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Smart Run Time Electricity Bill Calculation using LabVIEW

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Abstract*: *Usage of Electricity is gradually increasing in day-to-day life. Normally Electrical energy consumed in homes and Industries are measured using the energy meter. In the growing technology, the methodology of measuring the energy and bill calculation should be in a smarter way. The traditional method of billing system using the energy meter needs skilled person to calculate the energy and for the billing. In this paper it is proposed a smart way to measure energy using LabVIEW software for the real time energy measurement. Also, it is possible to measure the following parameters- Power factor, KWH, Voltage, Current, Frequency and Bill amount as on date. LabVIEW system integrated with DAQ hardware to measure the voltage and current. The developed system calculates electricity consumption according to the power factor (unity, leading and lagging) and generates the bill under multi-tariff structure.

Keywords: cDAQ-9174, Data Acquisition (DAQ), Energy, Energy meter LabVIEW, NI-9227, NI-9225.

I. INTRODUCTION

Every product we consume in our daily life is monitored and graded using some measuring standards. Similarly, electric power that we consume in our daily life is measured using energy meters. From those energy meter readings, the cost for the electric power we have utilized is calculated. In the existing conventional energy meter setup, consumers are presented with their usage details once per month along with their bills. The time period for the updates about the power usage of the customers is very long, so that they can't monitor their changed behaviour of power usage.

Traditional electro-mechanical meters which are being used now-a-days are subjected to drifts over rise in temperatures and time as a result of analog and mechanical nature of components in these conventional meters. The process of collection of energy readings from these meters is also very inefficient, as the person who records the readings should be present on the consumer's location to note down the readings. This method of collection of meter readings has some alarming problems. Even with the digital meters these problems persist.

To overcome all these, here is a new method for calculating the electricity bill at run time using the LabVIEW software. In this system, we are calculating the electricity bill 24/7 continuously. This system will provide awareness to the consumers about the power consumed daily and the bill developed due to the power consumption. This will result in very much reduction in the electric power consumption and reduction in the electricity bill every month.

The proposed system utilizes a commercial Data Acquisition Board (cDAQ) connected to a personal computer (PC) for a high accurate electricity measurement. The electricity is measured digitally using NI current and voltage modules and the results will be displayed using NI LabVIEW software.

II. DIFFICULTIES IN EXISTING SYSTEMS

Existing Manual energy measurement needs to be changed in many ways. If the consumers location is very far, the person who records those readings should reach there, which causes transport cost and time consumption. There are some other problems like missing of bills, inaccurate estimations and so on. Sometimes, the meters are placed in inaccessible regions. The inhabitants should be present in the locations during the measurement of meter values by the technicians. If the technical person has any personal problems, it may lead to wrong measurement of values. The hard copy of the record should be maintained with utmost care.

III. PROPOSED SYSTEMS

The proposed system consists of doing some modifications to the conventional energy meter. Introduction of a NI-9227 (current module) and NI-9225 (voltage module) and a cDAQ-9174 (conventional data acquisition board) to the conventional meter setup are those modifications. These instruments are finally connected into a personal computer (pc) consisting of LabVIEW software. Whenever the electric power is consumed, the current and voltage modules will sense the load consumed and sends the signals to the LabVIEW software. Using the LabVIEW software, the data from the cDAQ is processed and according to those values, respective electricity bill is calculated and are displayed.

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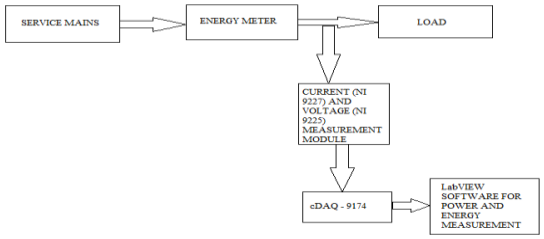
IV. BLOCK DIAGRAM

The block diagram of the proposed system is shown in the below diagram. The load circuit used here consists of resistive bulbs each of rating 100 watts. The supply provided to the loads is 230v AC supply. The current and voltages consumed by the load are measured by NI-9227 and NI-9225 respectively, and the measured data are processed by using cDAQ NI-9174.



