Parul University

FACULTY OF ENGINEERING AND TECHNOLOGY

BACHELOR OF TECHNOLOGY

ICT

WORKSHOP

(303107152)

1st YEAR

ELECTRONICS & COMMUNICATION ENGINEERING

DEPARTMENT

Laboratory Manual

ICT WORKSHOP

PREFACE

It gives us immense pleasure to present the first edition of Workshop Practical Book for the B. Tech. 1st year students for **PARUL UNIVERSITY.**

The ICT Workshop laboratory course at **PARUL UNIVERSITY, WAGHODIA, VADODARA** is designedin such a way that students develop the basic understanding of the subject in the practical session and then try their hands on the experiments to realize and check the Workshop concepts learnt during the practical sessions. The main objective of the ICT Workshop course is: To Understand every aspect of Electronics Sensors and components.

The objective of this ICT Workshop Laboratory Practical Book is to provide a comprehensive source for all the experiments included in the laboratory course.

We acknowledge the authors and publishers of all the books which we have consulted while developing this Practical book. Hopefully this ICT *Workshop Practical Book* will serve the purpose for which it has been developed.

INSTRUCTIONS TO STUDENTS

1. Be prompt in arriving to the laboratory and always come well prepared for the experiment.
2. Be careful while working on the equipment's operated with high voltage power supply.
3. Work quietly and carefully. Give equal opportunity to all your fellow students to work on the instruments.
4. Every student should have his/her individual copy of the ICT Workshop Practical Book.
5. Every student has to prepare the notebooks specifically reserved for the Workshop Practical work "ICT Workshop".
6. Every student has to necessarily bring his/her Workshop Practical Book, ICT Workshop Practical Class Notebook and Workshop Practical Final Notebook, when he/she comes to the practical to perform the experiment.
7. Record your observations honestly. Never makeup reading or doctor them to get a better fit on the graphor to produce the correct result. Display all your observations on the graph (If applicable).
8. All the observations have to be neatly recorded in the ICT Workshop Practical Class Notebook (as explainedin the ICT Workshop Practical Book) and verified by the instructor before leaving the laboratory.
9. If some of the readings appear to be wrong then repeat the set of observations carefully.
10. Do not share your readings with your fellow student. Every student has to produce his/her own set of readings by performing the experiment separately.
11. After verification of the recorded observations, do the calculation in the ICT Workshop Practical Class Notebook (as explained in the Workshop Practical Book) and produce the desired results and get them verified by the instructor.
12. Never forget to mention the units of the observed quantities in the observation table. After calculations, represent the results with appropriate units.
13. Calculate the percentage error in the results obtained by you if the standard results are available and alsotry to point out the sources of errors in the experiment.
14. Find the answers of all the questions mentioned at the end of each experiment in the Workshop PracticalBook.
15. Finally record the verified observations along with the calculation and results in the Workshop Practical Note Book.
16. Do not forget to get the information of your next allotment (the experiment which is to be performed by you in the next laboratory session) before leaving the laboratory from the Technical Assistant.
17. The grades for the Workshop Practical course work will be awarded based on your performance in the laboratory, regularity, recording of experiments in the Workshop Practical Final Notebook, lab quiz, regular viva-voce and end-term examination.

CERTIFICATE

This is to certify that

Mr./Ms...

with enrolment no. ....has successfully completed his/her laboratory experiments in the ICT Workshop (303107152) from the department of.. during the academic year................................

Date of Submission:.........................   Staff In charge:...........................

Head Of Department:...

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EXPERIMENT NO. 1

AIM: Identification, symbolic representation and testing of various electronics components.

APPARATUS:

THEORY:

Some of Electronic components used in electronic circuits are: - Diodes, Transistors, LED'S Pho- to diodes, IC'S, Rectifying bridges.

Diodes

Diodes are usually made from semiconductor materials, Silicon and Germanium being the most common. In electronics, a diode is a two-terminal electronic component that conducts electric current in only one direction. The term usually refers to a semiconductor diode, the most common type today. Diodes are fabricated from semi-conducting material. They have two leads: cathode (k) and an anode (A). The most important property of all diodes is their resistance is very low in one direction and very large in the opposite direction.

