A

MINI PORJECT REPORT

ON

"DIGITAL VOLTMETER USING 8051"

FOR PARTIAL FULFILLMENT
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CERTIFICATE

This is to certify that the Mini Project Report entitled "**DIGITAL VOLTMETER USING 8051**" has been successfully completed by

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Is a bonafide work carried out by them under the supervision of Dr. Mousami Turuk and it is approved for the partial fulfillment of the requirements for the Employability skills and Mini Project and Seminar Subject of T.E. E&TC – 2015 Course of the Savitribai Phule Pune University, Pune.

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Date :

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ABSTRACT

The digital voltmeter has been a key tool for electricians, engineers, and everyday users for decades. Though there have been improvements over the years, data logging still presented an inconvenience to users as measured values must be manually recorded. The Smart Digital Voltmeter aims to remedy this issue by allowing users to connect their smartphone to our meter via Bluetooth which will log data in real time. Using an ATmega328P-PU microcontroller, the project will measure AC and DC voltages, display three to four measurement parameters on an LCD while simultaneously transmitting the data to be plotted and recorded on the application. This paper will describe the input and user protection circuitry, the measurement technology, and the smartphone application design.

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1. INTRODUCTION

Traditional digital voltmeters allow users to measure voltage using two conductive probes and read the data on an LCD or LED display with high accuracy. These meters do not affect the circuitry under inspection because of the large input impedance between the measurement probes, upwards of 10MΩ. The Smart Digital Voltmeter accomplishes this same technology with the added convenience of wireless transmission of data to be stored and analysed once the probes have been removed and the data has been recorded.

This project utilizes the 10-bit analog to digital converter (ADC) that is built into the microcontroller. The ADC converts the measured voltage to a digital value between 0 and 1023 in which the code then converts this value back to an analog value to be displayed. For voltages above the ADC's reference voltage of 1V, the analog signal passes through a voltage divider before being fed into the microcontroller. The user selects the range with one of four switches in which the voltage is expected to be. If the voltage is not within the selected range, the display will prompt the user to select another range.

In the design process for this project, several aspects had to be kept in mind such as user and product safety, accurate measurements, and usability. As this project will potentially be used to measure large voltages, the first and foremost issue that needed to be addressed was the circuitry that would protect users from large voltage spikes, current inrush, power dissipation, and exploding components. Fluke, a well-known manufacturer of high end digital measurement technologies, presented a document on the dangers of measurement and the safety technology used to prevent these dangers titled "ABCs of Multimeter Safety." These guidelines served as the basis for the input protection of the project.

When it comes to the measurement circuitry, the voltage dividers and resistor values were chosen based on several factors such as the resolution and accuracy requirements, the size of the microcontroller's ADC, and the range that the product needed to be able to measure accurately. The meter is able to measure four ranges: millivolts, 1-10V, 10-100V, and 100V-1000V.

The final section of the design process comprised of wirelessly transmitting the measured data to the smartphone application via Bluetooth. The application needed to display both AC and DC values, along with plotting and updating the waveform in near real time. This functionality separates the Smart Digital Voltmeter from any other technology that is presently available.

1.1 Background and context:

Digital Voltmeter abbreviated as DVM is an instrument used to measure the electrical potential difference between two points in a circuit. The voltage could be an alternating current (AC) or direct current (DC). It measures the input voltage after converting the analog voltage to digital voltage and displays it in number format using a convertor. The usage of digital voltmeter has increased the speed and accuracy with which the readings are noted.

A digital voltmeter (DVM) displays the value of a.c. or d.c voltage being measured directly as discrete numerals in the decimal number system. Numerical readout of DVMs is advantageous since it eliminates observational errors committed by operators. The errors on account of parallax and approximations are entirely eliminated. The use of digital voltmeters increases the speed with which readings can be taken. Also, the output of digital voltmeters can be fed to memory devices for storage and future computations.

