

# Arduino Base Multimeter

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**Abstract:** *The main objective of this project is to build an Arduino nano based All in one multimeter, a device that can be used to measure the voltage, current and the power consumed by a load. There are number of ways that you can implement the Arduino nano based all in one multimeter Project. One of the easy ways is to interface a Voltage Sensor and a Current Sensor with Arduino, measure the voltage and current values and finally with some mathematics, you can calculate the Power in Watts. The Sensor Part of the circuit is responsible for measuring the Voltage across the load and Current through the load. Both these values, which are analog in nature, are given to the Arduino to its ADC. Arduino converts these values to digital values and makes a few calculations as displays the results on the LCD.*

**Keywords:** Micro controller, Sensor unit, Aurdino Board, Wattmeter, Measuring Instruments

## I. INTRODUCTION

As electrical engineers, we always depend upon meters/instruments to measure and analyse the working of a circuit. Starting with a simple multimeter to a complex power quality analysers or DSOs everything has their own unique applications. Most of these meters are readily available and can be purchased based on the parameters to be measured and their accuracy. But sometimes we might end up in a situation where we need to build our own meters. Say for instance you are working on a solar PV cell and you would like to calculate the power consumption of your load, in such scenarios we can build our own Wattmeter using a simple microcontroller platform like Arduino.

### 1.1 Measuring Instruments

A measuring instrument is a device for measuring a physical quantity. In the physical sciences, quality assurance, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events. Established standard objects and events are used as units, and the process of measurement gives a number relating the item under study and the referenced unit of measurement. Measuring instruments, and formal test methods which define the instrument's use, are the means by which these relations of numbers are obtained. All measuring instruments are subject to varying degrees of instrument error and measurement uncertainty.

These instruments may range from simple objects such as rulers and stopwatches to electron microscopes and particle accelerators. Virtual instrumentation is widely used in the development of modern measuring instruments.

### 1.2 Ammeter

The meter uses for measuring the current is known as the ammeter. The current is the flow of electrons whose unit is ampere. Hence the instrument which measures the flows of current in ampere is known as ampere meter or ammeter. The ideal ammeter has zero internal resistance. But practically the ammeter has small internal resistance. The measuring range of the ammeter depends on the value of resistance. The ammeter is connected in series with the circuit so that the whole electrons of measurand current passes through the ammeter. The power loss occurs in ammeter because of the measurand current and their internal resistance. The ammeter circuit has low resistance so that the small voltage drop occurs in the circuit.



Figure 1: Ammeter

### 1.3 Arduino

In default the Arduino is not equipped with a display to visualize measuring-data, for example from your temperature or your pressure Sensor. If you want to get the data shown you need a PC, printing the data to the console or mounting a display directly to the Arduino. So there is no simple way to WIRELESSLY visualize measuring-data. In this intractable Fig.2 will show how to transfer measured Sensor-data in real-time from your Arduino-Microcontroller to your Android-Smartphone via Bluetooth.

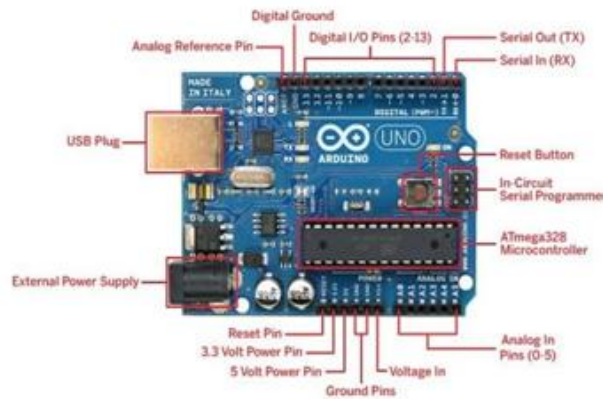


Figure 2: Arduino

## II. PROBLEM FORMULATION

It is difficult or sometimes even impossible to measure current, voltage and power at a time with ordinary multimeters and watt meters. It is very expensive to measure low power ratings with normal wattmeter and multimeter. To overcome these disadvantages we are going to design a special type of meter with Arduino nano microcontroller with the help of the Arduino Microcontroller we can measure voltage current and power at a time.

### 2.1 Existing Technology

The entire project can be divided into three basic blocks;

- 1) Power Sensor Unit
- 2) Processor Unit
- 3) Display Unit

The Power Sensor Unit allows the current to flow through a device whose power consumption needs to be measured. The Sensor Unit produces two voltages, one is the Voltage output from the power supply and another one is a voltage which ranges from 0 to 5V. The difference between these two voltages is proportional to the amount of Current flowing through the Sensor unit. The Processor Unit can take two input voltages both in the range of 0 to 5V. This unit takes the Sensor Unit's output as input voltages and uses the ADC to read these voltages. An Algorithm is then applied to calculate the Power consumption of the device. The unit then sends a 4bit data to the Display Unit to display the power

consumption in Watts. The Display Unit takes the 4bit data from the Processor Unit and produces a 16\*2 display for the current consumption of the device.

