

# COMPARISON BETWEEN A CONSTRUCTED ARDUINO BASED SYSTEM AND KEITHLEY SOURCEMETER 2400 ON SOME ELECTRONICS DEVICES

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## ABSTRACT

In this paper, a portable and cost effective arduino based system has been developed which measures the properties of the Device Under Test (DUT) by passing sweeping voltage across its terminals while measuring the corresponding current flowing through it. The system generates current-voltage data of the DUT and sends to a computer system for analysis. Also a comparison between the constructed arduino based system and Keithley SourceMeter 2400 on a resistor, Light Emitting Diode and BC548 transistor is presented. The constructed arduino based system effectively measures the ohmic value of the resistor, threshold voltage of the Light Emitting Diode, and the BC548 transistor's threshold voltage with great accuracy.

**Keywords:** Arduino, Sweeping Voltage, Device Under Test, Current-Voltage Data

## INTRODUCTION

Measurement is the integral part of modern science as well as of engineering, commerce, and daily life (Tal, 2015). It is important in science because it enables a scientist to verify theories and hypotheses. The results obtained from measurements determine the way people think and interact every day.

There are different instruments for the measurement of the properties of electronics components. One of the instruments is sourceMeter. A SourceMeter or Source-Measure Unit is a fixed combination of a voltage source with an ammeter in series and a current source with voltmeter in parallel (Guvench *et al*, 2000). The source and the measurement cannot be separated. Keithley's Series 2400 Source Measure Unit (SMU) Instruments are designed specifically for test applications that demand tightly coupled sourcing and measurement (www.keithley.com). However, this Keithley instrument is costly. Therefore, it is necessary to develop a low cost but efficient system of measurement which could be used to test components.

In this work, an automated system for the measurement of the properties of some electronics components has been developed. The performance parameters are IV characteristics curve, threshold voltage etc (Gour *et al*, 2016). The system applies a sweeping (automatically varying) voltage across the terminals of the Device Under Test (DUT) while measuring the corresponding current flowing through the device. An arduino (microcontroller) has been programmed to carry out the voltage-current characterization. The system can be interfaced with a computer using (USB cord) and the arduino software (as platform) for the display of data generated by the system.

This paper also presents the comparison between results obtained from the constructed arduino based system and results

obtained from the Keithley SourceMeter 2400 on some electronics devices such as resistor, light emitting diode and BC548 transistor. Measurement is the integral part of modern science as well as of engineering, commerce, and daily life (Tal, 2015). It is important in science because it enables a scientist to verify theories and hypotheses. The results obtained from measurements determine the way people think and interact every day.

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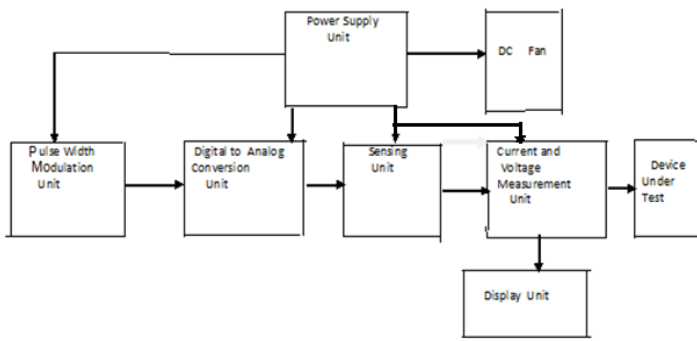
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## MATERIALS AND METHODS

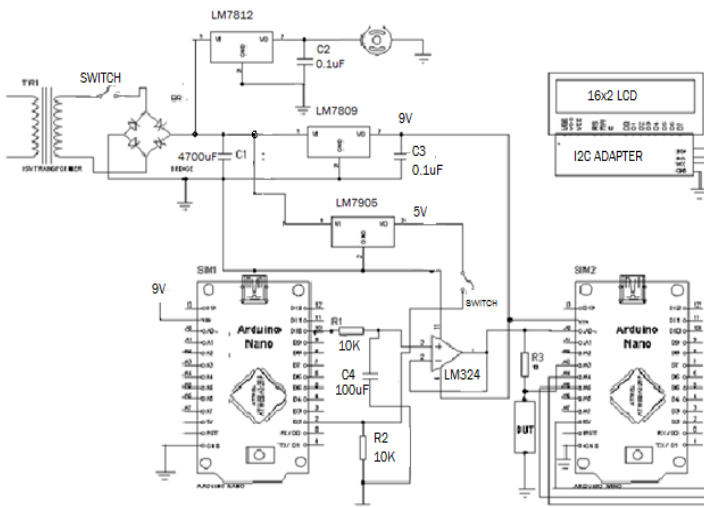
### System Model and Flow

The major units of the arduino based system for the measurement of the properties of some electronics components are: power supply unit, pulse width modulation unit, digital to analog conversion unit, sensing unit, current and voltage measurement unit and display unit. Figure 1 shows the block diagram of the constructed system.