When a diode is placed in a circuit and the voltage on the anode is higher than the cathode, it acts like a low value resistor and current will flow. If it is connected in the opposite direction it acts like a large value resistor and current does not flow. In the first case the diode is said to be "forward biased" and in the second case it is "reverse biased." The symbolic representation of di- ode is shown in below figure 1.

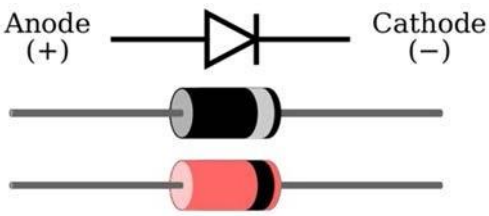

Fig 1. Symbolic representation of diode

The unidirectional behaviour of diode is called rectification, and is used to convert alternating current to direct current. However, diodes can have more complicated behaviour than this simple on- off action. These are exploited in special purpose diodes that perform many different functions. For example, specialized diodes are used to regulate voltage (Zener diodes), to electronically tune radio and TV receivers (varactor diodes), to generate radio frequency oscillations (tunnel diodes), and to produce light (light emitting diodes).

Testing of Diode using Multimeter:

Diodes can be tested using a multi meter. It is normally the resistance of the diode in both forward and reverse directions that is tested. There are however a number of points to remember when testing diodes. Digital Multimeters can test diodes using one of two methods:

1. Diode Test mode: almost always the best approach.
2. Resistance mode: typically used only if a Multimeter is not equipped with a Diode Test mode. Note: In some cases it may be necessary to remove one end of the diode from the circuit in order to test the diode. Things to know about the Resistance mode when testing diodes:

- Does not always indicate whether a diode is good or bad.
- Should not be taken when a diode is connected in a circuit since it can produce a false reading.
- Can be used to verify a diode is bad in a specific application after a Diode Test indicates a di- ode is bad.

A diode is best tested by measuring the voltage drop across the diode when it is forward-biased. A forward- biased diode acts as a closed switch, permitting cur- rent to flow.

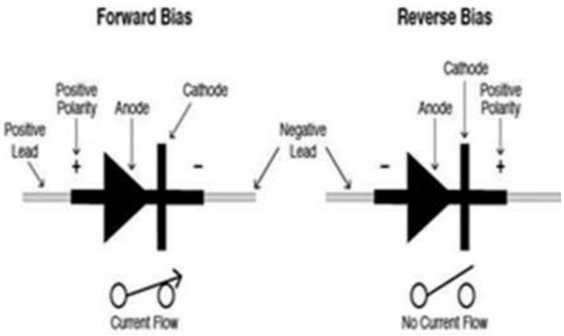

Fig 2. Diode Forward & Reverse Bias

A diode is forward-biased when the positive (red) test lead is on the anode and the negative (black) test lead is on the cathode. A Multimeters Diode Test mode produces a small voltage between test leads. The Multimeter then displays the voltage drop when the test leads are connected across a diode when forward-biased.

The Diode Test procedure is conducted as follows:

1. Make certain a) all power to the circuit is OFF and b) no voltage exists at the diode. Voltage may be present in the circuit due to charged capacitors. If so, the capacitors need to be dis- charged. Set the multimeter to measure ac or dc voltage as required.
2. Turn the dial (rotary switch) to Diode Test mode ( ). It may share a space on the dial with another function.
3. Connect the test leads to the diode. Record the measurement displayed.
4. Reverse the test leads. Record the measurement displayed.

Diode test analysis:

- A good forward-based diode displays a voltage drop ranging from 0.5 to 0.8 volts for the most commonly used silicon diodes. Some germanium diodes have a voltage drop ranging from 0.2 to 0.3 V.
- The multimeter displays OL when a good diode is reverse-biased. The OL reading indicates the diode is functioning as an open switch.
- A bad (opened) diode does not allow current to flow in either direction. A multimeter will display OL in both directions when the diode is opened.
- A shorted diode has the same voltage drop reading (approximately 0.4 V) in both directions.

- A multimeter set to the Resistance mode (Ω) can be used as an additional diode test or, as mentioned previously, if a multimeter does not include the Diode Test mode.

The forward-biased resistance of a good diode should range from 1000 Ω to 10 MΩ. The resistance measurement is high when the diode is forward-biased because current from the multimeter flows through the diode, causing the high-resistance measurement required for testing. The reverse-biased resistance of a good diode displays 0L on a multimeter. The diode is bad if readings are the same in both directions.

