

STUDY OF WEIGHT MEASUREMENT SYSTEM USING PIC MICROCONTROLLER

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ABSTRACT

In everyday life, we have been using electronic scales or weighing machines. In every grocery store, vegetable shop or a jewellery shop, weight measurement system is used. The weight of chemicals can be measured in laboratory and these items are weighed using electronic weighing machines.

Electronic weighing technology presents management with rapid, timely and accurate information that provides quick turnaround times for customers. Its popularity can be attested by its use in all the sectors of the industry. In fact, its spectrum of use spans from the traditional retail industry, to manufacturing and warehousing, to postal, health and transport industry.

A load cell is used to sense the weight of object, so here load cell works as a sensor. When load is applied the load column gets compressed and its length changes. This column acts as a primary transducer since it converts applied force into change in length. This change in length is not measured directly. At the same time strain gauge connected to load column gets compressed. The strain gauge acts as a secondary transducer since it records the displacement of the load column. As the strain gauge is compressed, its length gets changed, which depends on magnitude of the applied force on the top of the load cell. The resistance of strain gauge changes when its length changes. This change in resistance can be measured in terms of change in output voltage and amplified using differential amplifier. If the voltage comes to be negative, the inverter makes it positive. Thus, a load cell gives us a voltage level equivalent to the weight applied.

Key words: Kitchen scale, Altium, Proteus, Simulation, Load cell.

INTRODUCTION

A weighing machine is used to measure the weight of object. For kitchen use, we need to measure accurately the weight of ingredients. Kitchen scales are particularly important for consistent results and for weighing meats in order to estimate cooking time. For kitchen use, we need to

measure the quantity of vegetables, fruits and in cooking so you get the right amount of flour sugar and every thing .

Current analog scales employ sensing devices such as transducer load cell or piezoelectric sensors. They do not utilize a digital processor and their readouts to the user are analog hence the name. The scales either have a graduated dial scale and a rotatable pointer or a calibrated rotating dial.

This type of weighing balance has a number of disadvantages. Firstly, the dial has a poor resolution in that small differences in weight between different objects are not easily measured or detected. Secondly, the device has no memory thus the weight of a previously measured object is not stored and can only be recalled mentally or by keeping a written record of the measurements. Thirdly, calibration has to be done at the start of every measurement making it tedious and cumbersome. Fourthly, the device has high electrical power consumption particularly due to the electro mechanical actuator that works on heavy current.

Lastly, the efficiency of the machine is appreciably low due to the moving parts of the actuator in addition to the obvious high cost maintenance

Therefore in order to avoid this, the people are now using digital weighing machine. The weighing machine can measure weight of various products, and even the weight of human being according to its range .It is more accurate than the analog weighing machine.

So, we have made Electronic Weighing Machine for Kitchen use.

1. BLOCK DIAGRAM

Given below is the general block diagram of 'Weight Measurement System'. It shows basic building blocks of the project.

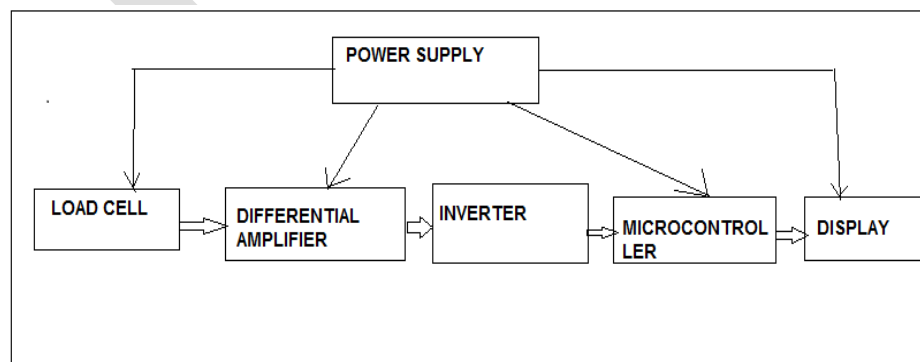


Figure 1: BLOCK DIAGRAM OF ELECTRONIC WEIGHING MACHINE

LOAD CELL : Load cell is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as “Load transducers”.

