In-campus Generator-Substation Monitoring and Control Using LabVIEW

Abhinav Shukla, Abhas, Rajesh Singh and Anita Gehlot

Abstract The various parameters which are used to measure the generators (which are used in substation) are their input power (in KVA-kilo volt amperes), terminal voltage, current, and power factor. Various methods came into existence in order to measure these parameters and some of them are by the use of Heffron–Phillips model, load model, and so on. But here we are using LabVIEW software as DATA LOGGER which will be helpful to monitor these given parameters more effectively and efficiently. Proteus simulation model is also developed to check its accuracy. In order to monitor these parameters, received data will be again transmitted through virtual serial port at 9600 baud rate and it is being received and displayed in the graphical user interface. This system will be easy to use with the help of this software and further studies can also be conducted so as to make it easier to use in the future years.

Keywords LabVIEW software · DATA LOGGER · Virtual serial port · Proteus model

1 Introduction

In the present scenario of automation and control, most of the systems which were mostly running slowly due to analog systems are now digitalized and became more advanced which gives very fast response in the required time interval. Whenever the electrical power is generated in a power plant, then it is being transmitted toward load side by the means of transmission lines. From the main station, the generated voltage is stepped up by the means of step-up transformers (also called power transformers) and then these are propagated over long distance. Now here comes the actual picture, i.e., in a campus there is also a substation and also a

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generator which distributes the power in the different parts of the campus depending upon the need. Now, in order control and monitor the various parameters of the generator which is used in the substation are the important part. It is important to know because if any excess voltage which cannot be beard by the load side can be controlled and monitored so that the overall loss can be minimized. Here, in this method of monitoring and control of these parameters, LabVIEW software will be used as a data logger in the receiver side. "Laboratory Virtual Instrument Engineering Workbench" (LabVIEW) is a system design platform and development environment for visual programming language from National Instruments. And also a DATA LOGGER which is a device that stores information time to time through the external world like instruments and sensors.

2 Related Work

Various methods came into existence in order to measure and control these parameters. Some of them are as follows: Karrari and Malik stated that parameters of synchronous generator can be done through online measurement in which a multivariable Linear transfer function was created and was transformed to the parameters of Heffron–Phillips model [1]. Ma et al. stated a load model in the power system simulation and control in which according to their study the constant impedance, current, and power load together forms a composite load model whose parameters were detected through field measurements by using measurement-based modeling practices as a tool but nothing such as a research was conducted and they made a possibility to measure those by the reduction of combination load parameters [2]. Chen et al. mentioned that in order to realize real-time measurement of power angles of generators and bus voltage phasors of substations in various locations for its stability for stability control another method based on GPS can measure the bus voltages and current along with the power angles of generators when they in working conditions [3]. Ranvir et al. proposed an innovative design which was based on a micro controller which measures the required parameters of a distribution transformer and communicates it wirelessly by the means of GSM modem which sends the electrical packet in the form of SMS [4]. Liang et al. designed a kind of monitoring and alarming system which monitors substation based on ZigBee wireless technology in which the system uses GPRS for remote transmission and makes a wireless substation monitoring system which reduces cost and gets constructed [5]. Nasipuri et al. presented a design along with the performance of a wireless sensor network which consists of 45 low-power nodes for sensing temperature and a high power node which performs a more specialized computations, furthermore each and every node communicates over a multi-hop mesh network which uses dynamic link quality-based routing protocol [6]. So, these were the methods which were used till now controlling and monitoring the different parameters used in a generator of the substation. Now, in this paper, these parameters will be controlled and monitored more efficiently by the use of

LabVIEW software as a data logger. The main feature of LabVIEW which is different from other acquisition programs is its highly modular graphical language in which the code is flexible, re-useable, and self-documenting [7].