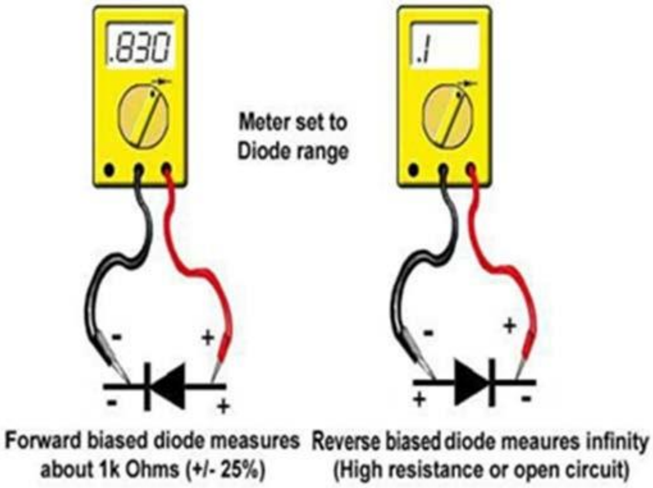

Fig 3. Diode Forward & Reverse Bias measurement using Multimeter

The resistance mode procedure is conducted as follows:

1. Make certain a) all power to the circuit is OFF and b) no voltage exists at the diode. Voltage may be present in the circuit due to charged capacitors. If so, the capacitors need to be discharged. Set the multimeter to measure ac or dc voltage as required.
2. Turn the dial to Resistance mode (Ω). It may share a space on the dial with another function.
3. Connect the test leads to the diode after it has been removed from the circuit. Record the meas- urement displayed.
4. Reverse the test leads. Record the measurement displayed.
5. For best results when using the Resistance mode to test diodes, compare the readings taken with a knowngood diode.

Light Emitting Diodes (LED's):

LEDs (Light Emitting Diodes) are constructed from a crystalline substance that emits light when a current flows through it. Depending on the crystalline material: red, yellow, green, blue or orange light is produced.

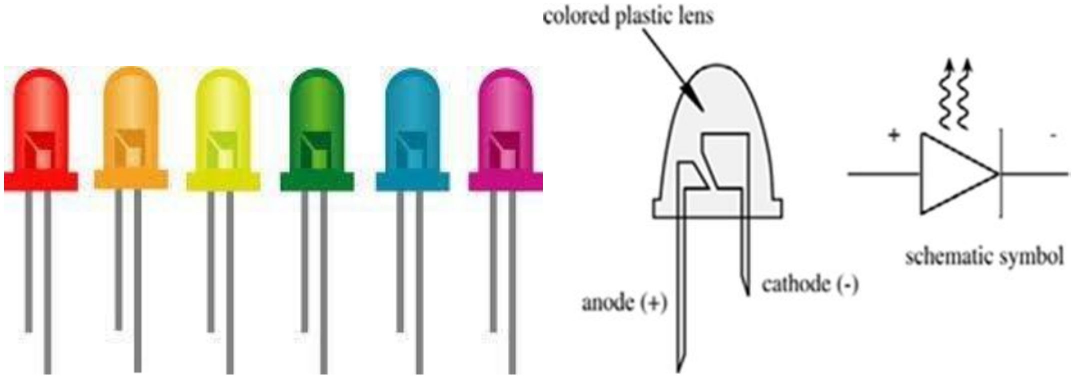

Fig 4. Types of LED & symbol

The cathode lead is identified on the body by a flat-spot on the side of the LED. The cathode lead is the shorter lead. LED can be tested in a similar way as that of p-n junction diode.

Zener Diode:

A Zener diode is a silicon diode that is optimized to conduct when it is reverse-biased. This article presents ways to identify one.