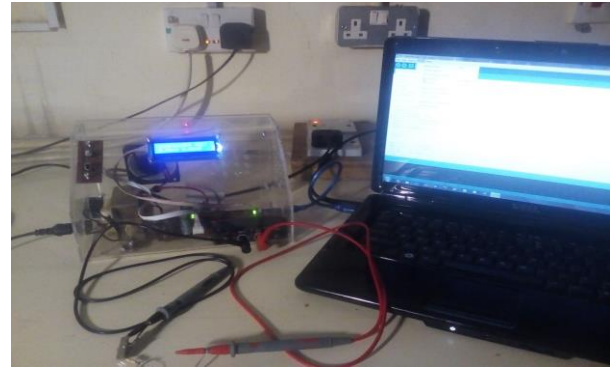


**Figure 1:** The Block Diagram of the Constructed System

The power supply unit supplies 9V to power the system. The Device Under Test (DUT) is connected in series with a 10Ω (shunt resistor) which helps in determining the sweeping voltage across the DUT and the corresponding current due to the activities of the pulse width modulation unit and digital to analog conversion unit ([www.engineersgarage.com](http://www.engineersgarage.com)). The current/voltage measurement unit measures the voltage across the DUT and the current flowing through it, then displays the results via a 16x2 LCD and a computer system as shown in the complete circuit diagram (fig.2), while figure 3 shows the setup of the constructed system for the measurement of the properties of electronics components. C computer language was used to program the two arduino for pulse width modulation and current-voltage measurement (Brian 2011).



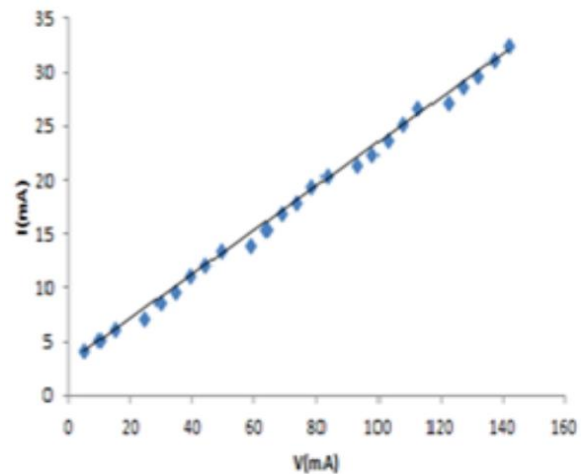
**Figure 2:** The complete circuit diagram of the constructed system for measurement of the properties of some electronics components.



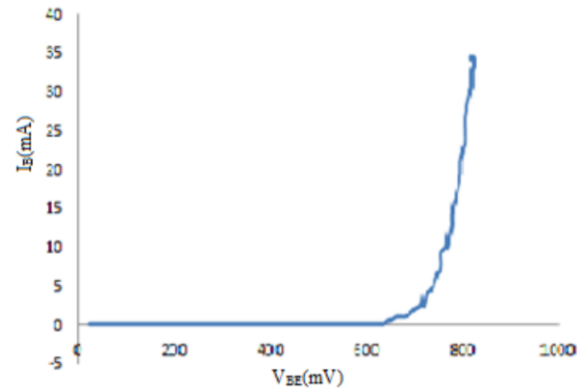
**Figure 3:** The Setup of the constructed System for the Measurement of the Properties of Some Electronics Components

### RESULTS AND DISCUSSION

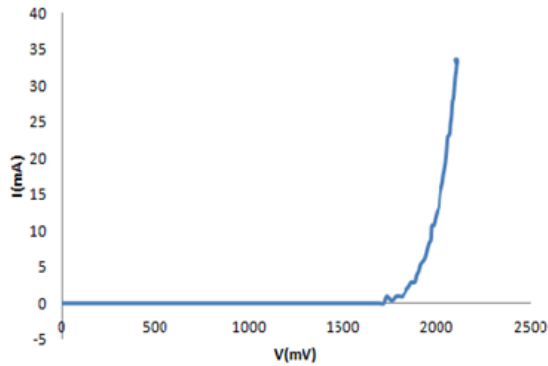
Keithley SourceMeter 2400 and the constructed arduino based system were both used to carry out the current-voltage (I-V) characterization of a 4.7Ω Resistor, Red Light Emitting Diode and BC548 transistor for comparison. The (I-V) data generated by the arduino based system on arduino integrated development environment (IDE) were copied to Microsoft Office Excel in order to plot their graphs. Figures (4-9) show the results obtained from the two systems.