3 System Description

The monitoring system consists of transmitting side and receiving side. Transmitting side is in the substation side which consists of various types of sensors which usually consists of current sensor, voltage sensor, and power sensor which measures the corresponding values, respectively. Then a controller is used (Arduino) which processes the information and ZigBee is used for its transmission and a 20 × 4 LCD display is also there. And on coming to the receiver side again a ZigBee module along with the controller circuit and a 20 × 4 Display. An additional feature is also added which the Lab view Software which will be used as a data acquisition of the measured parameters in the system. Both the sides have been given a power supply. The system usually consists of a transmitting part and a receiving part. The transmitting part is placed at substation and the receiving part is in the energy block of the campus. In this diagram it is quite clear that the sensors which are named as SENSOR 1, SENSOR 2, and SENSOR 3 are supposed to measure the rated current, voltage and apparent power, respectively. Since the given parameters will give the analog output in the form of sinusoidal wave hence they are interfaced with the analog input pins of Arduino (which is the controller of the transmitting side) and since Arduino has inbuilt ADC which changes analog signal to digital signal And then the controller is further interfaced with the 20 × 4 LCD display which displays the results of output parameters and then further the data packet is transmitted wirelessly by the means of ZigBee module through serial communication. Then coming to receiver side, its received by the ZigBee module and then again fed back as a input for Arduino which displays it in the 20 × 4 LCD display and also seen in lab view software which provides a graphical user interface and controls the substation and studies the characteristics of current and voltages from time to time through data logging (or data acquisition). Current sensing is the important part and mostly functioned on a smart power chip, earlier method to sense current was done by inserting a resistor in their current path but now methods have come up which measures current without any heat dissipation [8]. Similarly voltage between two wires is measured by the means of voltage sensors. Power sensors are also used which measures the rated power which is in Kilo Volt Amperes (KVA) and the output of these sensors is interfaced with the analog input pins of Arduino (controller of the circuit). Arduino is a microcontroller which is easy to use which is platform-independent that its code runs in any of the operating system (e.g., Mac OS, LINUX, and Windows). Then these sensed values are further processed and transmitted serially by the means of ZigBee module and ZigBee mostly uses GPRS for transmitting data [5]. Now, the data packet which is generated is displayed in the 20 × 4 LCD of transmitting side of the system. Then the

data packet is transmitted serially and is received to the receiving part of the ZigBee then it is further send to controller and its being displayed in the LCD of the receiving side of the system. Then now the similar data can be also seen in the LabVIEW software which is used as a data logger (or sometimes it is also called data acquisition). In recent years, LabVIEW is replacing the embedded microprocessor control systems which were used in laboratory though a personal computer [9]. LabVIEW provides User, simple generated control software along with a professional GUI. Now let us see how we can use LabVIEW as a data logger/data acquisition. Data acquisition is an automated process of getting data in the form of voltage/current signal and storing them in the computer for analysis purposes. Here, VISA which refers to Virtual Instrument Software Architecture which provides the programing interface between hardware and developed environments such as LabVIEW. Now in the diagram which is given below is the demonstration of the LabVIEW in which we are doing some of the settings like we choose and control appropriate COM port by clicking on the VISA resource name, then adjusting the Baud rate at 9600, choosing the data bits 8 and placing parity and flow control at none (Figs. 1, 2 and 3).

Let us get interacted with the basic block diagram of data acquisition system. In this diagram we can see that it consists of a transducer (or any sensor say temperature/voltage) which changes it into a voltage signal (an electrical signal)