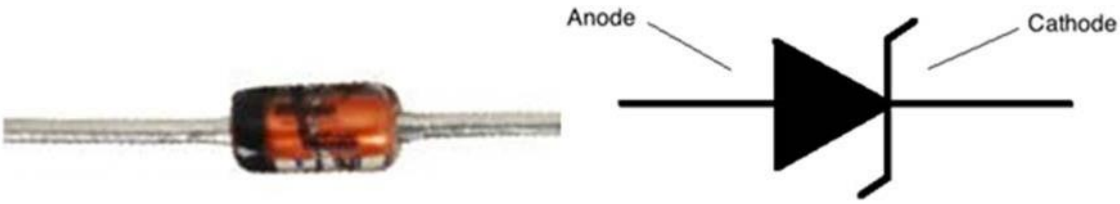

Fig 5. Zener diode and its symbol

A Zener diode is a silicon diode that is optimized to work in what is known as the breakdown region. This means they are able to conduct when they are reverse-biased. This is unlike normal diodes, which will self-destruct.A Zener diode's breakdown voltages can range from 2 to 200 volts, making it useful in a variety of applications.

One popular usage is that of a voltage regulator. This is due to the Zener's ability to maintain constant output voltages when there are current changes in the circuit. This makes Zener's ideal as inputs to other circuits, or as voltage references for op-amps.

Testing of Zener diode using multimeter

1)Anode-Cathode Diode Resistance Test:

Using multimeter select the resistance function place the positive probe on the anode of the diode and the negative probe on the cathode of the diode (the black strip), as shown Figure 6 below. The diode hundred thousands of ohms should read a moderately low resistance, maybe a few Meter may read around 450kΩ.

Figure 6 Anode-Cathode diode resistance test

Figure 7 Cathode- Anode diode resistance test

2) Cathode-Anode Diode Resistance Test

Using the same test set up as mentioned above now reverse the connections such that the positive probe of the multimeter is now on the cathode of the diode and the negative lead on the anode refer figure 7. In this condition the diode should read a much higher resistance, well over 1MΩ. A typical reading may, for example, be 2.3MΩ. The multimeter may even indicate 'OL' for an open circuit, since the resistance is so high. A healthy Zener diode should read relatively low resistance in the forward biased direction and very high resistance in the reverse biased direction.

Testing of Zener diode using voltage function of multimeter

A second test to check a Zener diode is to measure its voltage with a voltmeter of a multimeter. Feed voltage to the Zener diode in reverse bias in series with a resistor. The voltage must be higher than the rated Zener voltage of the Zener diode.

As shown in below figure 8 Zener diode and a 1kΩ resistor are supplied 9Volts from 9V battery.

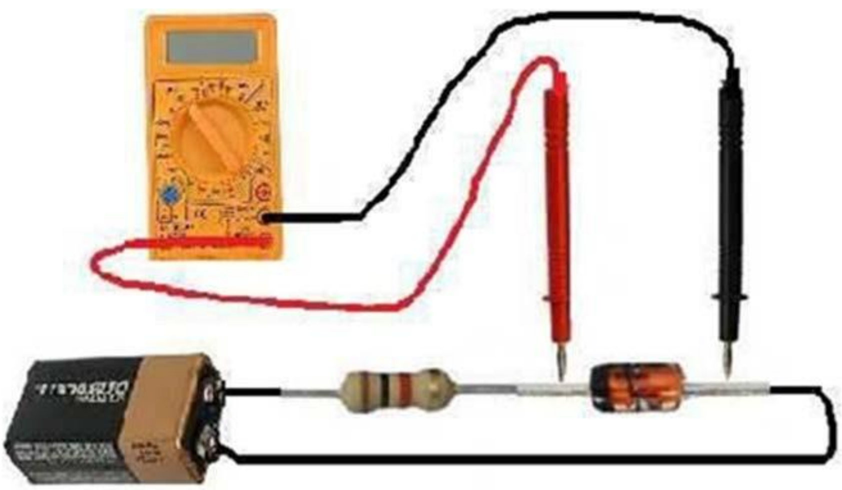

Fig 8. Voltage test of Zener diode

In above figure the rated voltage of Zener diode is 5.1V and the applied voltage is 9V. When measuring the voltage across the Zener diode, it must measure a voltage near its rated Zener voltage. If a Zener diode reads a voltage near its rated Zener voltage, VZ, then the diode is healthy.

