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Department of Electronics – Wayamba University of Sri Lanka

DIGITAL POWER MONITORING SYSTEM WITH POWER LINE COMMUNICATION

E.A.K.K Edirisinghe*, M.A.A Karunarathna

Department of Electronics, Wayamba University of Sri Lanka, Kuliyapitiya, Sri Lanka
*eakkedirisinghe@gmail.com**

ABSTRACT

The monitoring of electric power helps to identify the important power quality problems such as voltage sags and swells, interruptions, harmonics, and high-frequency noise, consistently seen in industrial and household applications. Troubleshooting these problems requires accurate measurements and analysis of power quality with monitoring instruments that can effectively locate issues and identify solutions. A digital power meter to measure power consumption of home appliances could be an ideal solution for this. This report focused on digital power monitoring device with power line communication (PLC). The complete system is divided into two units and they are measuring unit and transmission unit. Measuring unit measures the voltage and frequency applied to the appliance (or voltage drop across the load), current through the appliance, power factor and most importantly the power consumption of the appliance when the appliance is plugged into the device. A sensor module is used to sense the current and LCD displays are used to display measured values. To observe the measured data at two different outlets in two different locationsMamba shield – narrow band power line communication modules are used to establish communication between two power outlets.

Keywords: Power Line Communication, Transmission, Arduino, LCD

1. INTRODUCTION

The commercially available power monitoring systems were developed using Joulemeter[6] projects, We-Mo insight switch (Wi-Fi enabled system)[4], using circuit level power measurements and etc. Due to high initial cost, lack of portability, inaccurate measurements lead them to failures in this matter. Most power meters that already exist in the market suffer with a few number of distinct design shortcomings. Another fact is that, most power meters

are not facilitated with observing the measured data at two different outlets in two different locations. It is possible to achieve that using this power meter, if both locations get supply over the same phase line and use the power distributed by the same grid substation. The device works under the basic functions as shown in Figure1.

