Design And Construction Of Digital Multi-Meter Using PIC Microcontroller

Khawn Nue, Dr. KyawSoe Lwin, Hla Myo Tun

Abstract: This thesis describes the design and construction of digital multi-meter using PIC microcontroller. In this system, a typical multi-meter may include features such as the ability to measure AC/DC voltage, DC current, resistance, temperature, diodes, frequency and connectivity. This design uses of the PIC microcontroller, voltage rectifiers, voltage divide, potentiometer, LCD and other instruments to complete the measure. When we used what we have learned of microprocessors and adjust the program to calculate and show the measures in the LCD, keypad selected the modes. The software programming has been incorporated using MPLAB and PROTEUS. In this system, the analogue input is taken directly to the analogue input pin of the microcontroller without any other processing. So the input range is from 0V to 5V the maximum source impedance is 2k5 (for testing use a 1k pot). To improve the circuit adds an op-amp in front to present greater impedance to the circuit under test. The output impedance of the op-amp will be low which a requirement of the PIC analogue input is.

Keyword: PIC 16F887 Microcontroller, LCD display, MPLAB, PROTEUS.

I. Introduction

Nowadays many measurement instruments have been used in all laboratories throughout the world. Unfortunately, their accuracies are mostly proportional to the time period. As time passes, they may function incorrectly and generate some errors. The mistaken results from such instruments can cause serious problems in economic system and life safety since they will be used for validating product standards in the importing and exporting industries. In order to ensure that they work perfectly, the calibration process is required. In the past, the calibration has to be performed manually and this process usually takes long time. Presently, fully automatic calibration systems have been used worldwide and they play an important role in the calibration of measurement instruments. They can improve measurement accuracy, repeatability and minimize routine jobs. This system is to measure AC/DC voltage, current, diodes, temperature, connectivity, frequency and resistance using PIC microcontroller. To carry out the design consideration and production of a useful consumer product of PIC microcontroller. The whole process of the digital multi-meter is controlled by PIC 16F887 microcontroller.

II. DIGITAL MULTI-METER SYSTEM

A multi-meter or a multi-tester, also known as a volt/ohm meter or VOM, is an electronic measuring instrument that combines several measurement functions in one unit. A typical multi-meter may include features such as the ability to measure voltage, current and resistance. Modern multi-meters are often digital due to their accuracy, durability and extra features. In a Digital Multi-meter the signal under test is converted to a voltage and an amplifier with an electronically controlled gain preconditions the signal. A Digital Multi-meter displays the quantity measured as a number, which prevents parallax errors. The inclusion of solid state electronics, from a control circuit to small embedded computers, has provided a wealth of convenience features in modern digital meters.