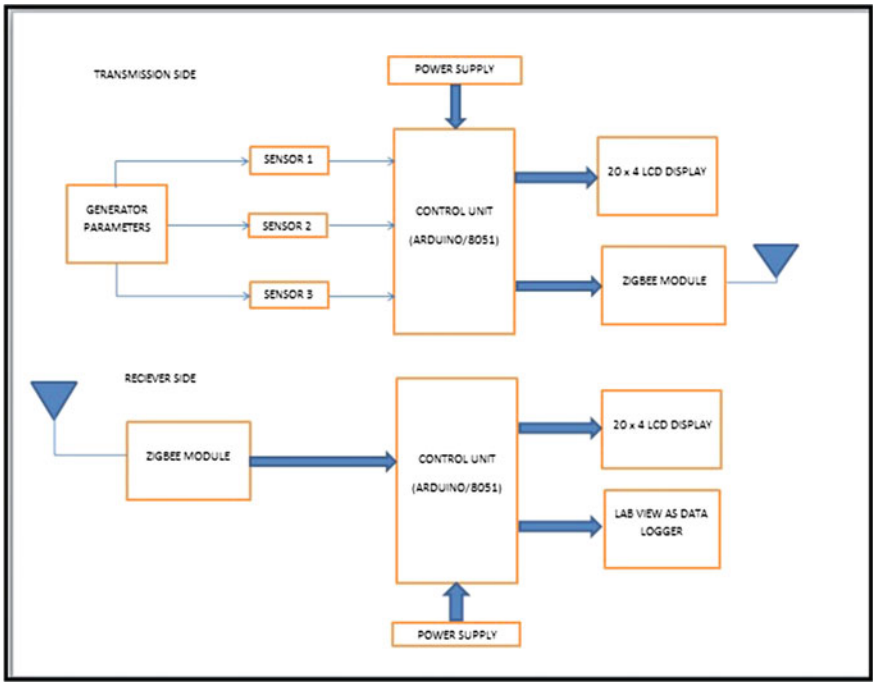


Fig. 1 Block diagram of the system

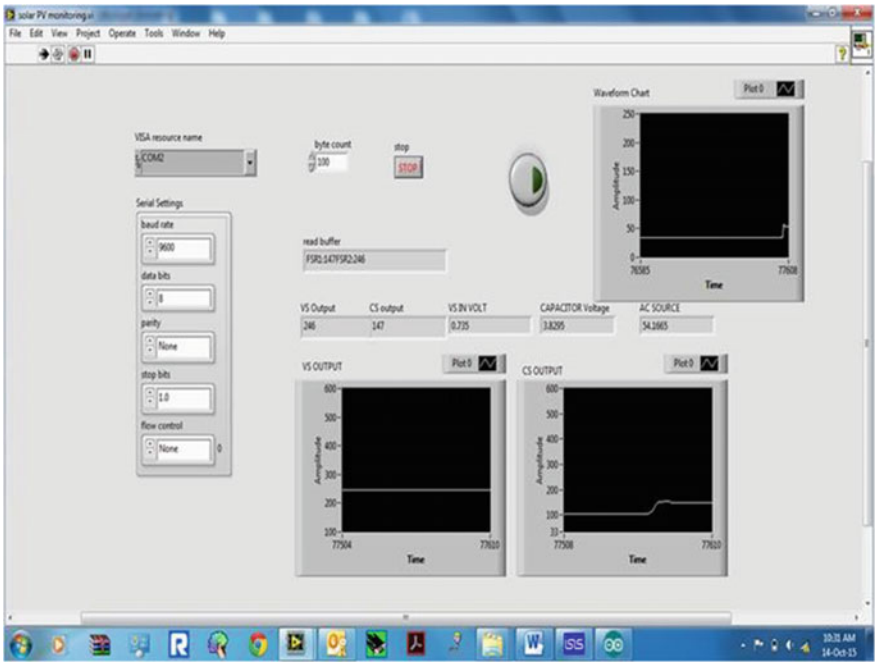
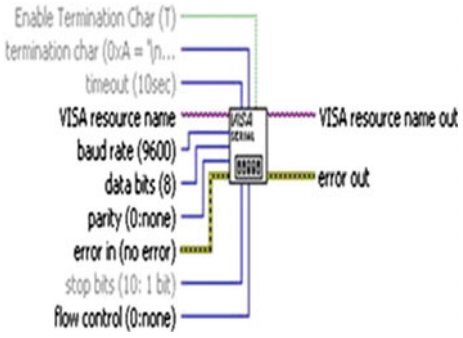


Fig. 2 GUI of LabVIEW

Fig. 3 VISA serial port



which is further amplified through means of signal conditioning (which is for amplification, filtering) and the amplified output is fed again as a input to the DAQ hardware and its interfaced with computer by means of a USB cable and then the output is seen in the computer and further analysis is also done in the received data (Figs. 4, 5 and 6).

