# N Analysis Of Renewable Energy Sources Using An Integrated Data-Acquisition System

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**Abstract:** *Data-acquisition systems are used in renewable energy source (RES) applications in order to collect the data such as temperature, voltage of industrial appliances, for evaluation purposes. In this paper, a software based system for RES systems is used to analyze the performance of industrial appliances. The proposed system consists of a set of sensors for measuring both environmental, devices changes (e.g. temperature, humidity etc.) and electrical parameters (voltage and current etc.).The collected data are first monitor using precision electronic circuits and then interfaced to a PC using a data-acquisition card. The MATLAB program is used to further process, Simulate and analysis the collected data in the PC disk. The proposed design permits the rapid system development and has the advantage of flexibility in the case of changes, while it can be easily extended for controlling the RES system operation.*

**Keywords:** *Renewable energy sources, Data-acquisition system,Microcomputer,Sensors,MATLAB.*

## I. INTRODUCTION

Industries are required to operate within a relatively close set of safety limits. These safety limits or operating conditions are designed to allow for safe operation of the equipment or system design specification are not too exceeded.The renewable energy sources(RESs)are used in many RES power systems all over the world. A drawback of RES systems is that the installation cost is high, so there is a need to design optimization methods. However, such an effort requires detailed knowledge of equipment, device and environment data of the site where the system will be installed and operational results from similar systems, if available. Numerous data-acquisition systems have been introduced in order to collect and process such data, as well as monitor the performance of RES systems under operation, in order to evaluate their performance[1–3].A photovoltaic battery charging and water –pumping system performance is monitoring by use of data-acquisition methods [4], [5].An A/Dconverter is a binary signal output and it interfaced to a microcontroller based unit records a set of sensors' signals, while the collected data are stored in a local EPROM. The data's stored in the microcontroller are transmitted to a PC through serially connected RS-232. The similar architecture has been implemented in [6–8] for solar irradiation and ambient temperature measurements. In all the above-mentioned cases, Windows xp operating software was support specifically for each application, in order to display and process the collected data on the PC.

A different approach has been proposed in [9], shown in Fig.1 (b).A data-logging is an electronic device is used to monitor a process by use of sensor and it be interface with computer. The collectable data are transmitted to a PC through anRS-232serialinterface, where they are processed using the MATLAB data software. However, a data logging unit lacks flexibility compared with a data-acquisition card approach, while, in addition, it cannot be used for RES system control. A normal method of design described above is that a microcontroller based data-logging unit is used to measure the signals and interface the collected data to a computer through an RS-232 interface. However, serial data transmissions minimize the system performance if an advanced control capability is desired.

In this paper, a PC based data-acquisition system for monitoring both meteorological data and RES system operational parameters is proposed. A block diagram of the proposed system isshowninFig.1(c).A set of sensors are used to measure atmospheric and soil conditions, as well as quantities regarding the energy produced by the hybrid photovoltaic/wind generator power system, such as the photo- voltaic array voltage and current, the wind generator speed etc. The sensor signals are first filtered and amplified using precision electronic circuits and then are inter- faced to a PC ,through the PCI bus ,using a commercially available data-acquisition card. The data are collected and further processed then it displayed on the monitor and analysis using the MATLAB software. This method has the merit of rapid data-acquisition system development and flexibility in the case of unstable state, while it can be easily monitor and control through RES system

operation. Also, the MATLAB provides an graphical output that permits the system operators to process easily the required data, using complex data-processing algorithms, without detailed knowledge of the data-acquisition system design [10].The proposed system data- acquisition has been interfaced to a low-power RES system and sensor to monitor the performance of the systems, based on that it can be easily the control systems.