DIFFERENTIAL AMPLIFIER : Amplifies the output of Load Cell.

INVERTER : It inverts the output of differential amplifier.

MICROCONTROLLER : The output from differential amplifier will be given microcontroller.

POWER SUPPLY : Supply is given to differential amplifier, PIC and LOAD CELL.

LCD : The output voltage is converted into digital form and displayed on LCD.

2. ELECTRONIC HARDWARE AND DESIGN ASPECTS

2.1 Load Cell:

A load cell is described as a “weight measurement device necessary for electronic scales that display weights in digits.” However, load cell is not restricted to weight measurement in electronic scales.

Load cell is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as “Load transducers”.

The load cells based on strain gauges. Hence, the term ‘load cell’ means ‘strain gauge-based load cells’.

The sensing or spring element is the main structural component of the load cell. The element is designed in such a way that it develops a strain, directly proportional to the load applied. Sensing elements are normally made of high strength alloy steels (nickel plated for environmental protection), precipitation-hardened stainless steels, heat-treated aluminum alloys, or beryllium copper alloys.

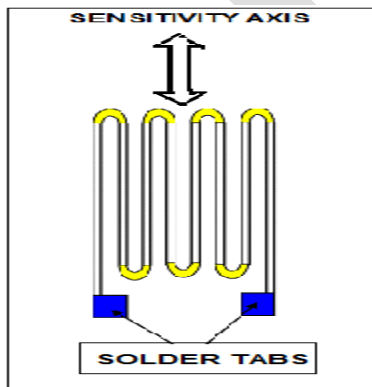


Fig2.1 shows a foil-type strain gauge

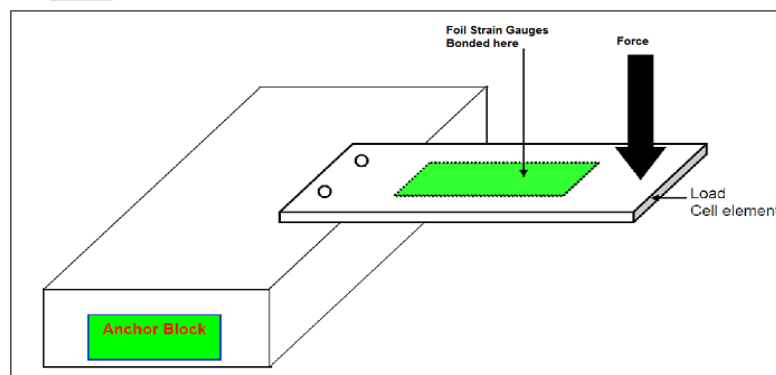


Fig2.2 Principle Of Mounting Load Cell

CHARACTERISTICS OF LOAD CELL :

1. Highly precise and linear measurements
2. Little influence due to temperature changes.
3. Long operating life due to lack of moving parts or any parts that generate friction.
4. Ease in production due to small number of components.
5. Excellent fatigue characteristics

The Load cell which we are using is for Kitchen scale i.e we can measure weight of vegetables, fruits etc.

Available load cells are 6 Kg., 10 Kg., 20 Kg., 40 Kg., 80 Kg and others. Out of these available load cells we will choose 6 Kg. load cell as it satisfies all the requirements.

We have used the load cell which is available in local market.

Load cell selected – CZL601-6Kg.

2.2 MICROCONTROLLER

The output from differential amplifier will be given microcontroller. We can use an 8051 microcontroller, PIC microcontroller or AVR microcontroller.

The 8051 microcontroller does not have in built analog to digital converter i.e. ADC block. Hence, a separate A to D circuitry will be required along with microcontroller, which will increase number of components.

PIC microcontroller has in built 8 bit or 10 bit ADC. Hence with use of PIC microcontroller, circuit will become compact.