1.2 Relevance:

A digital voltmeter is a versatile and accurate voltmeter which has many laboratory applications. On account of developments in the integrated circuit (IC) technology, it has been possible to reduce the size, power requirements and cost of digital voltmeters. In fact, for the same accuracy, a digital voltmeter now is less costly than its analog counterpart. The decrease in the size of DVMs on account of the use of ICs, the portability of the instruments has increased.

1.3 Aim of the project:

In this project, I'll show how to design a Digital Voltmeter using 8051 Microcontroller and also explain its working. Voltmeter is a measuring instrument, used to measure the voltage difference between two points in electrical network.

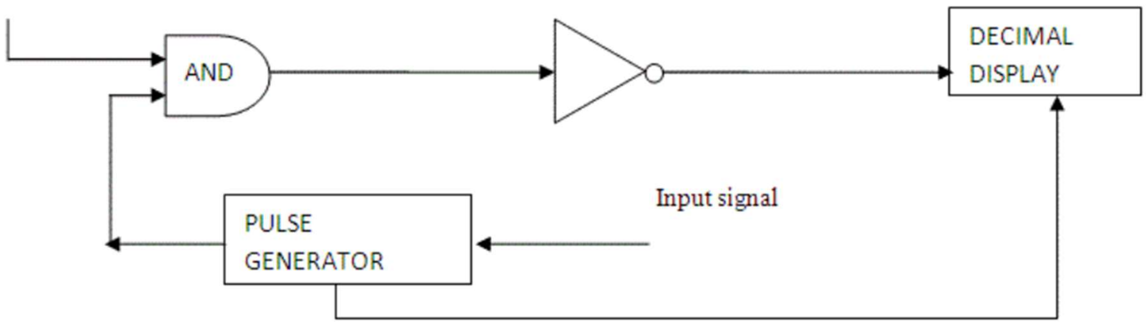
1.4 Objectives:

- To count the voltage in multiple devices using a digital means.
- Evolution of the old analog voltmeter to a Digital one.
- To learn about implementing 8051 microcontrollers.

2. SYSTEM DESIGN

The voltmeter can be broken down into four basic systems: input protection, measurement circuitry, wireless transmission, and application design. To best describe the design and operation of these systems, they will be analysed separately. In each section, the strategic hardware design and software implications will be presented. A. Analog vs Digital Voltmeter The digital voltmeter is different from all kinds of analog voltmeters because it is the only voltmeter that obtains a measurement digitally rather than an analog reading. In other words, a digital multimeter directly indicates a measurement value rather than relying on deflection. Digital voltmeters are excellent instruments because they completely eliminate error due to parallax. Parallax is when a user attempts to read the pointer on a scale. With digital voltmeters, any two users will not have two results that differ by more than 0.01%. Similar to analog and digital clocks, digital voltmeters have a high-speed reading advantage. The user simply takes one quick look and instantly reads the recorded measurement on the digital voltmeter rather than looking at a pointer and deciding which marker it is pointing to the closest. Additionally, high speed readings of digital voltmeters can be stored in memory for further analysis. This speeds up the recording process because none of the analog voltmeters have this capability. Digital voltmeters have other advantages such as being versatile and accurate, compact and cheap, having low power requirements, increased portability, and the ability to measure both AC and DC voltages. Analog voltmeters do not go without their respective advantages as well. Analog meters are most handy when comparing certain voltages. When a user measures a voltage from a circuit, and wants to see the voltage's magnitude in relation to a different circuit, the user can instantly see the needle's position in both cases. A physical needle in this case is very useful in determining voltages of two different circuits in comparison to one another very quickly. Likely the biggest advantage of analog voltmeters over digital voltmeters, is that analog voltmeters have a needle. Due to this needle, the user can see much easier when a voltage reading alternates between multiple values, unlike a digital voltmeter which goes haywire. B. Input Protection Before selecting the safety measurements for the voltmeter, all of the possible hazardous phenomenon that could occur when using the product must be identified. The most obvious threat are high voltage transients. According to Fluke's "ABCs of Multimeter Safety, voltage spikes can be generated from motors, capacitors, and power conversion equipment such as variable speed drives . Additionally, lightning strikes on substations, power plants, and most commonly transmission lines can also cause high voltage transients. These transients can even occur on low-voltage power circuits and can reach values as high as many thousands of volts. In a case like this, the voltage rating alone is not enough information to tell the user how well the measurement device was designed to not break from these high transient impulses. This is where the user depends on safety margins already built into the voltmeter. Before selecting a range of input protection components, many possible different forms of input protection were considered. One device used for overload protection in voltmeters is fuses. A fuse is a very thin wire that melts or vaporizes when current passing through it exceeds a particular fuse rating. Fuses are available with current ratings from 1/500 Amps to hundreds of amps. The thin wire can made from aluminum, tin-coated copper, or nickel. Most fuses in electronic equipment are cylindrical in shape and are glass or ceramic with a metal cap at each end. The current rating and voltage are written on one of these two metal end caps. Fuses are placed near the start of the circuit on a measurement device such as a voltmeter in order to monitor the current going into the meter. If the current entering the probes of the voltmeter is too high for the prevent further damage to the device. Although fuses are not very necessary because the high input impedance of a voltmeter already limits most of the current that can pass into the meter, fuses serve as an extra protection against overcurrent. Overcurrent can cause electric components to overheat and cause a fire. It is beneficial to incorporate a fuse into the voltmeter design because if worst case scenario occurs, it is cheaper to replace a fuse rather than purchase a new meter. Adding a fuse into a voltmeter also helps count for the user making a mistake and connecting the meter's probes where they should not be touching. If lightning were to strike on equipment with a fuse, the user may open the device and, upon examining the parts, see that only the fuse was damaged rather than the power supply or other components.