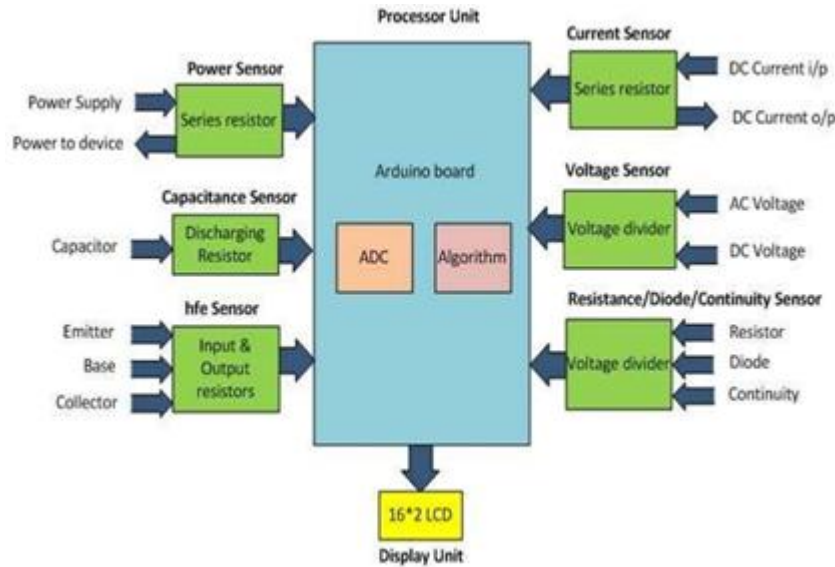


Figure -3: Block diagram

## 2.2 Proposed Technology

The circuit is designed to fit into systems operating between 0-24V with a current range of 0-1A keeping in mind the specification of small applications. But you can easily extend the range once you understand the working of the circuit. The underlying principle behind the circuit is to measure the voltage across the load and current through it to calculate the power consumes by it. All the measured values will be displayed in a 16\*2 Alphanumeric LCD. For ease of understanding the arduino wattmeter circuit is split into two units. The upper part of the circuit is the measuring unit and the lower part of the circuit is the computation and display unit.

## III. HARDWARE IMPLEMENTATION

The measuring unit consists of a potential divider to help us measure the voltage and a shunt resistor with a Non-Inverting Op-amp is used to help us measure the current through the circuit. The output voltage of a potential divider can be calculated using the below formulae. The same be used to decide the value of your resistors, you can use our online calculator to calculate value of resistor if you are re-designing the circuit. Next we have to measure the current through the LOAD. As we know microcontrollers can read only analog voltage, so we need to somehow convert the value of current to voltage. It can be done by simply adding a resistor (shunt resistor) in the path which according to Ohm's law will drop a value of voltage across it that is proportional to the current flowing through it. The value of this voltage drop will be very less so we use an op-amp to amplify it. The circuit for the same is shown below. Here in our case the value of  $R_f$  is 20k and the value of  $R_{in}$  is 1k which gives us a gain value of 21. The amplified voltage from the Op-amp is then given to a RC filter with resistor 1k and a capacitor 0.1uF to filter any noise that is coupled. Finally the voltage is then fed to the Arduino analog pin.

## 3.1 Working

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer

(but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins.