OBSERVATION

Table1. Comparison for various PIC microcontrollers is as given in following table

Parameter	PIC18F4520	PIC16F685	PIC18F452
Operating frequency	8MHz	20MHz	8MHz
Program memory	32768 words	4096 words	32 Kbytes
Data memory	1536 bytes	256 bytes	1536 bytes
I/O Ports	A, B, C,D,E	A, B, C	A, B, C, D, E
10 Bit ADC channels	12 channels	12 channels	8 channels

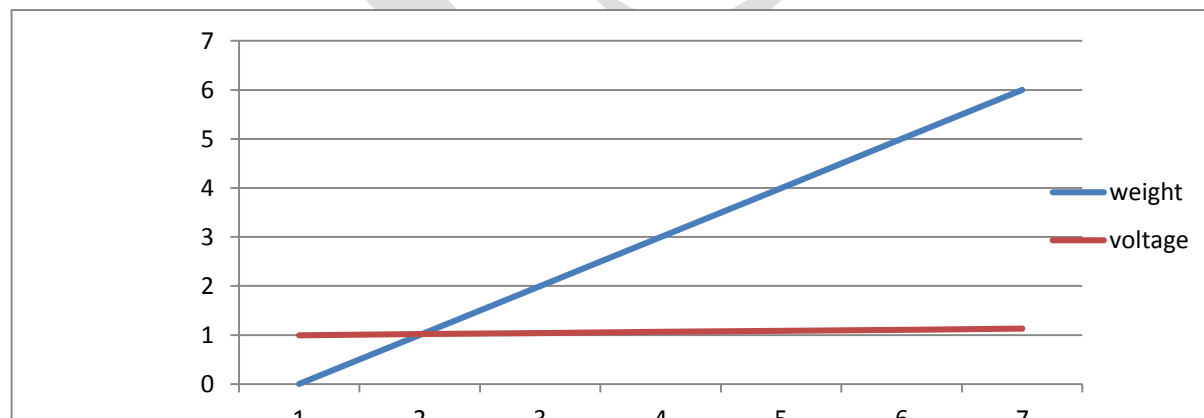
Number of instructions	75	35	75
Packages	40 pin DIP 44 pin PLCC 44 pin TQFP	20 pin DIP	40 pin DIP 44 pin PLCC 44 pin TQFP

Selected Microcontroller- PIC18F452 is chosen.

OBSERVATION TABLE

Table 2. Weight and input voltage to PIC

Weight(Kg)	Output Voltage(V)
0	0.997
1	1.020
2	1.042
3	1.064
4	1.086
5	1.108
6	1.130



2.3 CALCULATIONS

Equation of straight line

$$Y = mX + C$$

At $X=0$ and $Y=0.997$

Answer $C=0.997$

To Calculate slope

$$m = \frac{1.108 - 1.042}{5 - 2}$$

$$m = 0.022$$

Now,

$$X = \frac{Y - c}{m}$$

$$X = \frac{Y - 0.997}{0.022}$$

2.4 DISPLAY : Liquid crystal display i.e. LCD is used for display purpose. A 16 x 2 LCD is used to display results in 4 bit mode

2.5 POWER SUPPLY:

+5V, 500mA for Load Cell

+5V, 1A for +VCC

-5V, 1A for -VEE

2.6 POWER BUDGET

Table 3. Power Budget

Component	Voltage Requirement	Current Requirement	Power Dissipation
Load Cell	5V	500mA	2500mW
PIC 18F452	5V	1.6mA	8mW
LCD 16*2 Display	5V	103mA	515mW
Difference Amplifier +VCC	5V	1nA	5nW
-VEE	- 5V	1nA	5nW
Total			3.023W

3.SOFTWARE ASPECTS

3.1 SOFTWARES USED IN THE PROJECT

We have used following software:

1. MikroC pro software: This software is used for programming the microcontroller. It has an in built library for LCD display and ADC.

2. Proteus Simulation: This software is used for simulating the complete circuit before implementing on PCB.

3.2 Simulation Software:

Simulation of circuit was done through software called '**PROTEUS**'. The code is written in mikro C software where .HEX file is generated. This .HEX file is loaded onto the IC. Proteus has debugging facility. Proteus has a comprehensive and powerful environment for building models and analysing effects on system. It has high level of programmability and built in flexibility. It is high speed simulation software which is reliable, accurate and compact. It has interactive visualisation and analysis tool which is useful for error checking.