2.1. Block Diagram



Explanation of various blocks:

- **Input signal:** It is basically the signal i.e. voltage to be measured.
- **Pulse generator:** Actually it is a voltage source. It uses digital, analog or both techniques to generate a rectangular pulse. The width and frequency of the rectangular pulse is controlled by the digital circuitry inside the generator while amplitude and rise and fall time is controlled by analog circuitry.
- **AND gate:** It gives high output only when both the inputs are high. When a train pulse is fed to it along with rectangular pulse, it provides us an output having train pulses with duration as same as the rectangular pulse from the pulse generator.
- **NOT gate:** It inverts the output of AND gate.
- **Decimal Display:** It counts the numbers of impulses and hence the duration and display the value of voltage on LED or LCD display after calibrating it.

CODE:

```
#include<reg51.h>
#define lcd P3
#define dat P2
sbit rs=P1^6;
sbit e=P1^7;


void delay (int);
void display (unsigned char);
void cmd (unsigned char);
void init (void);
void string (char *);
void intro (void);
char i=0;
```

```
void delay (int d)
{
	unsigned char i=0;
	for(;d>0;d--)
	{
		for(i=250;i>0;i--);
	    for(i=248;i>0;i--);
	}
}
void cmd (unsigned char c)
{
	lcd=c;
	rs=0;
	e=1;
	delay(10);
	e=0;
}
void display (unsigned char c)
{
	lcd=c;
	rs=1;
	e=1;
	delay(10);
	e=0;
}
void string (char *c)
{
	while(*c)
	{
		display(*c++);
	}
}
void init (void)
{
	cmd(0x38);
	cmd(0x01);
  cmd(0x0c);
	cmd(0x80);
}
void intro (void)
{
	string("  Electronics  ");
	cmd(0xc0);
	string("     Hub      ");
	delay(2000);
	cmd(0x01);
```

```
        string("   Digital    ");
        cmd(0xc0);
        string("   Voltmeter   ");
        delay(2000);
        cmd(0x01);
        cmd(0x80);
}

void main()
{
        unsigned int temp=0;
        unsigned int temp1=0;
        float val=0.0;

        init();
        intro();
        dat=0xff;
        while(1)
        {
                if(i==0)
                {
                        string(" Volts - ");
                        i++;
                }
                val=dat*0.02;  // 0.02 is resolution of adc
                val=val/0.2;   // 0.2 is nothing but (R2/(R1+R2)) resistor values in the voltage
sensor
        cmd(0x89);
                if((val>=1.0) && (val<10.0))
                {
                        display(' ');
                temp=val*1000;
                temp1=((temp/1000)+48);
                display(temp1);

                        display('.');

                temp1=(((temp/100)%10)+48);
                display(temp1);
                }
                else if((val>=10.0) && (val<100.0))
                {
                        temp=val*100;
                temp1=((temp/1000)+48);
                display(temp1);
```