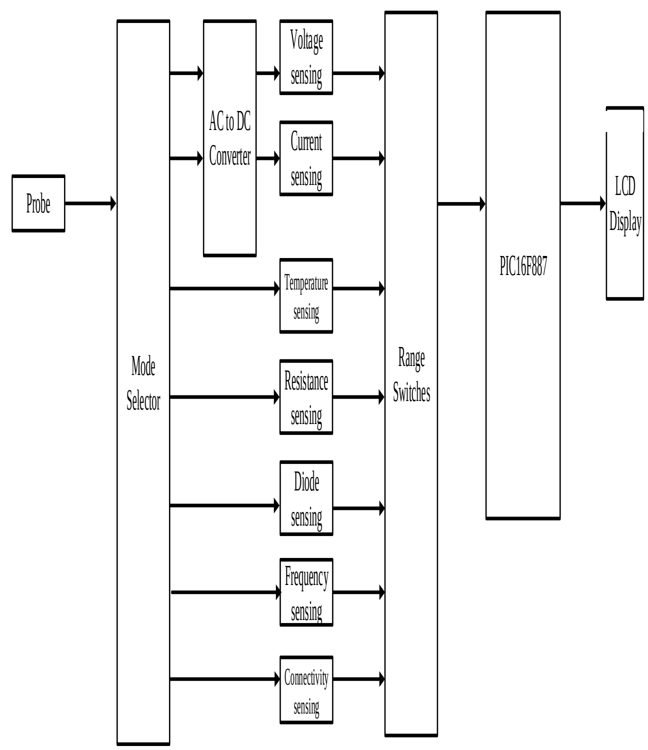


Fig. 1 *Block Diagram of Digital Multi-meter*

V. Software Implementation

Software Implementation can be divided into sixparts: measuring voltage, measuring current, measuring resistance, measuring frequency, measuring continuity and measuring diode. Program for this system is composed of main Processing (sensing/ assigning/ displaying).Microcontroller is main processing unit in remote control system. PIC16F887is chosen to perform the functions needed for digital multi-meter system.

• *Khawn Nue, Dr. KyawSoe Lwin and Hla Myo Tun Department of Electronic Engineering, Mandalay Technological University khawnnue554@gmail.com*