Transistors

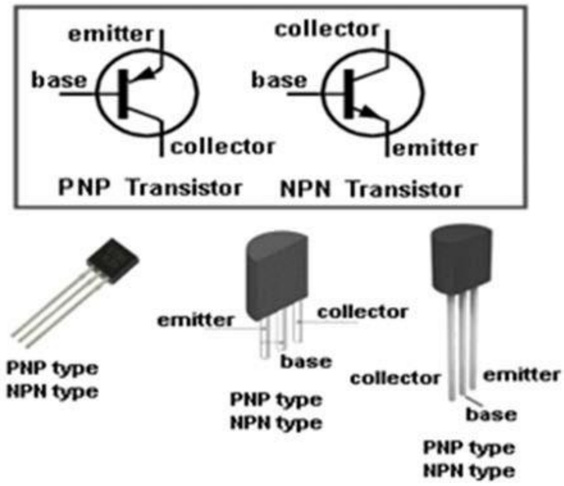

Figure 9 Bipolar Transistor symbol

Transistors are active components and are found every- where in electronic circuits. They are used as amplifiers and switching devices. As amplifiers, they are used in high and low frequency stages, oscillators, modulators, detectors and in any circuit needing to perform a function. In digital circuits they are used as switches. The most common type of transistor is called bipolar and these are divided into NPN and PNP types. Their construction-material is most commonly silicon or germanium Bipolar transistors have three leads: for base (B), emitter (E), and for collector (C).

How to test a BJT:

A digital multimeter is used to test the base to emitter and base to collector PN junction of the BJT. By using this test, you can also identify the polarity of an unknown device. PNP and NPN transistor can be checked using the digital multimeter.

The digital multimeter consists of two leads: black and red. Connect the red (positive) lead to the base terminal of the PNP transistor, and the black (negative) lead to the emitter or base terminal of the transistor. The voltage of a healthy transistor should be 0.7V, and the measurement across the emitter collector should read 0.0V. If the measured voltage is around 1.8V, then the transistor will be dead. Similarly, connect the black lead (negative) to the base terminal of the NPN transistor, and red lead (positive) to the emitter or collector terminal of the transistor. The voltage of a healthy transistor should be 0.7V, and the measurement across the emitter collector should read 0.0V. If the measured voltage is around 1.8V, then the transistor will be dead.

Step 1: Transistor Function on Multimeter

If the model number is not known, it is impossible to de- tail about the type of transistor just by looking at it. To ease the process, multimeters come with a function where one can calculate HFE or small signal Forward Current Gain of a bipolar transistor.

Figure 10 Transistor function on Multimeter

Apart, from detailing with the forward gain value, the HFE function solves two problems.

•Type of the transistor can be found.

•Collector, Base, Emitter terminals can also be known.

Step 2: Checking Transistor

1) Testing an NPN Transistor.

Place the three legs of the Transistor first in the E-B-C formation. The multimeter will show the reading if this formation is correct, else it will show over range. If the previous method doesn't work, place the three legs of the

Transistor in the B-C-E formation. If multimeter shows reading then it's correct. The reading is nothing but the HFE of that transistor.

Fig 11. Testing of NPN Transistor

2) Testing PNP Transistor.

Place the three legs of the transistor in the same manner as discussed above. After placing the transistor in the correct formation, multimeter would show the HFE value of the transistor.

Fig 12. Testing of PNP Transistor

Uni Junction Transistor:

The Unijunction Transistor or UJT for short, is another solid state three terminal device that can be used in gate pulse, timing circuits and trigger generator applications to switch and control either thyristors and triacs for AC power control type applications. Like diodes, unijunction transistors are con- structed from separate P-type and N-type semiconductor materials forming a single (hence its name Uni-Junction) PN-junction within the main conducting N-type channel of the device.

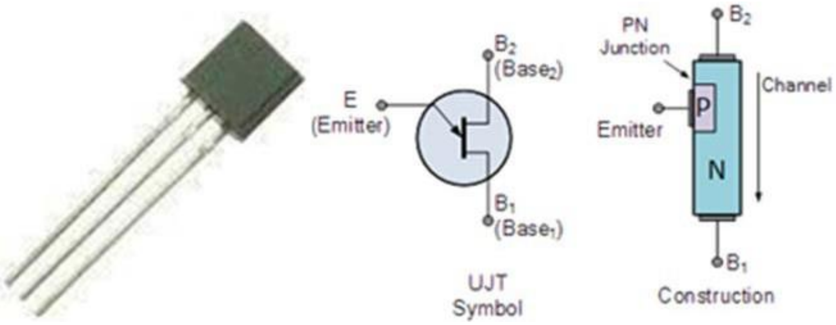

Fig 13. Unijunction transistor symbol and construction

Although the Unijunction Transistor has the name of a transistor, its switching characteristics are very different from those of a conventional bipolar or field effect transistor as it cannot be used to amplify a signal but instead is used as a ON-OFF switching transistor. UJT's have unidirectional conductivity and negative impedance characteristics acting more like a variable voltage divider during breakdown.