3.3 Programming Software:

The software used is Mikro C pro. It is a powerful, feature rich development tool for PIC microcontroller. It is designed to provide the programmer with the possible solution for developing applications for embedded systems, without compromising performance or control. PIC and C fit together well. PIC is used in a wide variety of applications, and C, prized for its efficiency, is the natural choice for developing embedded systems. It supports every level of developer for a number of applications right from the basic level to a more complex level. We can build, compile and debug and test all types of codes in this software. It has an inbuilt library for LCD display and ADC.

3.4 ALGORITHM

Step 1 – Start

Step 2 – Declare port pins which are used for LCD module.

Step 3 – State which pin is to be used as analog input and send logic 1 to that pin. Send logic 0 to all other pins to show that those pins are used as digital input.

Step 4 – Initialise ADC.

Step 5 – Read ADC output and store it in a temporary variable.

Step 7 – Initialise LCD by sending proper commands.

Step 8 – Repeat steps from 2 to 7.

Step 9 – End

4. CODE FOR WEIGHT MEASUREMENT SYSTEM

```
sbit lcd_RS at RD2_bit;  
sbit lcd_EN at RD3_bit;
```

```
sbit lcd_D4 at RD4_bit;
sbit lcd_D5 at RD5_bit;
sbit lcd_D6 at RD6_bit;
sbit lcd_D7 at RD7_bit;
sbit lcd_RS_direction at TRISD2_bit;
sbit lcd_EN_direction at TRISD3_bit;
sbit lcd_D4_direction at TRISD4_bit;
sbit lcd_D5_direction at TRISD5_bit;
sbit lcd_D6_direction at TRISD6_bit;
sbit lcd_D7_direction at TRISD7_bit;
int adc_rd;
float adc_val;
float wt;
char finaltxt[8];
float quant=5.0/1024;
void main()
{
//char res[5];
PORTD=0xFF;
TRISD=0xFF;
ADCON1=0Xc0;
ADC_Init();
LCD_Init();
lcd_cmd(_LCD_CLEAR);
lcd_cmd(_LCD_CURSOR_OFF);
while(1)
{
adc_rd=ADC_Read(0);
adc_val=adc_rd*quant;
wt=(adc_val-0.361)/0.079;
sprintf(finaltxt,"%1.2f",wt);
lcd_cmd(_LCD_CLEAR);
Lcd_Out(1,1,"WEIGHT: ");
Lcd_Out(1,9,finaltxt);
Lcd_Out(1,14,"KGs");
Delay_ms(1000);
}
}
```