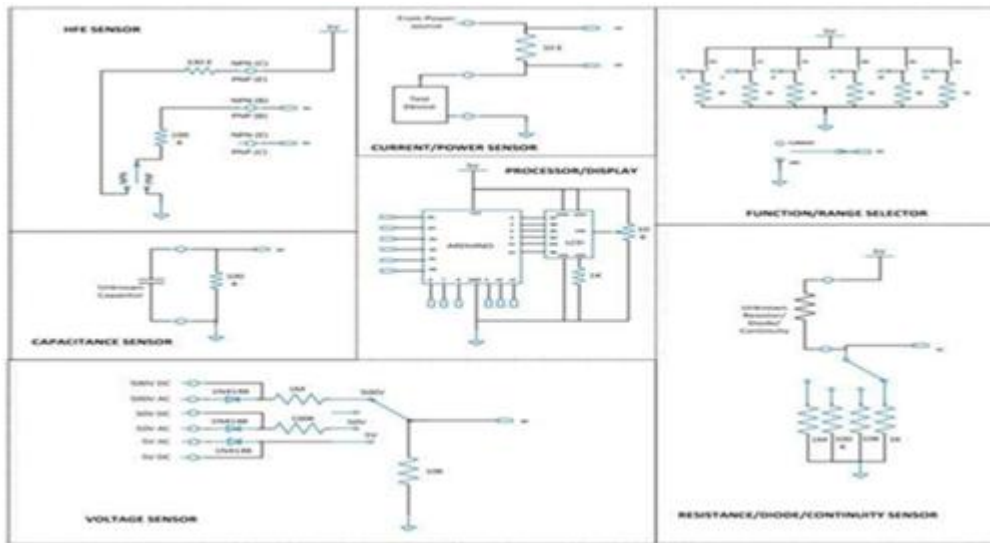


Figure 4: Schematic diagram

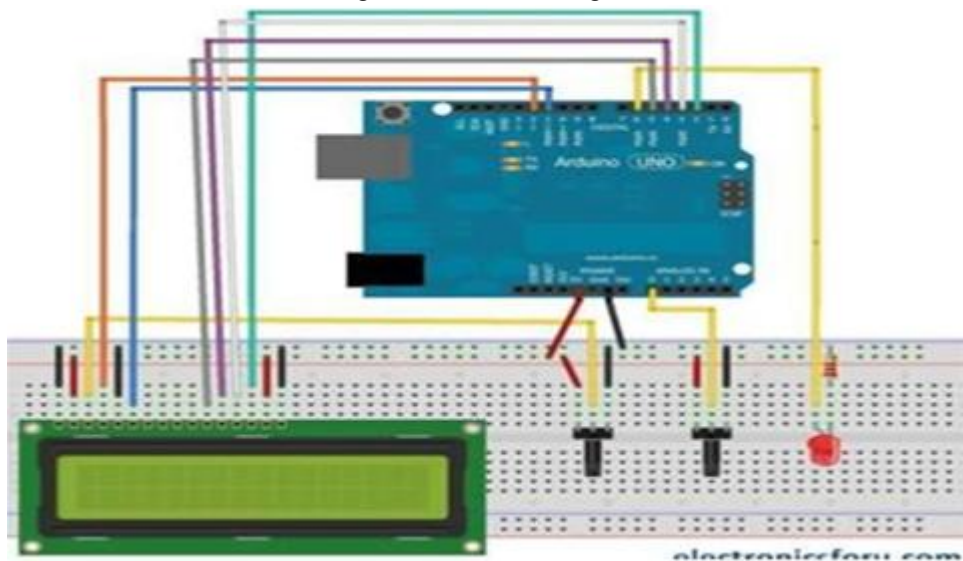


Figure 5 : LCD Circuit Connection

### 3.2 Arduino Uno

The Uno with Cable is a micro-controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs); 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. "Uno" means one in Italian and is the name to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

## IV. RESULTS

This kit explains about the project "Arduino Nano All in One Meter". In this project when supply is given, Arduino and LCD are powered up. Power supply is adjusted to 24V with the help of RPS. When the load is connected, voltage, current, and power values are displayed on the LCD.

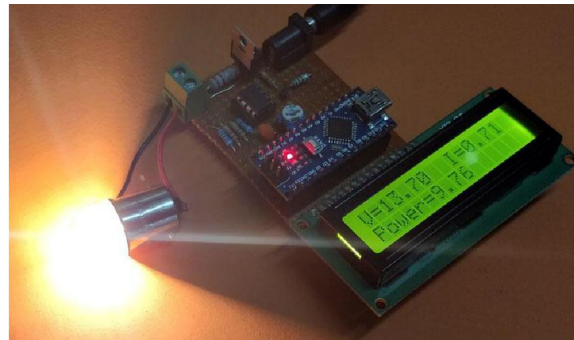


Figure 5: Arduino Nano All In Multimeter

### V. CONCLUSION

This is a project based on Arduino board which can measure the voltage, current and power consumption of the devices at a time. When we connect this wattmeter on to a device which is in operation, the 16\*2 LCD displays its voltage value in volts, current value in amperes and power consumption value in Watts. The project uses an Arduino pro mini board whose ADC feature is used along with the concept of Ohm's law and Voltage Divider circuit to develop this Wattmeter. This project is cost friendly and have less complexity. This project gives more accurate results for the parameters.

### VI. FUTURE SCOPE

This Arduino based all in one meter project has many more upgrades that can be added to increase the performance to auto data logging, plotting graph, notifying over voltage or over current situations etc. Also we can add other parameters like energy, power factor etc by changing the source code. By changing the component ratings in the circuit we can measure high loads.

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