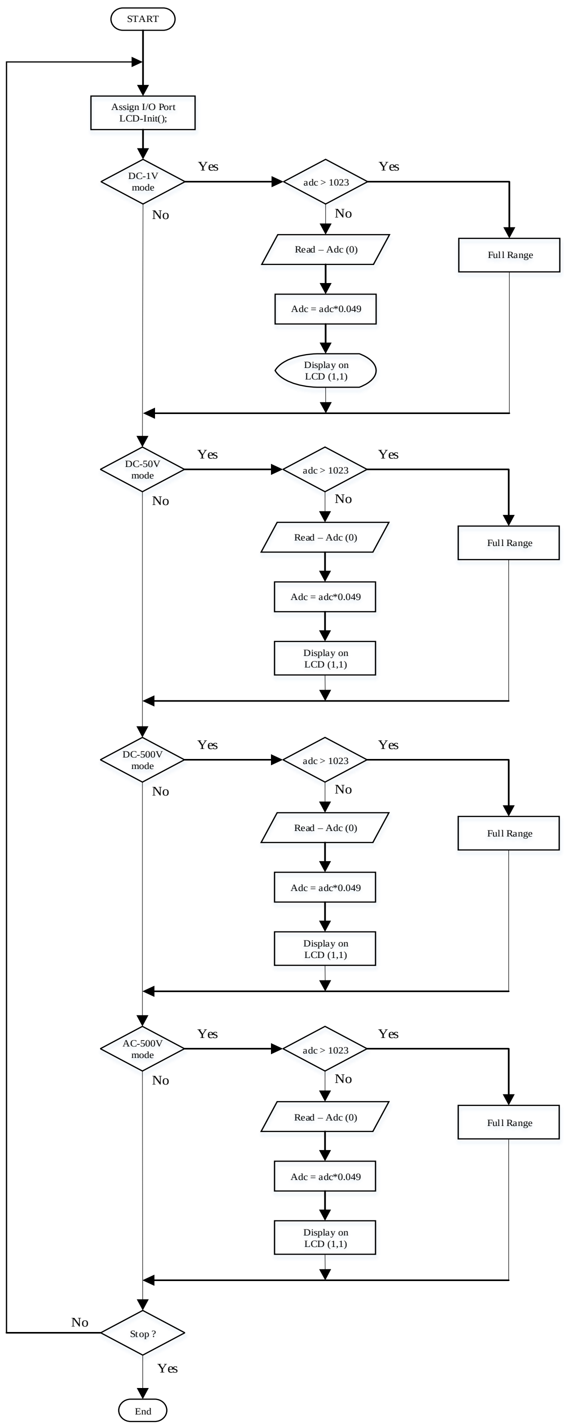


Fig.2 *Flow Chart of voltage measurement*

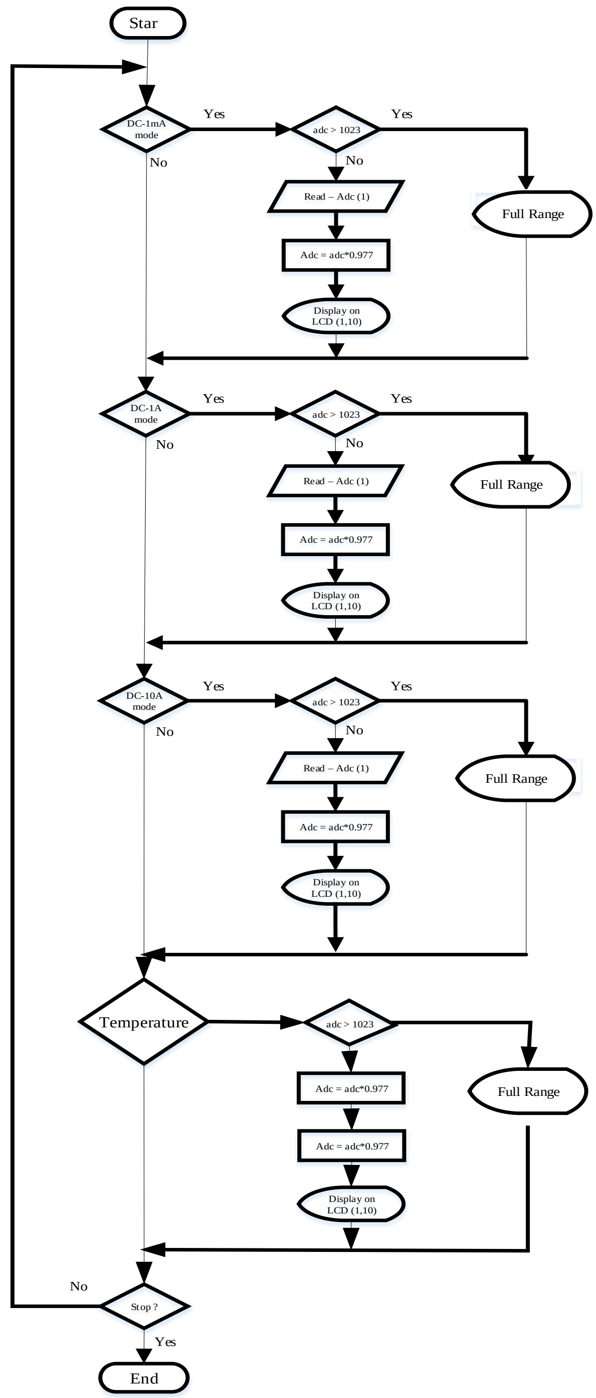


Fig.3 *Flow Chart of current measurement*

The flow chart of the voltage measurement system is shown in figure 2. At the start of the program, PIC needed to be initialized the I/O pins assigned and clock frequency. After that, the PIC receives the corresponding code from the specified pin.Firstly selection dc mode for 0-1V, 0-50V, 0-500V.For 0-1V, it will read between 0 to 1V. For more than 1V, it will be display full range.For 0-50V, it will read between 0 to 50V. For more than 50V, it will be display full range.For 0-500V, it will read between 0 to 500V. For more than 500V, it will be display full range.Similarly for selection ac mode.

Current is the electron flow that causes electrical equipment to operate. When the equipment is turned on, it is considered a “load” on the circuit. A load is any electrical component, such as a lamp, stereo, motor or heating element, that draws current. Current is measured in amperes, or amps. Each load has a rated current limit that should not be exceeded. If a load pulls too much current, excessive heat is produced that may cause insulation damage, component failure and possible fire hazards. If the load is under its rated current limit, it may perform poorly.

The flow chart of the current and temperature measurement system is shown in figure 3. At the start of the program, PIC needed to be initialized the I/O pins assigned and clock frequency. After that, the PIC receives the corresponding code from the specified pin.To test for current, first determine testing DC current. Then set the switch to the appropriate function DC current. To test for temperature, it is related for full -55 C to 150 C range and then an output voltage linearly proportional to the temperature in degree centigrade.

