

EP 315 Project Report

# Autoranging Digital Multimeter

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## Aim

The aim of the project was to build an autoranging digital multimeter that can measure DC and resistance and display it on an LCD.

## Hardware and Software used

Atmega168 microcontroller board, LtSpice, opamps, demux, analog bilateral switch IC's, zener diode 5.1V, resistors.

## Range

Voltage range - around 100 mV to 20 V

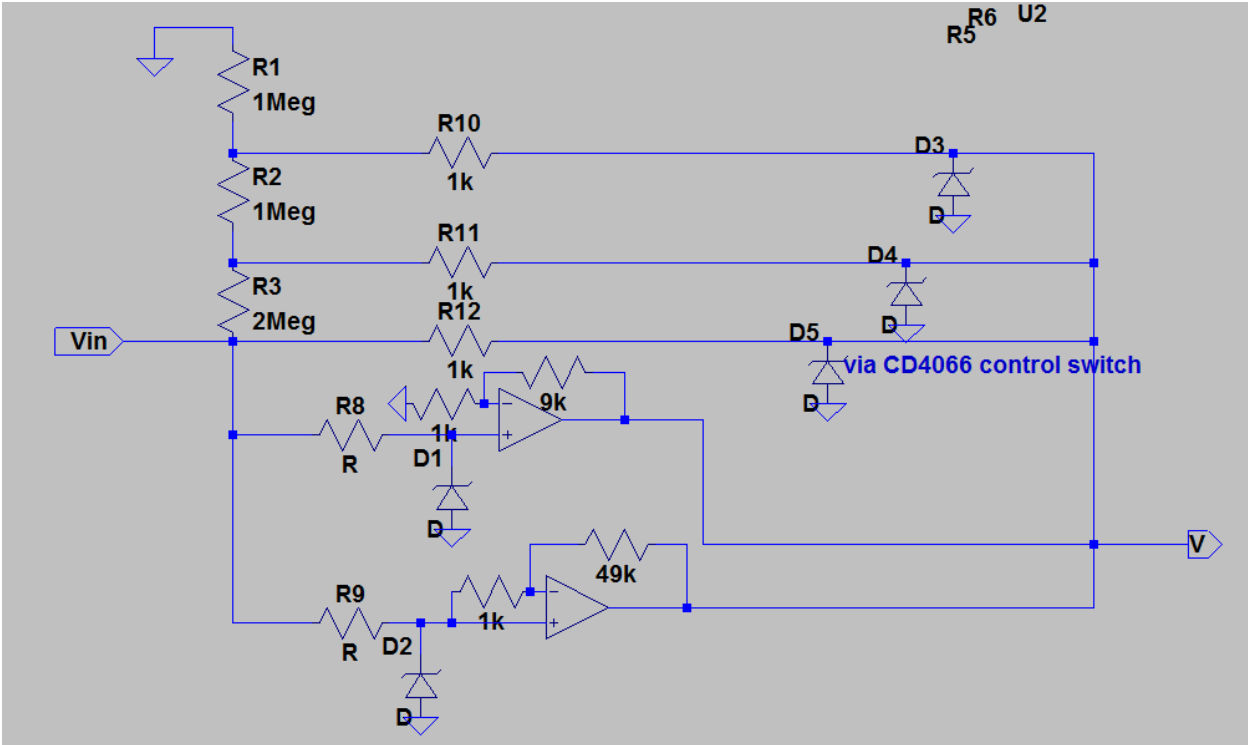
Resistance range -  $k\Omega$  to  $M\Omega$