V. SIMULATION/ EXPERIMENT RESULTS

The meter used for the measurement of energy utilized by the electrical load is the Energy Meter. It is used in households and industries for measuring the power consumption. In this system, the current module NI-9227 is used to measure the current that is consumed by the loads. Here, we are using the Channel AI0 to measure the current values. The AI0+ terminal is connected to the phase of the energy meter, and the AI0- terminal is connected to the load. The current values are measured as analog values and are converted into 24-bit digital signals via Delta-Sigma ADC. The samples are taken in continuous mode and the sampling time of the module is 0.2s. The voltage module NI-9225 is used to measure the voltage at which the loads are operated. Here, we are using the Channel AI0 to measure the voltage values. The AI0+ terminal is connected to the Phase terminal of the energy meter, and the AI0- terminal is connected to the Neutral terminal of the energy meter. The Delta-Sigma ADC is used to convert the analog voltage values into 24-bit digital values. The samples are taken in continuous mode and the sampling time of the module is 0.2s.

In this system, cDAQ module NI-9174 is used as bridge circuit to connect the current and voltage modules to the LabVIEW software. The channel 1 and 2 of the cDAQ are utilized here. The data are sent as 24-bit digital signals via a USB B/A converter cable. Serial transmission occurs between the cDAQ and the LabVIEW software.

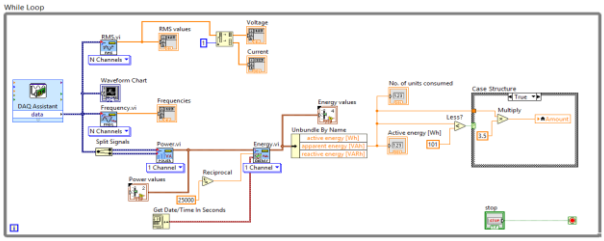


Figure 5.1 Block Diagram of the proposed system

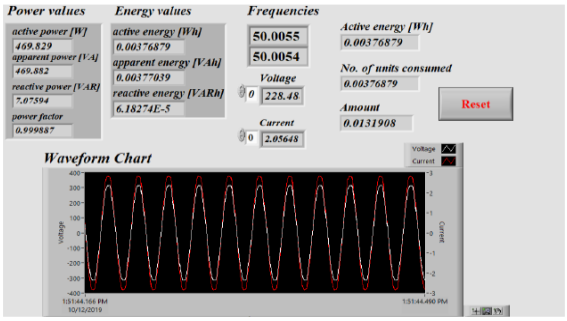


Figure 5.2 Output waveform for resistive load

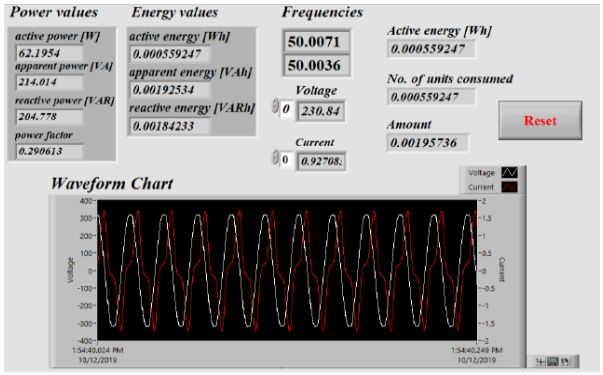


Figure 5.3 Output waveform for Inductive load

The below Sub VI calculates the frequency values based on the load given and is fed from the main VI.