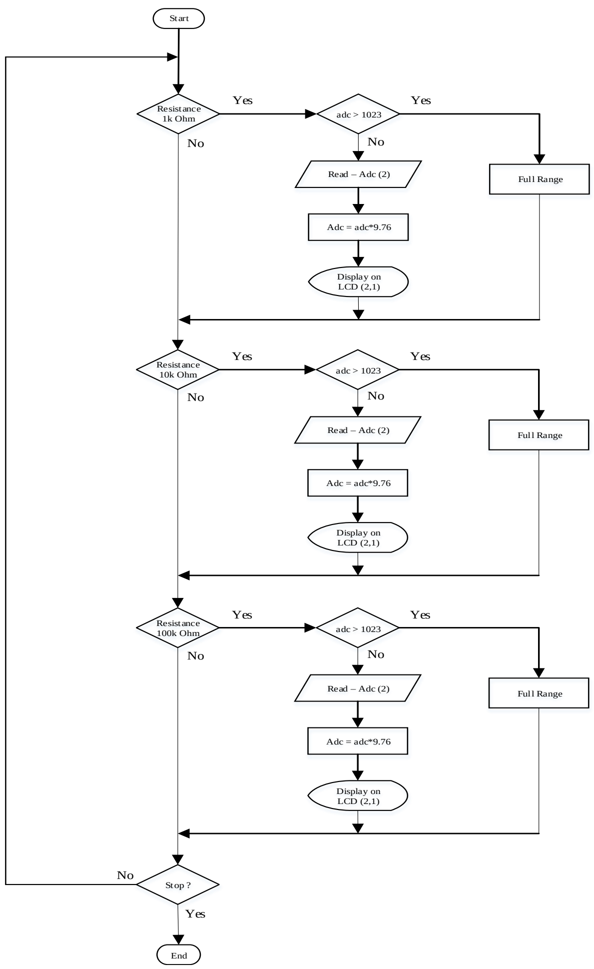


Fig.4 *Flow Chart of resistance measurement*

Resistance opposes the flow of current. The higher the resistance, the lower the current flow. Insulation used for cables has a very high resistance, impeding current flow. Conversely, the cable's copper conductor has low resistance, facilitating current flow. Proper resistance is critical. Too much resistance in electric wires and connections can result in overheating and possible fire hazards, while too little resistance may result in a short or performance problems. Components called resistors help maintain proper resistance in equipment.The flow chart of the resistance measurement system is shown in figure 4. At the start of the program, PIC needed to be initialized the I/O pins assigned and clock frequency. After that, the PIC receives the corresponding code from the specified pin. To test for resistance, first turn the power off in the circuit or component for testing.

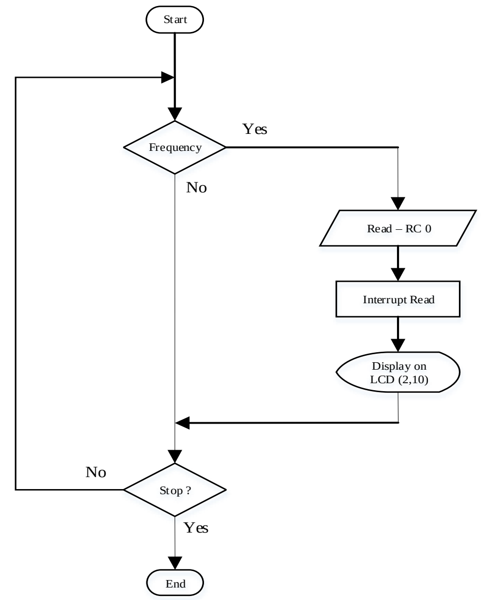


Fig.5 *Flow Chart of frequency measurement*

These digital multi-meters is measured in Hertz (Hz) the number of times per second a wave form repeats.The flow chart of the resistance measurement system is shown in figure5.