## How we proceeded:

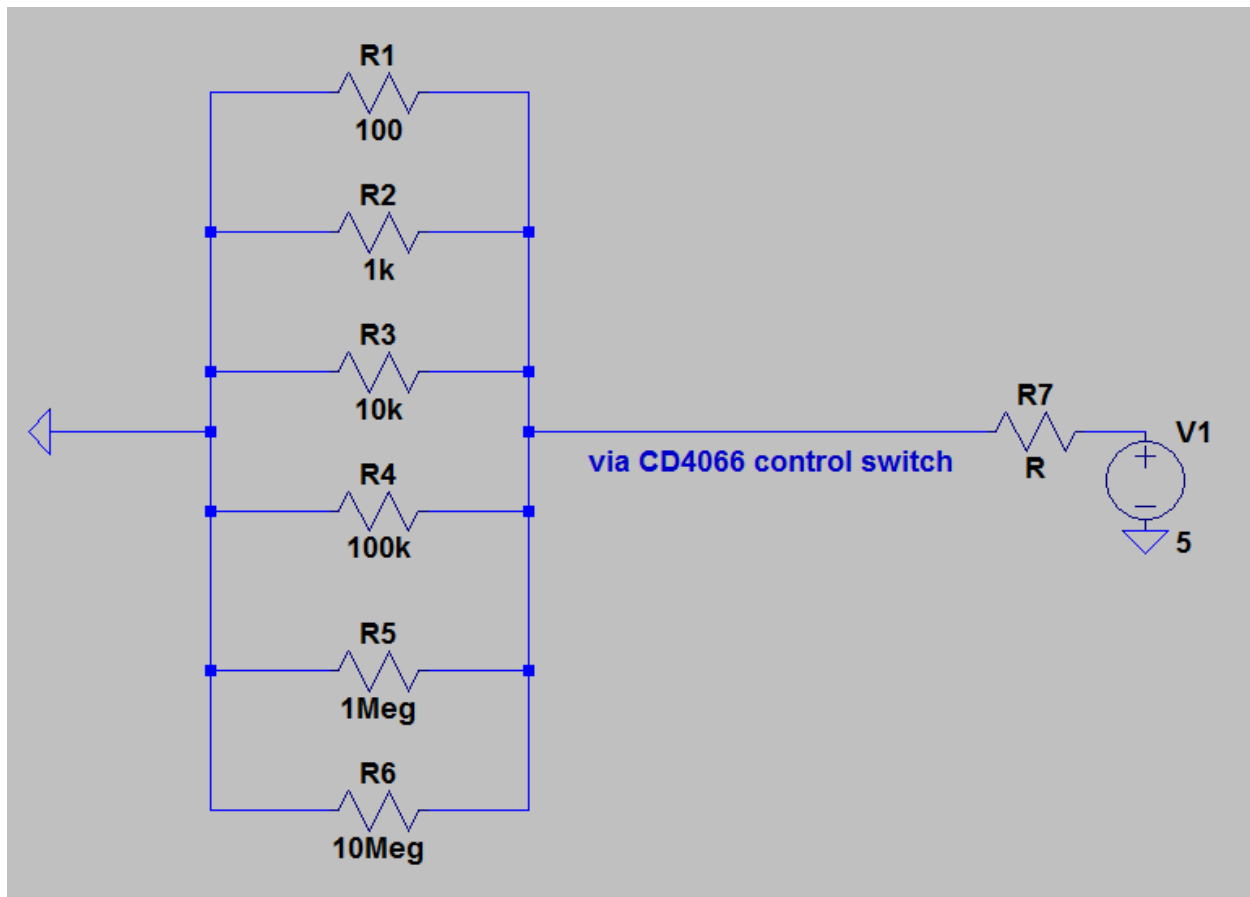
- At first, we gave analog input to the arduino to make it measure voltages between 0V and 5V. Thus we have a multimeter of range 5V.
- We then moved on to higher voltages. To be able to measure them, we needed to scale them down which was done using a resistor ladder. Here, we extended our multimeter to voltages of range 10V and 20V.
- Next, we used opamps to scale up and be able to read very small voltages. We used two opamps to get ranges of 100mV and 500mV.
- To include the auto ranging part, we used a control switch IC - CD4066. This IC reads the lowest (most amplified) voltage first and successively proceeds on to the higher reading (less amplified) if the previous level read 0. The final output on the LCD is the voltage as measured by the suitable level. The code used to control this IC is appended below.
- To make it better, we also included protection circuits to ensure that the input to the IC as well as the arduino stays within the range of 0V to 5V. This protection circuit was made using zener diodes.
- We followed a similar approach to measure resistance. We first made resistance measurement circuits (ohmmeters) for different order of magnitudes of resistances.
- Our program measures values using all the above ohmmeters and reports the most reliable value. We use CD4066 to switch between various ohmmeters.

**Circuit Diagram:**

Voltmeter-



Ohm meter-



## Conclusion

Our digital multimeter is fairly accurate for some ranges (within 10% of the actual value). The voltage range of our Auto DMM can be improved by including a more extensive potential divider (for being able to measure higher voltages) and more amplifiers (for increasing precision in measuring very low voltages). As far as our Auto Ohmmeter is concerned very small resistances can't be measured due to limitations of IC4066 that we are using for auto switching.

## References

- [http://en.wikipedia.org/wiki/Successive\\_approximation\\_ADC](http://en.wikipedia.org/wiki/Successive_approximation_ADC)
- <http://www.allaboutcircuits.com/>
- [http://www.eng.buffalo.edu/courses/mae576/LABS/lab2\\_2003.pdf](http://www.eng.buffalo.edu/courses/mae576/LABS/lab2_2003.pdf)

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