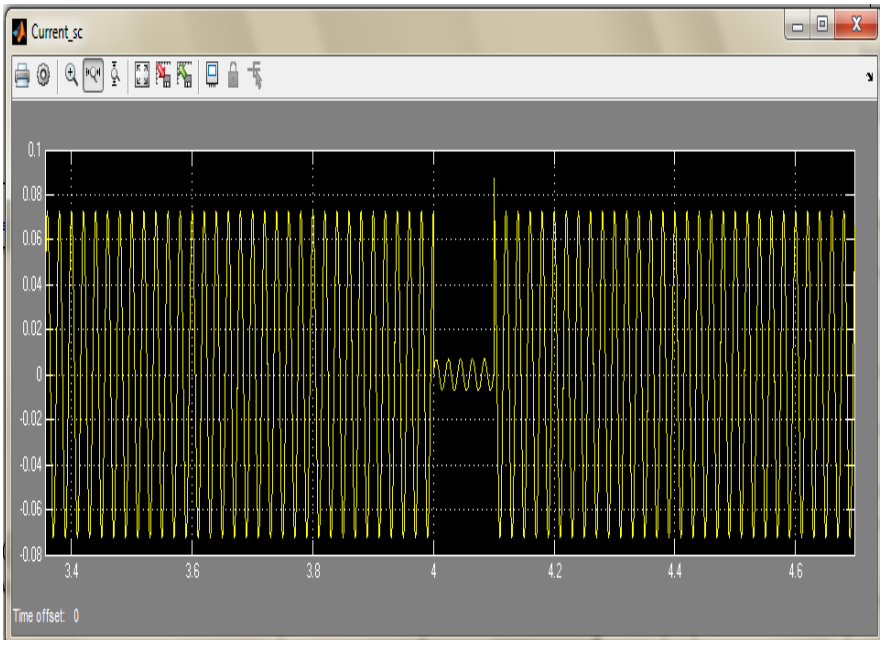

Fig. 8 Current waveform for RC Load

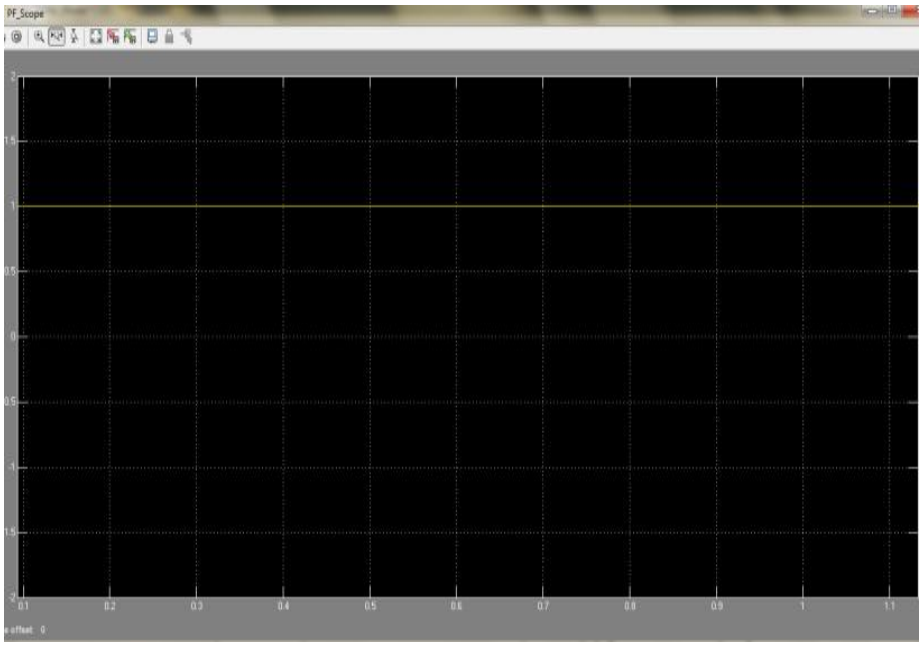

Fig.9 Power factor for R load

From Figure 11, the value of voltage is the same as the voltage of the resistive load. But the value of current produced by R- C load decreases compared to R load. This is because capacitor function as charges and discharges the electric charge that stores in it. As compared to theoretical part, the current is directly proportional to the voltage and inversely to the resistance. In this case, the value of the resistance is fixed. As the resistor discharges the capacitor the voltage drops and the current is reduced.

Fig.10 power factor for RL load

As shows in Figure 10, the graph shows the power factor less than 1 and consists of ripples. The ripples occurred due to noise that might come from the inductor itself. Thedisturbance gives a small effect to the system which caused the ripple formation on the power factor graph.

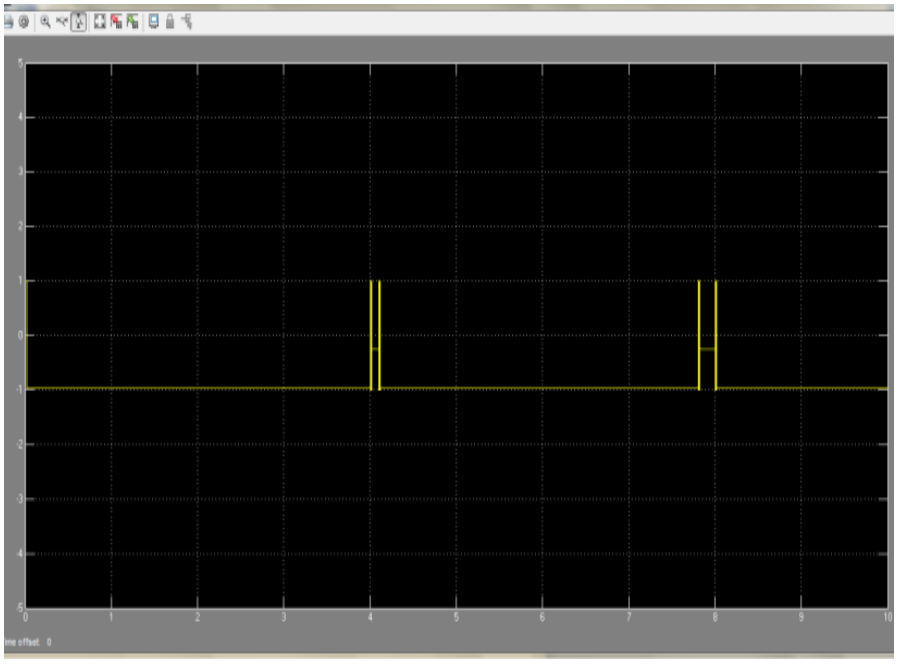

Fig.11 Power factor for RC load

5. Conclusion

Energy Monitoring using IOT techniques is an innovative model which is developed to control home appliances remotely over the cloud from anywhere in the world. In this proposed system, the current sensor is used to sense the current and also can view the values on internet using IoT. The proposed system will provide the updated energy values in every 1 to 3 seconds on the internet using customised public cloud. In the present system, energy consumption is accessed using Wi-Fi, hence the system will help to the consumers to secure from unwanted use of electricity. IoT system where a user can monitor and view their energy consumption and pay the bill in Online mode. Also, a system where a user can receive SMS, when he/she crosses threshold of electricity usage slab can be equipped. We can make a system which can send SMS to the concerned meter reading man of that area when theft is detected at consumer end. Also using cloud analytics we can predict future energy consumptions.

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