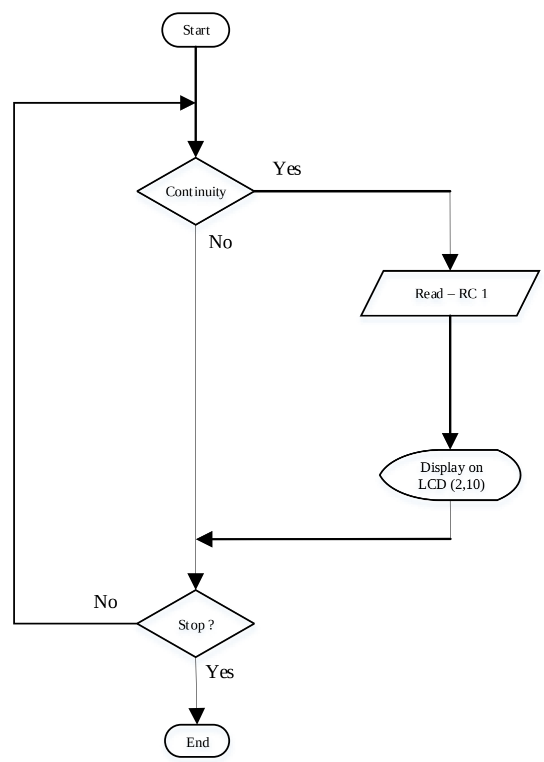


Fig.6 *Flow Chart of connectivity measurement*

Testing for continuity is used to test to verify if a circuit, wire or fuse is complete with no open connect test probe across two points of the circuit under testing. If continuity exists built-in buzzer will sound and display on LCD “connect”. If continuity does not exists display “opened” on LCD.

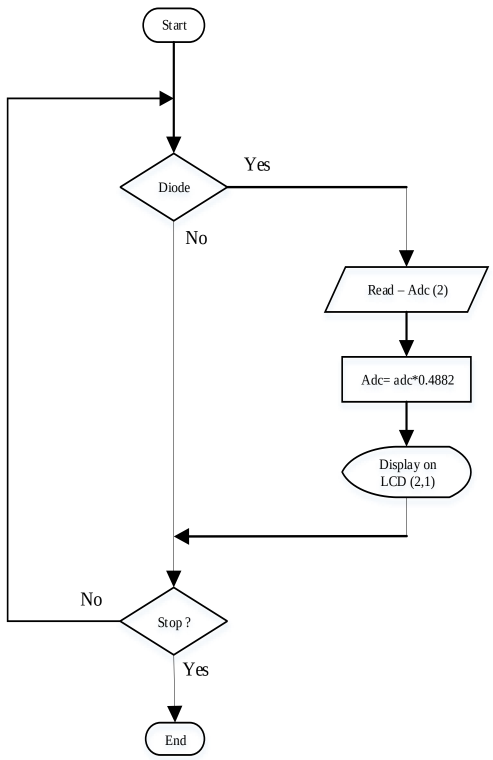


Fig.7 *Flowchart of diode measurement*

If the probe connection is forward the LCD will show the approximate forward voltage drop of the diode. If the probe connection is reversed, only LCD “open” will be displayed.

VI. Test and Result Photos of the System

In this system, the digital multi-meter can be measured voltage, current, temperature,resistance, diode, frequency and connectivity. The operation of the digital multi-meter condition and result will display on LCD screen as shown in Fig. 8.