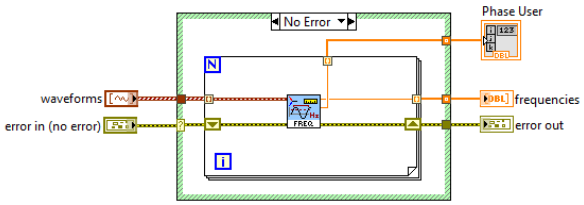


Figure 5.4 Sub VI to calculate frequency

The active or real power, apparent power and reactive power are calculated by using the below sub VI. It utilizes the load current and voltage values fed from the current and voltage modules to calculate those values.

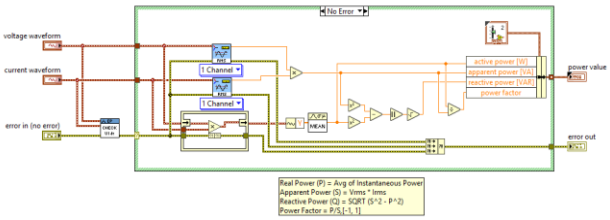


Figure 5.5 Sub VI to calculate Power

The energy is a time dependent one. Similarly, as like power, the active or real energy, apparent energy and reactive energy is calculated by using the below sub VI. The energy is calculated by using the power values from the power sub VI and time stamps (Energy=Power x Time).

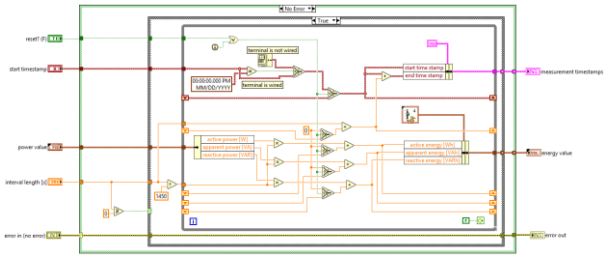


Figure 5.6 Sub VI to calculate Energy

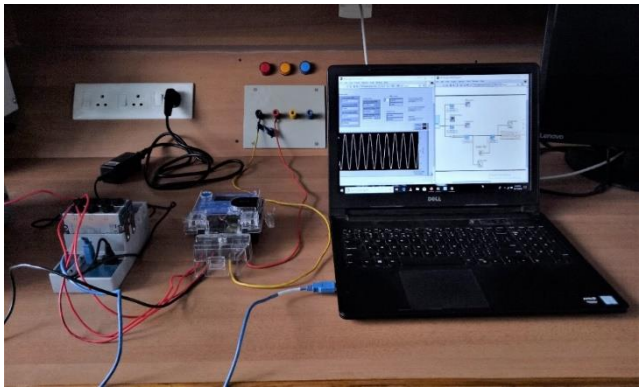


Figure 5.7 Overall hardware setup

VI. RESULT AND DISCUSSION

This project can be implemented in both domestic and industrial areas. In the proposed system, along with the electricity bill calculation, we can integrate a GSM module with which we can send the periodic diagnostic details to the consumer and the Electricity Board. We can send notifications during emergency situations also. We can also integrate a Kill circuit which operates during emergency conditions. We can able to integrate a limiter circuit, in which we can set a limit (can be energy or cost), which limits the supply of electricity once after the limit is reached. If we use Internet of Things (IOT) with the proposed system, we can able to monitor our Energy meter from anywhere around the world. When implemented in Power Stations, this system has the ability to perform power factor corrections and can be able to maintain the power factor within the desired limits.