## II.    THE SENSORS AND THE INTERFACE CIRCUITS

A block diagram of the Renewable Energy Sources system under consideration is shown in Fig.2.The positions of the sensors used a real so indicated in the figure. The power plant consists of two photo voltaic (PV) arrays of 450 and 300W, respectively, and a 2kW permanent magnet (PM) wind generator (W/G).Both the W/G and one of the PV arrays are bused to charge a 24V battery stack, by means of appropriate battery chargers. ADC /AC inverter is used to supply the load, which in this case is the lamp array of a parking lot. The second PV array is connected to the electric grid through a grid-connected-type inverter. The size of the above RES plant is experimental, but the proposed data-acquisition system can be interfaced to RES, temperature display and Computer, where the power consumed by PC and RES system is negligibly low.
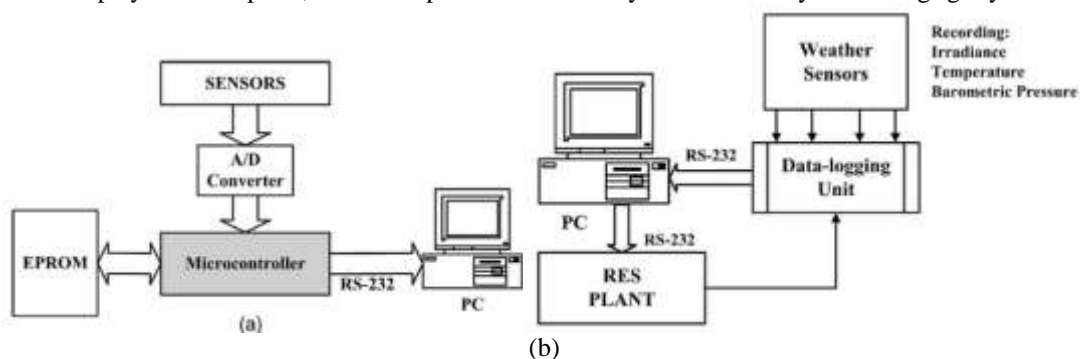


**Fig.1 Data-acquisition architectures for RES systems**:        (a) a microcontroller -based system, (b) a data logging unit connected to a PC.

In RES systems provided with batteries as storage units, the battery service time depends on the estimated state of charge, which is highly sensitive to the current measurement errors. In such cases, if the battery chargeMonitoring is based on amp-hour measurements using Hall-effect sensors [11], a circuitry improving he measurement accuracy is essential.

All currents are measured with Honeywell Micro switch CSLA1CF type Hall-effect sensors. The non-intrusive method of measurement and the low power loss are very low is the one of the advantages of this type of sensor. A disadvantage is that the zero current offset voltage and its temperature coefficient of 0.05% Creative to the offset

**Fig.2.  The RES system block diagram and the sensors used**.
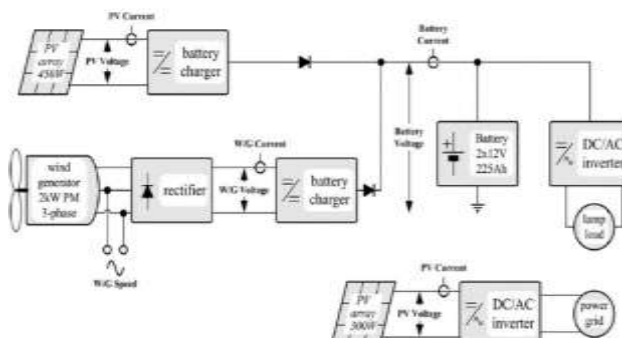


at 25 °C. The measurement of currents as high as 100A in order to use of a single wire turn wound around the magnetic core, causing relatively high errors when measuring low currents, due to the sensor temperature coefficient. Thus, there is a necessary need of a temperature compensation arrangement. The Hall-effect sensor provides the output in response to a magnetic field. The forward voltage temperature drift of a small signal

diode balances the Hall-effect sensor off set voltage temperature drift. The Hall-effect sensors compensation circuit tested in the laboratory features a temperature coefficient of $dV_H/dT$= -0.8mV/□ C, while the compensation diode has a coefficient of $dV_D/dT$= - 2.3mV/□ C, where $V_H$ is the Hall- effect sensor output voltage, $V_D$ is the compensation diode voltage and $T$ is the temperature.

The instrumentation amplifier output voltage $V_c$ is given by the following equation:

$Vc = (V_H-V_{r1}).G_1+ (V_{r2}-V_D).G_2$ ------------------ (1)

Where $G_1$, $G_2$ are the amplifier A1,A2 gains, respectively, and $V_{r1}$,$V_{r2}$ are reference voltages.