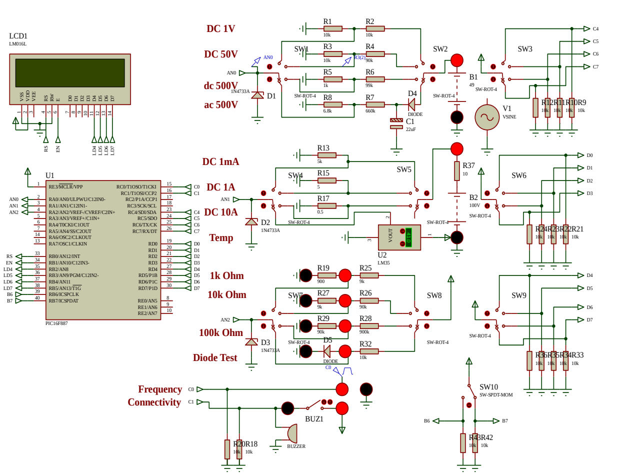


Fig.8 *Simulation diagram of digital multi-meter*

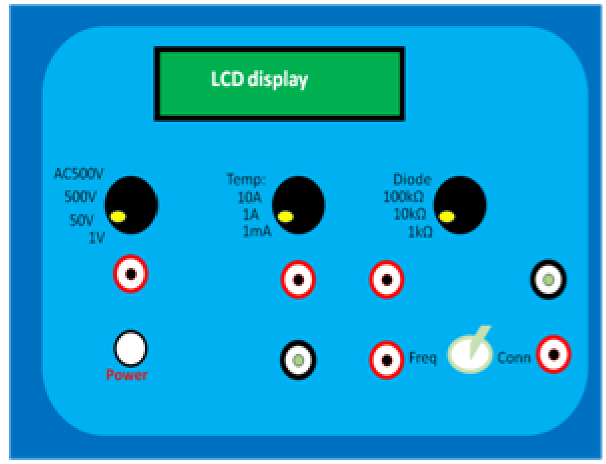


Fig. 9 *Prototype design of Digital Multi-meter*

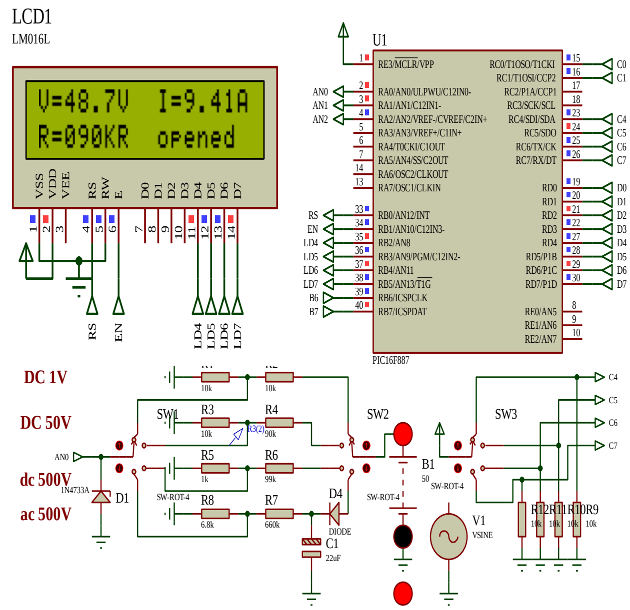


Fig.10 *Simulation result of voltage sensing*

Fig.11 *Test and result of voltage sensing*

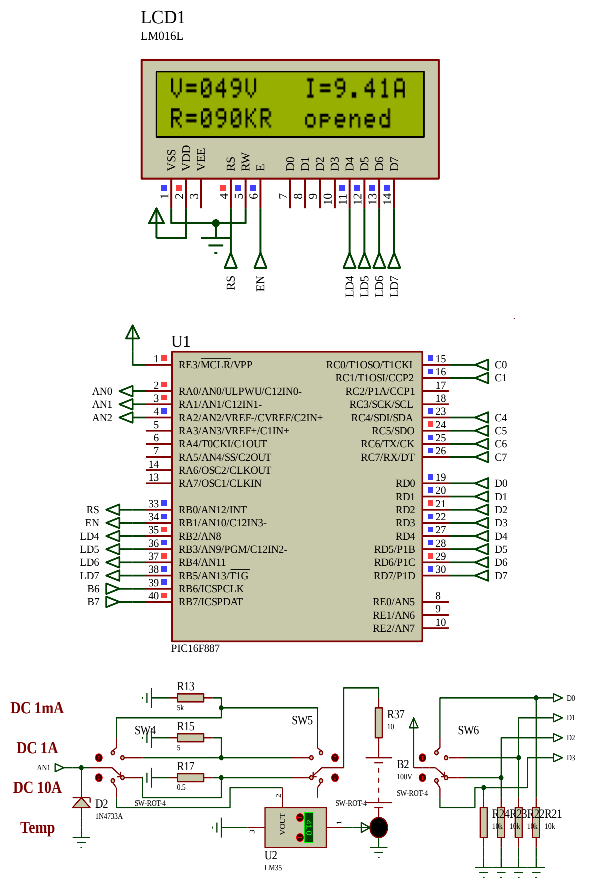


Fig.12 Simulation result of current sensing

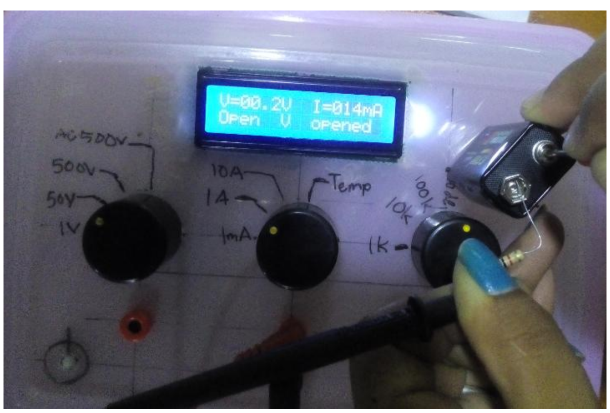
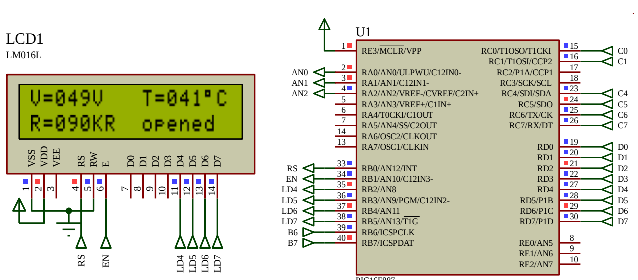