VII. CONCLUSION

As a conclusion this system can operate maximum power range of 4000 watts. It can operate under all the three (Inductive, Capacitive, Resistive) types of loads. The meter is thus highly useful mainly to the uneducated consumers. This system fulfils its objective of reducing human errors and reduces the tedious workload of the workers. The design incorporates the following innovations:

Run time electricity bill calculation. Ability to work 24/7 hours. Reliability. Robustness. Accuracy in bill calculation. Ease of installation. Ease operation maintenance. Low maintenance costs. High safety of handling

REFERENCES

1. Cataliotti A. and Cosentino V., A PC-based wattmeter for high accuracy power measurements, Instrumentation and Measurement Technology Conference (I2MTC), IEEE 1453–1458
2. Misakian, Measurement of electrical parameters near AC and DC power lines Instrumentation and Measurement Technology Conference, IMTC-88 Conference Record, 5th IEEE
3. Kuznetsov V., Kuznetsov A., Measurement of power quality factors in electricalnetworks, Precision Electromagnetic Measurements Digest, Conference
4. IEEE Master Test Guide for Electrical Measurements in Power Circuits, IEEE Power and Energy Society
5. Driesen J., Deconinck, Development of a measurement system for power quantities in electrical energy distribution systems, Instrumentation and Measurement Technology Conference, Proceedings of the 19th IEEE Page(s), 2, 1625-1630
6. Influence of Instrument Transformers on Quality of Electrical Power and Energy, Measurement Industrial Electronics, ISIE IEEE International symposium
7. IEEE Master Test Code for Electrical Measurements in Power Circuits Power Engineering Society
8. A.K. Sawhney, A Course In Electrical And Electronic Measurements And Instrumentation, Publisher, Dhanpat Rai and Co.,
9. T.E.D. Liacco Real-Time Computer control of Power Systems, Proceedings of the IEEE, 62(7), 884 -891
10. D. Al. Katsaprakakis, D.G. Christakis, A. Zervos and S. Voutsinas, A Power Quality Measure, IEEE Transactions on Power Delivery, 23(2)
11. Sandesh J., Singh T.S. and Phulambrikar S.P., improve power factor and reduce the harmonic distortion of the system, Research Journal of Engineering Sciences, (5), 31-36
12. Hao-wei Yao, Xiao-wei Wang, Lu-sen Wu, Dan Jiang, Teng Luo, Dong Liang, "Prediction method for Smart Meter Life Based on Big Data", Procedia Engineering, vol. 211, pp. 1111–1114, 2018
13. Soma Shekara Sreenadh Reddy Depuru, Lingfeng Wang,Vijay Devabhaktuni,"Smart meters for power grid: Challenges, issues, advantages and status.", Renewable and Sustainable Energy Reviews, vol. 15, pp. 2736– 2742, 2011
14. L. Yang, X. Chen, J. Zhang, H. V. Poor, "Cost-Effective and Privacy-Preserving Energy Management for Smart Meters", IEEE Transactions on Smart Grid, vol. 6, no. 1, pp. 486-495, Jan. 2015.
15. Nabil Mohammad*, Anomadarshi Barua and Muhammad Abdullah Arafat"A Smart Prepaid Energy Metering System to Control Electricity Theft", 2013 International Conference on Power, Energy and Control (ICPEC) 978-1-4673-6030-2/13/$31.00 ©2013 IEEE
16. G.Vani, V.Usha Reddy "Application of Smart Energy Meter in Indian Energy Context" IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 10, Issue 3 Ver. III (May – Jun. 2015), PP 07-13
17. Yingying Cheng, Huaxiao Yang, Ji Xiao, Xingzhe Hou, "Running State Evaluation Of Electric Energy Meter", PP-978-1-4799-4565-8, 'Workshop on Electronics, Computer and Applications', IEEE 2014.
18. Amit Bhimte, Rohit K.Mathew, Kumaravel S, "Development of smart energy meter in labview for power distribution systems", "IEEE INDICON 2015 1570186881", 2015.
19. Cheng Pang,Valierry Vyatkin,Yinbai Deng, Majidi Sorouri, "Virtual smart metering in automation and simulation of energy efficient lightning system" IEEE 2013.
20. Tejas Gujrati, "Optimization in mart Grid and Homes", 2018 Advancement in Engineering & Technology, ISBN-978-93-86878-15-1.

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