Initially, both potentiometers are trimmed so that $V_{H=}V_{r1}$ and $V_{D=}V_{r2}$. Then, the amplifier gain $G_1$ is calculated as:

$G_1= V_{.cmax} / S_{H Imax}$ --------------------(2)

Where $V_{c,max}$ is the desired maximum output voltage of amplifier A1,$S_H$ is the sensor sensitivity(V/A) and $I_{max}$ is the maximum measured current.

All other techniques for atmospheric and soil condition sensor signals are amplified differentially using AD625 type instrumentation amplifiers, while the outputs from the amplifiers are connected to the data-acquisition card analog input channels and it connected through low-pass RC filters and protection diodes, as shown inFig.3.

The Humidity, Instruments temperature and ambient temperature are measured using the RotronicMP100A type hygrometer, while the barometric pressure and the global irradiation are measured using the Delta-T Devices BS4 type barometer and the GS1 type pyranometer respectively. The wind speed and direction are measured with the help of Vector Instruments A100R type anemometer and the W200 P type windvanes respectively.

The soil temperature is measured with aPT100 Platinum resistance RTD type sensor and the soil heat flux is measured with a Hukse flux HFP01type heat flux plate. Its output voltage period is proportional to the soil volumetric water content and is converted to an analog signal with the LM331precision frequency-to-voltage converter.
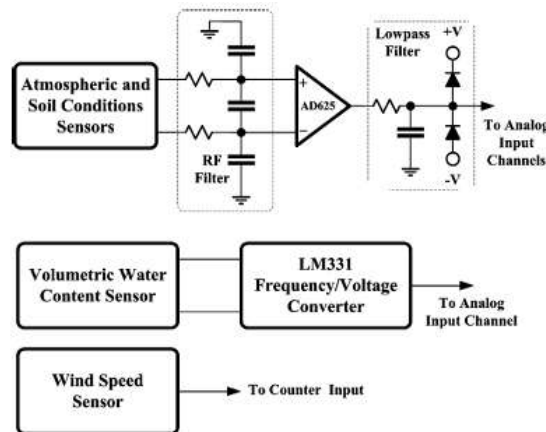


**Fig.3. Block diagrams of the atmospheric and soil condition sensor interface circuits**.

### III. THE DATA COLLECTION AND PROCESSING INTERFACES:

The data-acquisition system uses the National Instruments PCI-6024 E type DAQ card installed in a PC. All instrumentation amplifier outputs and the digital signals are connected to the card through the external CB-68LPR686 connect or block. The MATLAB software runs under the Windows95/98/NT/2000 operating system and it requires a processor, a minimum RAM of 512MB and 2GB of disk storage space.MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:
• Math and computation
• Algorithm development
• Modelling, simulation, and prototyping
• Data analysis, exploration, and visualization

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB uses software developed by the LAPACK and ARPACK projects, which together represent the state-of-the-art in software for matrix computation.MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

## IV.  The Experimental Results

The monitoring system with the help of MATLAB and power system described above is verified using RES and industrial Instruments. The Hall-effect sensors use dare wound with a single turn, giving a sensitivity of 26mV/A. The temperature compensation circuit has the temperature in the range of 20–30 C. The zero current temperature drift measured is less than 3% of the sensor sensitivity, while if no temperature compensation is used, then the maximum zero current temperature drift, in the same temperature range, would be about 15% of the sensor sensitivity. These results show the accuracy improvement of the Hall-effect sensor current measurements by the compensation circuit.

## V.  Conclusion

Data-acquisition systems are used to monitor the performance of the RES systems in order not only to measure the meteorological conditions, but also to obtain data regarding the system performance for valuating purposes. Most present data-acquisition systems collect the data of need and store them in a flash memory until the system operator downloads them to a computer. In this paper, the development to fan integrated computer-based data-acquisition system for RES plants is described. The proposed method is based on precision electronic circuits and an easy-to-use graphical environment, based on the MATLAB program, for processing, displaying and storing the collected data. The system operator can easily process the measured parameters using any MATLAB built-in function available. The proposed architecture has the advantages of rapid development and flexibility in the case of any need, while it can be easily extended for controlling the RES system operation.

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