Fig.13 Test and result of current sensing



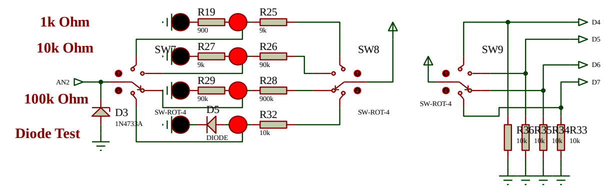


Fig.14 Simulation result of resistance sensing

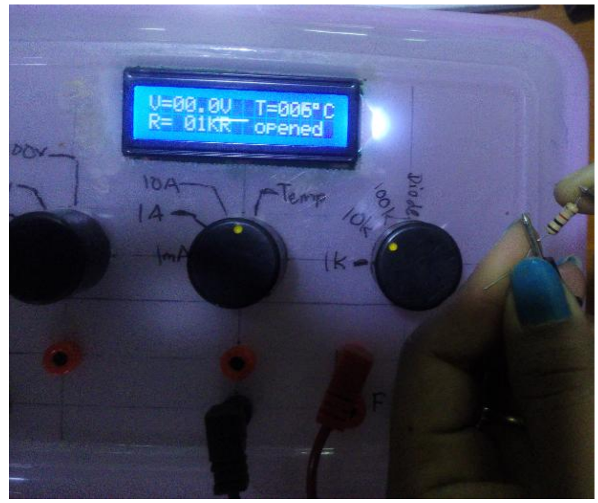


Fig.15 Test and result of resistance sensing

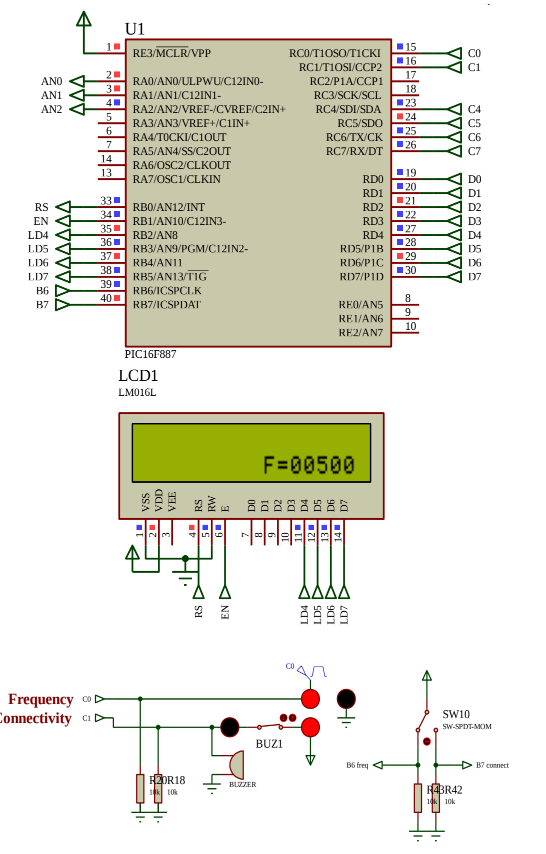
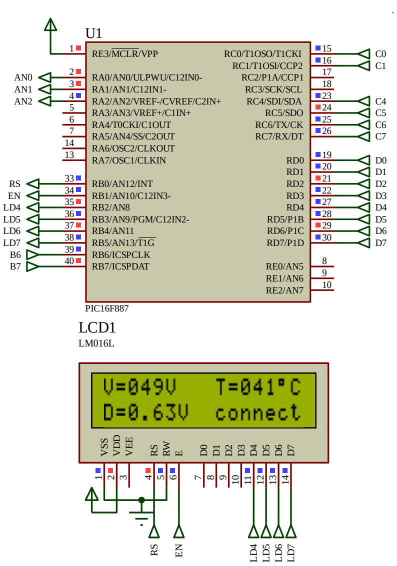


Fig.16 Simulation result of frequency sensing

Fig.17 *Test and result of frequency sensing*

VII. Conclusion

A microcontroller is essential if an automated system is to be achieved. A PIC microcontroller (PIC16F887), together with some auxiliary components were chosen and implemented in the design for the reasons that have been addressed in the previous chapter and sections. This design had to establish physically how the circuit to work and by other hand we were programming and programming until the measure was desired. Nowadays, many measurement instruments have been used in all laboratories through the world. Unfortunately, their accuracies are mostly proportional to the time period. At time passes, they may function incorrectly and generate some errors. In this digital multi-meter can be easily to use the user and safety. The system is flexible and safer to use. Smart feature can be added or withdrawn as per requirement and hence design is fully cost effective. By modifying this system, it is more useful and real apply the world.



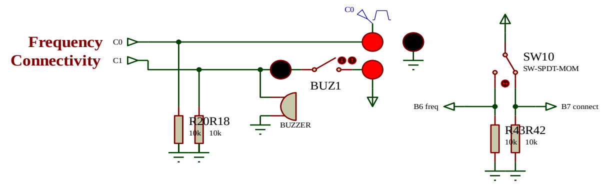


Fig.18 *Simulation result of frequency sensing*

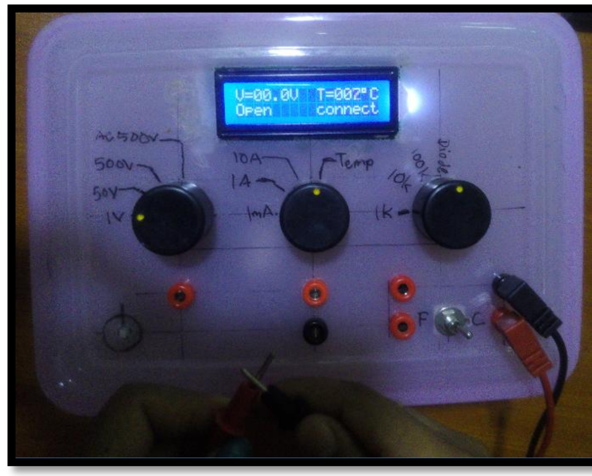


Fig.19 *Test and result of connectivity sensing*

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