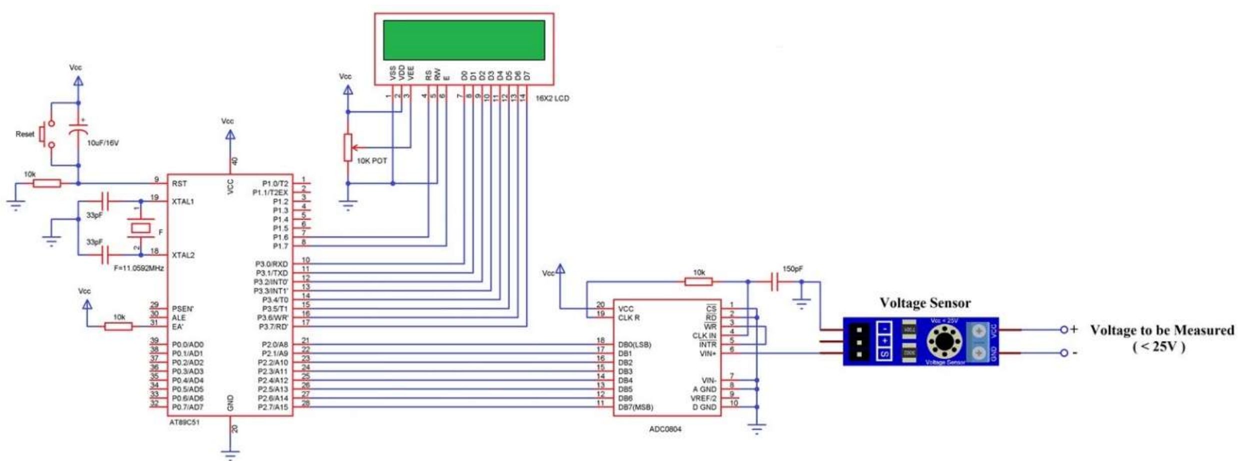
```
				temp1=(((temp/100)%10)+48);
			display(temp1);

				display('.');

				temp1=(((temp/10)%10)+48);
			display(temp1);
			}
			else
			{
				display(' ');
				string("0.0");
			}
			delay(1000);
 }
	while(1);
}
```

Implementation

This project aims at building a Digital Voltmeter using an 8051microcontroller. All the data accessed and processed by them microcontroller is the digital data. And thus, the usage of an analog-to-digital converter finds its necessity here. A standard analog-to-digital converter ADC0804 is used in the current project. The input voltage (which is the analog input)is restricted to be in the range of 0-15V. The processed data in the 8051 is used to drive a display output on a LCD display unit. The display is in the form of digits and is accurate to a value of one decimal. The input voltage is desired to be that of a DC voltage for steady



3. Learning Outcome:

- Learnt about the 8051 Microcontroller.
- Learnt about the using of Software to implement the project.
- Learnt about how actually a digital voltmeter is made.

4. **Conclusion:**
   The Smart Digital Voltmeter is a unique technology that combines the usefulness of a traditional digital voltmeter with the convenience of automatic data logging and waveform display. Making use of analog-digital conversion, voltage dividers, wireless transmission and sorting algorithms, product development relied on nearly all aspects of electrical and computer engineering. Additionally, new technologies such as varistors and thermistors were learned through the course of this project. The project was developed using the electrical and computer design techniques the team learned throughout the ECE program and personal study.