CIRCUIT DESIGN

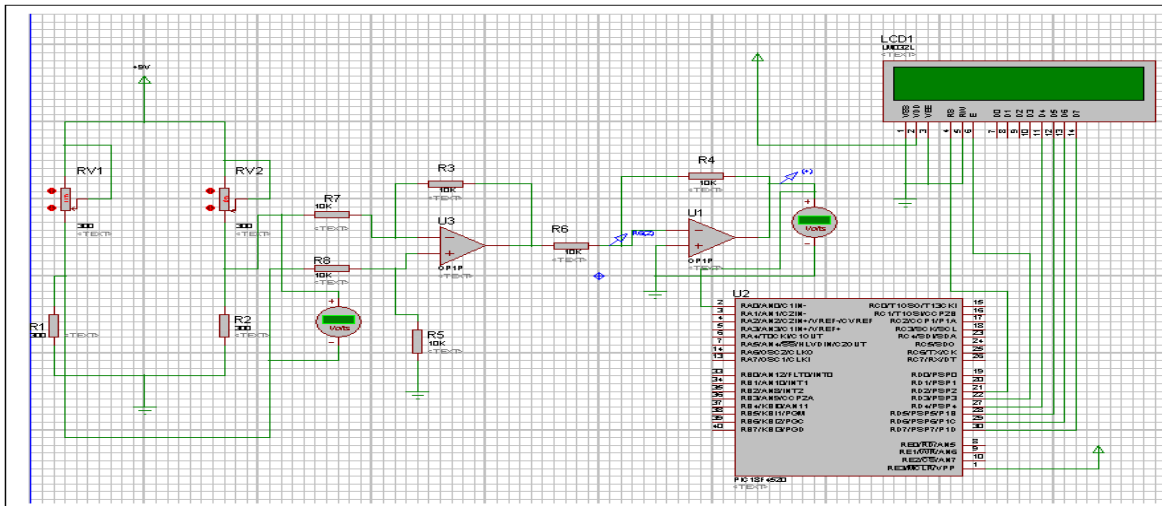


Figure3. Detailed circuit diagram of "Weight Measurement"

5. SIMULATION RESULTS

Simulation results for PIC as well as LCD are as shown in following diagram. The micro c code is loaded into PIC18F452 IC and result is displayed on LCD.

The detailed circuit diagram of Weight Measurement System is as shown below

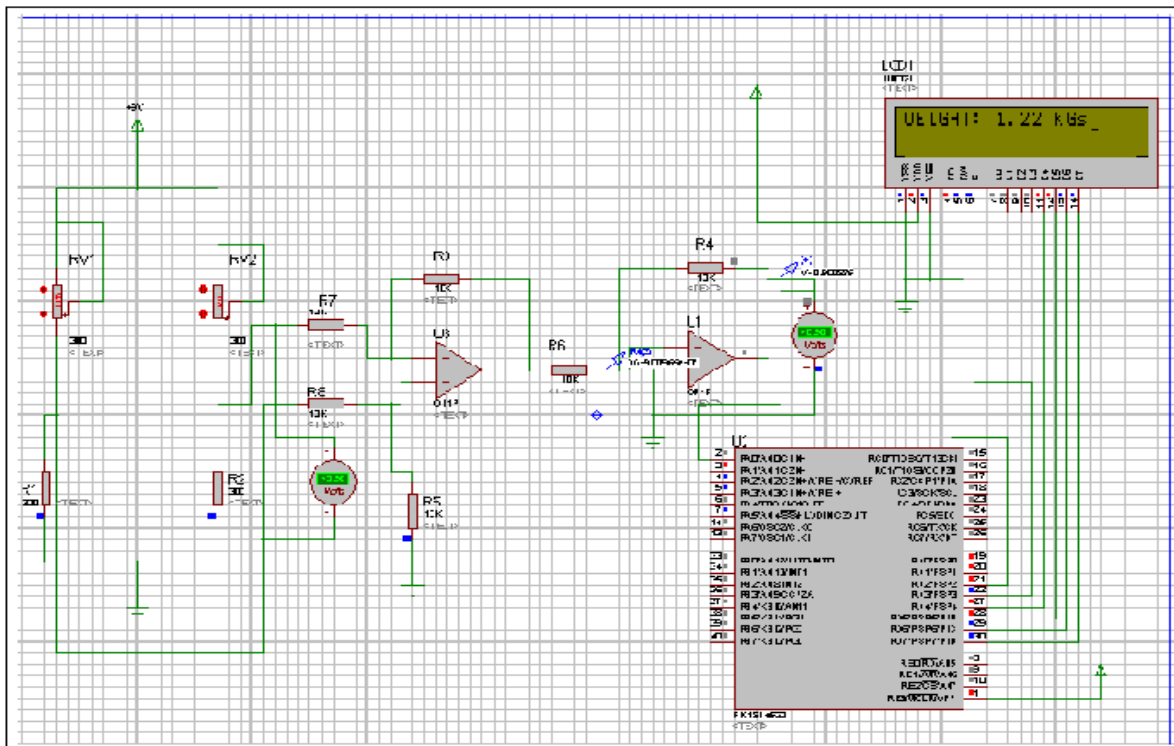


Figure4. Proteus simulation of "Weight Measurement System"