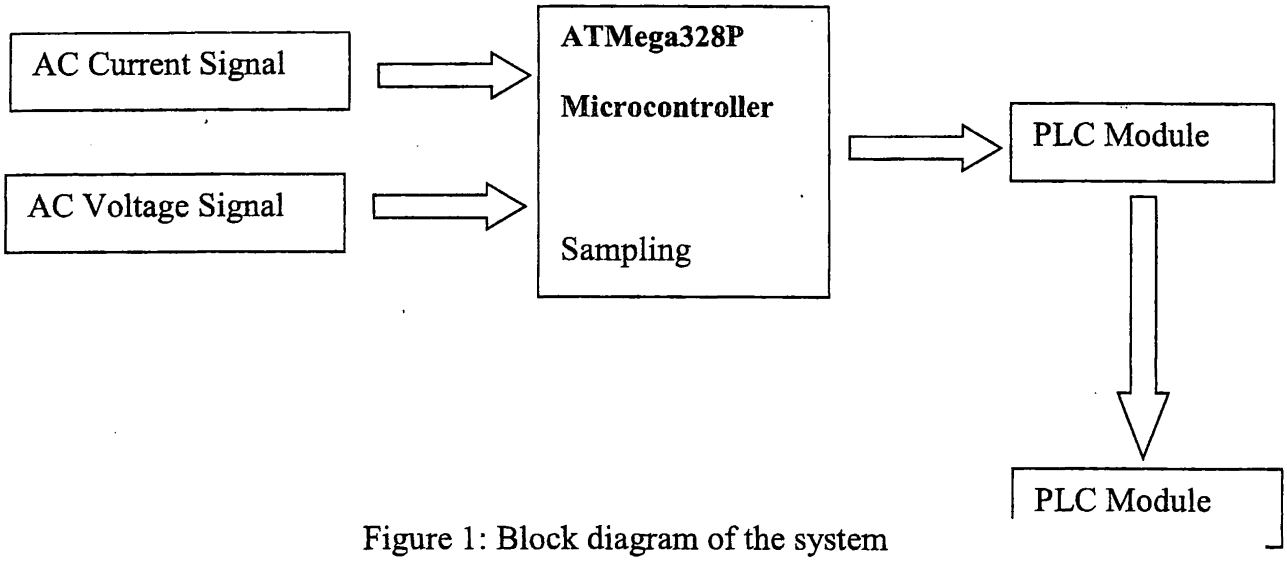

Figure 1: Block diagram of the system

2. EXPERIMENTAL

Before designing the main circuit, different types of power meters available in the market and existing industry used power meters are evaluated, even the wireless power meters that use Bluetooth technology are analyzed to find functionality and operation. There were systems given for both digital and analog circuits. Theoretically or manually power can be calculated using the basic equation, P = VI. Therefore it would be so easy to calculate power if the RMS values of voltage and current could be measured. Voltage refers to the voltage signal applied at the load/appliance and the current refers to the current signal that flows through the load. Thus the power dissipated by the load can be easily calculated through the Arduino supported components. (Arduino – an open source language with highly available electronics modules). Device is plugged in to the power outlet and appliance is plugged in to the device. Supply AC voltage signal is reduced by the simple voltage divider circuit and the reduced signal is fed to the Microcontroller. ACS712[5] Current sensor module is used to sense and feed the AC current signal passing through the appliance to microcontroller. ATMega328P[1] microcontroller with an Arduino Uno board is used for sampling and fast analog to digital conversion. 16x2 LCD is programmed to display the measured and calculated parameters. Mamba shield[3]– narrow band power line communication modules are used to establish communication between two power outlets. One shield transmits these data displayed on the

measuring unit display and the other shield receives them. The received data are again displayed on a 16x2 LCD available in the transmission unit at the receiving outlet. In order to program this LCD, separate Arduino[4] is used. Two Arduino boards are used with these 2 PLC modules (one for each). The approach for the complete power monitoring device has been taken in two steps. First approach is to finalize the measuring unit to check whether the required readings could be obtained precisely at a single outlet before moving on to the transmission unit. The second approach is to finalize the transmission unit/ communication part. Once the required parameters could be measured at one outlet, then it's all about transmitting data to another outlet. Also this device is only applicable in 220V/230V single phase systems. Descriptive diagram of measuring unit is shown in the Figure2.