Fig. 4 Block diagram of data acquisition system

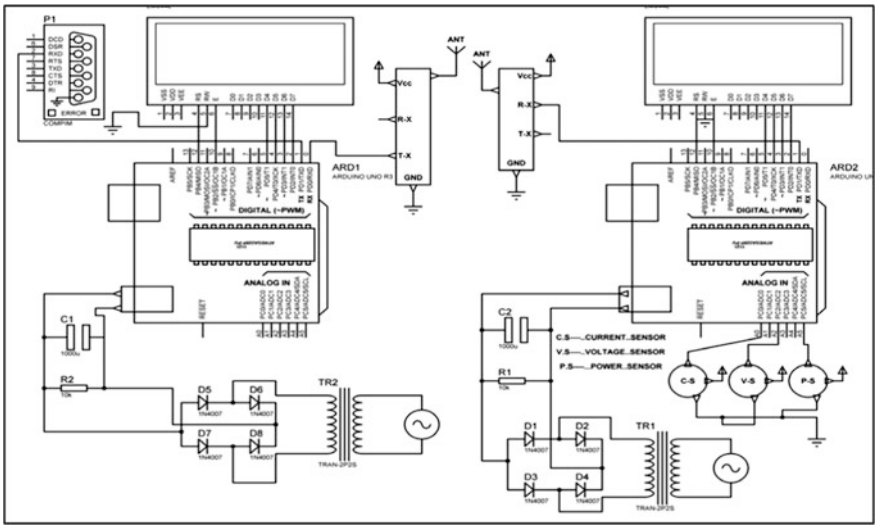


Fig. 5 Circuit diagram of the monitoring system

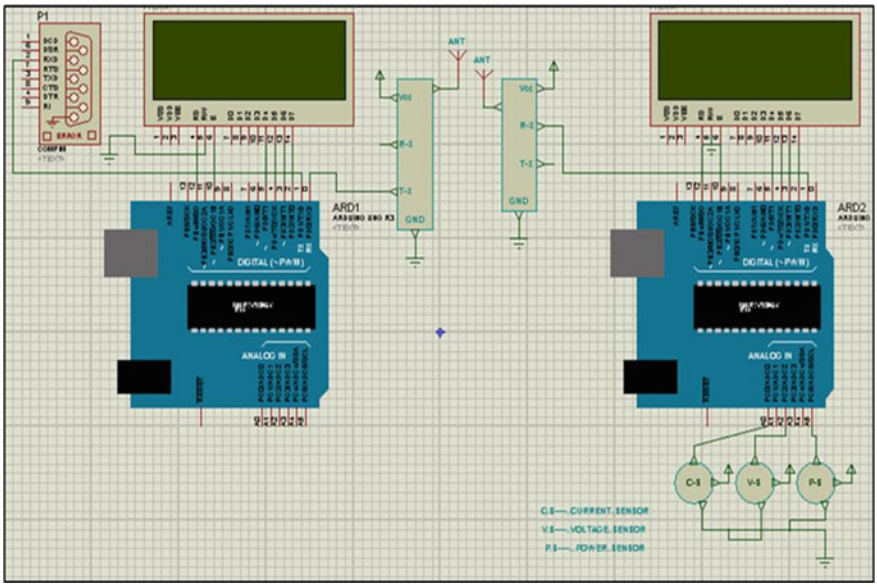


Fig. 6 Proteus model of the system

4 Results and Conclusions

Though previous researchers came up with methods which were useful for the measurement of parameters of the generator and substations, it had some disadvantages like the use of wireless sensor networks will increase the complexity and also becomes difficult to configure and also increase the cost of the hardware. Similarly, other methods also have some disadvantages. Hence, measurement of the various parameters of the generator-substation which is to be monitored and controlled by the using LabVIEW as a DATA LOGGER (or data acquisition) which is more efficient and is easy to use in LabVIEW. As LabVIEW mostly works on VISA serial port and provides a graphical user interface which is more easy to see and configure it and also displays the data more fast and accurately and supports extensively for interfacing with other equipment's like sensors and many more hardware at last we can say that use of LabVIEW is a useful and a perfect method which can be used and further modifications can be so as to reduce future gaps.

References

1. Karrari, M., and O. P. Malik. "Identification of physical parameters of a synchronous generator from online measurements." Energy Conversion, IEEE Transactions on 19.2 (2004): 407–415.
2. Ma, Jin, et al. "Reducing identified parameters of measurement-based composite load model." Power Systems, IEEE Transactions on 23.1 (2008): 76–83.
3. Chen, Yunping, et al. "A new approach to real time measurement of power angles of generators at different locations for stability control." Power Engineering Society Winter Meeting, 2000. IEEE. Vol. 2. IEEE, 2000.
4. Ranvir, Kunal V., et al. "Substation Monitoring System."
5. LIANG, Hu-hui, et al. "ZigBee-based substation monitoring and alarming system [J]." Power System Protection and Control 12 (2010).
6. Nasipuri, Asis, et al. "Wireless sensor network for substation monitoring: Design and deployment." Proceedings of the 6th ACM conference on Embedded network sensor systems. ACM, 2008.
7. Kalkman, Cor J. "LabVIEW: a software system for data acquisition, data analysis, and instrument control." Journal of clinical monitoring 11.1 (1995): 51–58.
8. Forghani-Zadeh, Hassan Pooya, and Gabriel Rincon-Mora. "Current-sensing techniques for DC-DC converters." Circuits and Systems, 2002. MWSCAS-2002. The 2002 45th Midwest Symposium on. Vol. 2. IEEE, 2002.
9. Krauß, A., U. Weimar, and W. Göpel. "LabView™ for sensor data acquisition." TrAC Trends in Analytical Chemistry 18.5 (1999): 312–318.