PCB LAYOUT

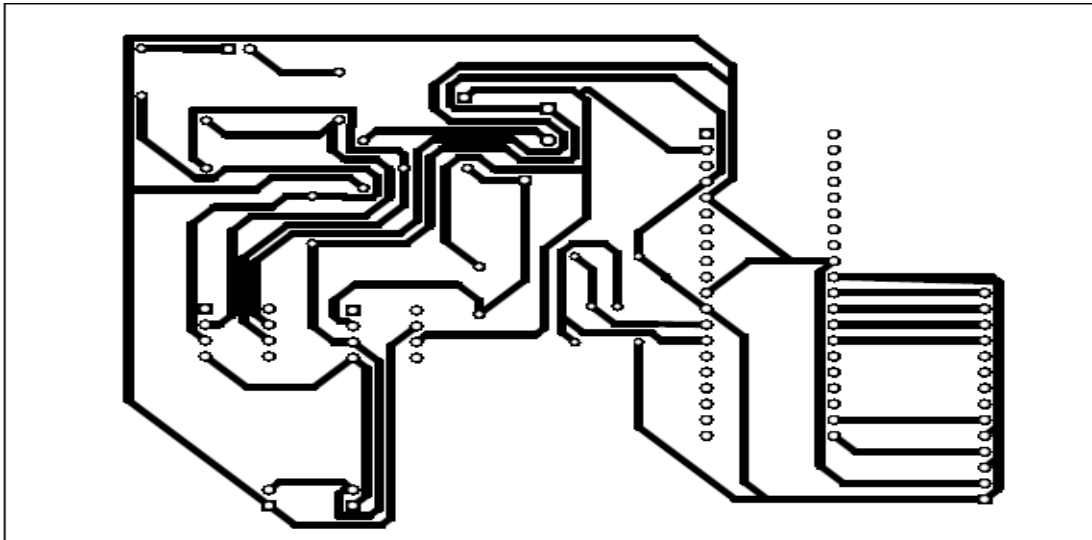


Figure5. PCB Layout for Weight Measurement System

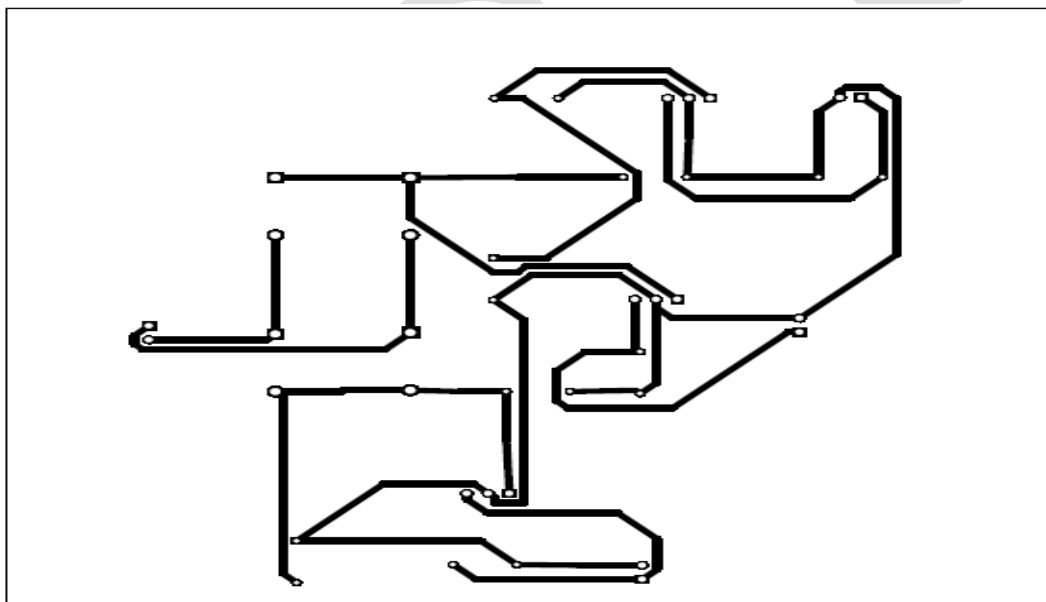


Figure6. PCB Layout for Power Supply

6.TESTING OF MODULES

6.1 TESTING OF LOAD CELL

1. Load cell assembly is built.
2. A 5 volt supply is given to the load cell.
3. Output of load cell is measured for no load condition on digital multimeter.
4. Output of load cell is measured for standard weights on digital multimeter.