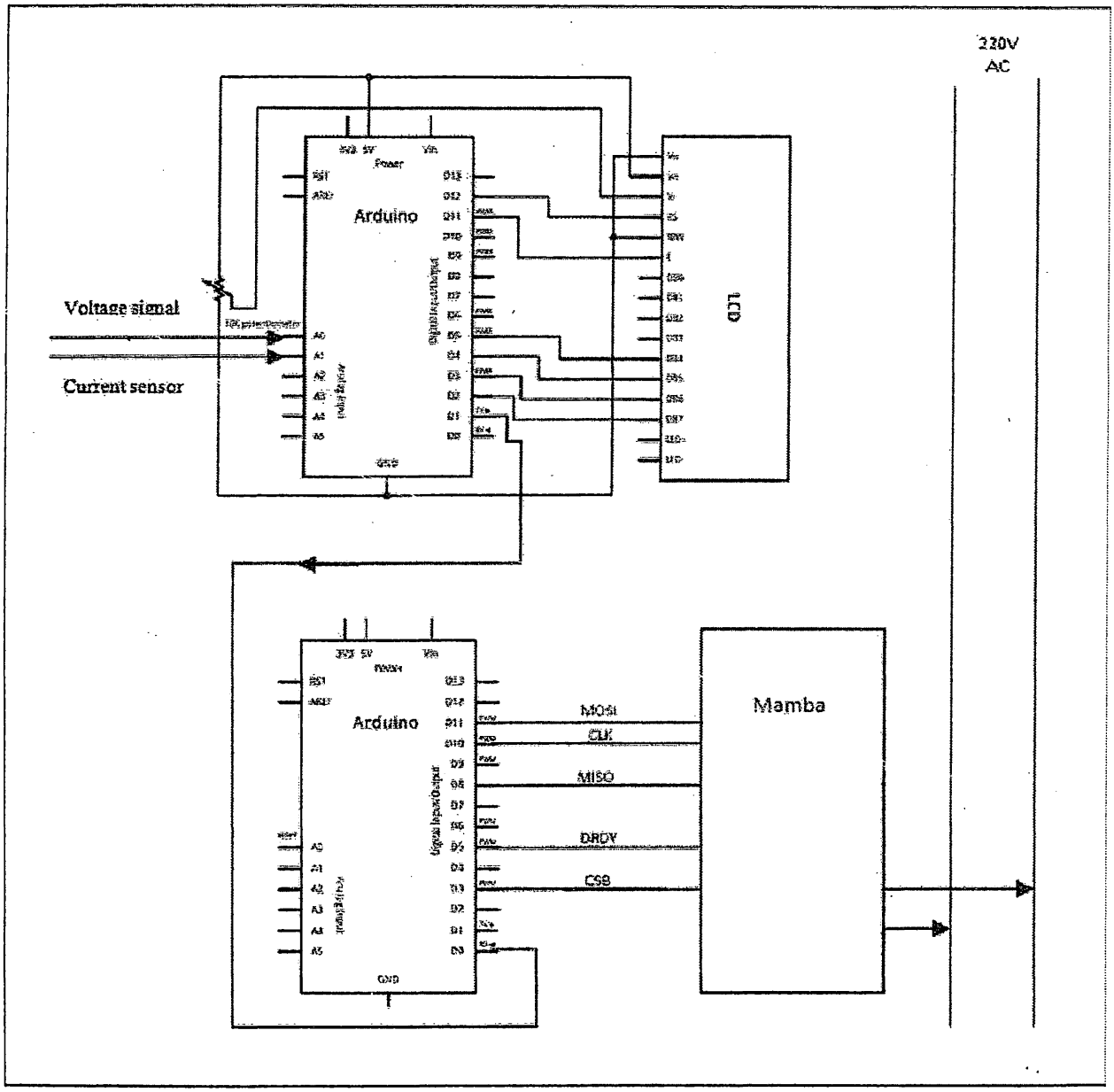

Figure 2: Schematic diagram of measuring unit

3. RESULTS AND DISCUSSION

After designing the complete device, evaluation of the system is implemented in two parts. Initially the measuring unit is evaluated to verify that the unit is functioning properly and measuring the readings accurately. Subsequently the transmission unit is evaluated to verify that the readings are transmitted over power lines between any two outlets without any interference. During the measuring unit evaluation process, digital multimeter is used to measure the supply AC voltage from the outlet. Then the measuring unit is directly plugged in to measure the supply voltage. In this case the current is displayed "0.000A" since no appliance is connected to the unit so that the inner circuitry gets open circuited resulting no current flow through the current sensor. Developed system measured power quality parameters when it attached to household appliances.

4. CONCLUSION

Digital power monitoring with PLC system can be developed to measure three phase power quality parameters by improving system designs and using high end devices. Utilizing surge protector in power monitoring systems is an added advantage. A surge protector is a system designed to protect electrical devices from voltage spikes. A surge protector attempts to limit the voltage supplied to an electric device by either blocking or by shorting to ground any unwanted voltages above a safe threshold. In this present system is not capable of filtering surges in the grid. However as the further development this device can be improved to filter voltage fluctuations and power abnormalities when they appeared in the grid using a surge filter. As a result of this, appliances can be protected from lightning/surges and protection against overloads as well. Furthermore protection for short circuit issues can be reduced by using those filtering systems. By providing required voltage and current, appliances can be utilized longer life without defects. Therefore improved power monitoring systems provide great reliability on home appliances with necessary details about their behavior.

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