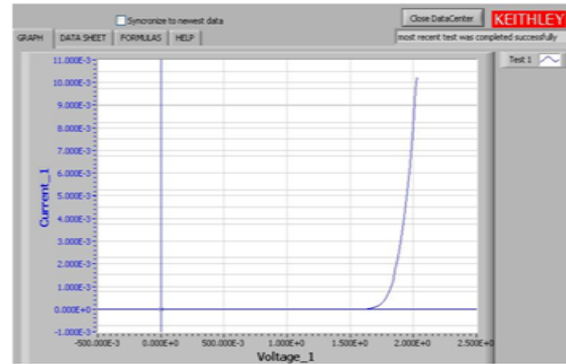
**Figure 4:** I-V Characteristic of a 4.7Ω Resistor using the Constructed System



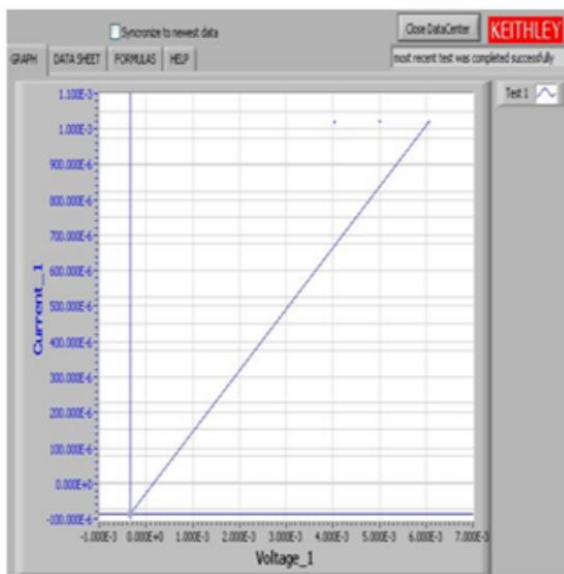
**Figure 5:** Forward Voltage of a BC548 Transistor using the Constructed system



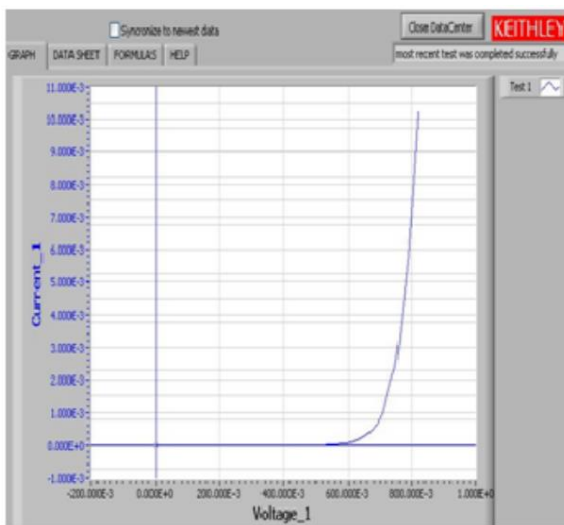
**Figure 6:** I-V Forward Characteristic of a Red Light Emitting Diode using the Constructed system



**Figure 9:** I-V Forward Characteristic of a Red Light Emitting Diode (LED) using Keithley SourceMeter 2400



**Figure 7:** I-V Characteristic of a 4.7Ω Resistor using Keithley SourceMeter 2400



**Figure 8:** Forward Voltage of a BC548 Transistor using Keithley SourceMeter 2400

The 4.7Ω resistor was characterized using both the constructed system and Keithley sourceMeter 2400; 4.82Ω (figure 4) and 5.47Ω (figure 7) were obtained respectively. 0.71V was obtained by both systems as the threshold voltage of the BC548 transistor (figures 5 and 8). With the constructed system, threshold voltage of the red LED was obtained to be 1.83V (figure 6), while with Keithley source meter 2400, 1.80V was obtained. Note: threshold voltage is the forward voltage at which a diode begins to conduct substantially (Peter, 2007).

As it could be seen from the results obtained by both the constructed system and Keithley sourceMeter 2400, it shows that the constructed system works properly. However, it has some fluctuations. The fluctuations could be possibly due to the resolution of the arduino nano, which informs further research.

### Conclusion

The constructed arduino based system for the measurement of the properties of some electronics components effectively measures ohmic values of resistors, threshold voltages of diodes and bipolar transistors' threshold voltages with great accuracy. In spite of the little fluctuations observed, it could be used as an alternative to Keithley sourceMeter 2400. The system is cost effective and portable.

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