Table5. Voltage measured at the output of Load Cell

Weight in Kg	Voltage
0	0 mv
0.5	2 mV
1	4 mV
1.5	6 mV
2	8 mV
2.5	10 mV
3	12mV
3.5	14 mV
4	16 mV
4.5	18mV
5	20mV

6.2 TESTING OF PIC AND LCD

1. Connect OPAMP OP07
2. Give output of load cell as input to differential amplifier between V- and V+.
3. Give 5 V supply voltage to VCC and -5 V supply voltage to -VEE
4. 5 V supply voltage is given to PIC as well as LCD.
5. LCD connected to PIC.
6. The program is loaded into PIC.
7. Weight is display on LCD.

PROJECT PHOTO

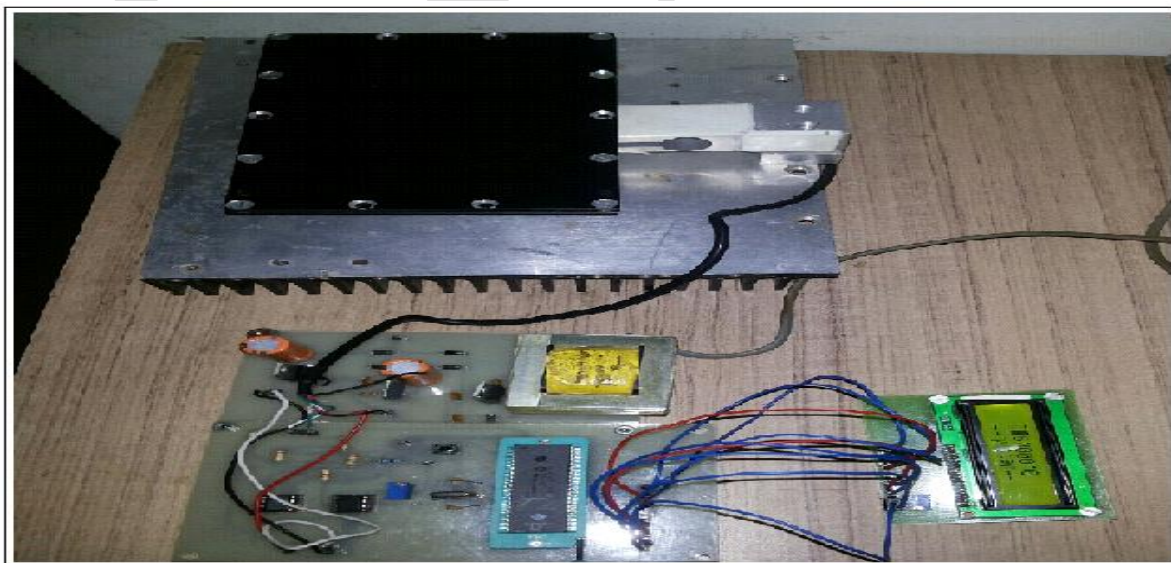


Figure7. Weight displayed by the circuit for 0Kg



Figure8. Weight displayed by the circuit for 1Kg

7. CONCLUSION

In this project, we developed microcontroller based Electronic Weighing Machine. We have used load cell for measurement of weight. The transducer used is a foil strain gauge based load cell mounted to operate by the bending principle. This system is more accurate than analog scale weighing machine.

We can measure the weight of fruits, vegetables etc. We can also measure the weight of ingredients. Weight measurement is used in shops, vegetable shop, jewellery shop, hotels. Electronic weighing technology presents management with rapid, timely and accurate information that provides quick turnaround times for customers.

The developed microcontroller based electronic weighing balance has following advantages:

1. Low-cost, flexible and portable. This system is able to measure mass in the range of 0 to 6kg
2. As Pic Microcontroller has inbuilt ADC, size is compact.
3. Accuracy is more.

6. REFERENCES

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