Like N-channel FET's, the UJT consists of a single solid piece of N-type semiconductor material forming the main current carrying channel with its two outer connections marked as Base 2 (B2) and Base 1(B1). The third connection, confusingly marked as the Emitter (E) is located along the channel. The emitter terminal is represented by an arrow pointing from the P-type emitter to the N- type base.

How to test a UJT:

UJT (Uni junction transistor) can be easily tested by using a digital Multimeter. The three steps for testing the health of a UJT are as follows.

1. Measuring the resistance between B1 and B2 terminals. Set your digital Multimeter in resistance mode. Connect the positive lead of multimeter to the B1 terminal and negative lead to the B2 terminal. The Multimeter will show a high resistance (around 4 to 10K). Now connect the positive lead to B2 terminal and negative lead to B1 terminal. Again the Multimeter will show a high resistance (around 4 to 10K). Also both the readings will be almost same.

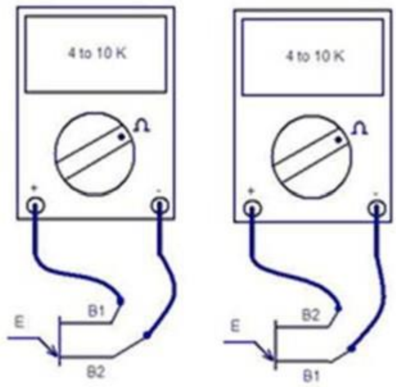

Fig 14. Measurement of Resistance

1.Reverse biasing the emitter junction.

Set the digital Multimeter in resistance mode. Connect negative lead of the multimeter to the emitter and positive lead to the B1.The multimeter will show a high resistance (around 100's of K's).Now connect the negative lead once again to the emitter and positive lead to B2.Again the meter will show a high resistance. In both cases the reading will be almost same.

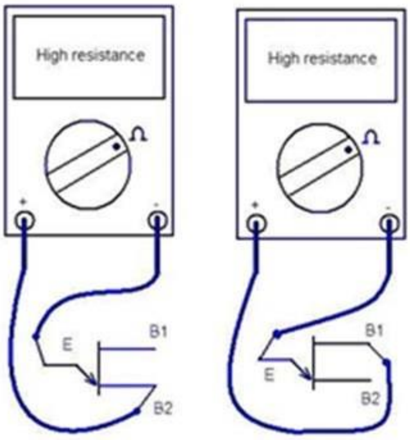

Fig 15. Reverse Biasing Emitter Junction

2.Forward biasing the emitter junction.

Set the digital Multimeter in resistance mode. Connect the positive lead to the emitter and negative lead to B1.The multimeter will show a low resistance (around few 100 ohms).Now connect the positive lead once again to the emitter and negative lead to the B2 terminal. Again th e Multimeter will show a low resistance reading (around few 100 ohms).In both cases the reading will be almost same. This test is almost like forward biasing a diode.

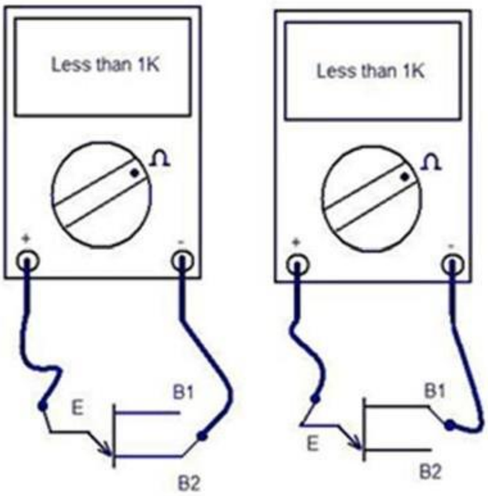

Fig 16. Forward Biasing Emitter Junction

PROCEDURE:

CONCLUSION:

Questions:

1. **Explain Thyristor in Brief.**
2. **What is difference in NPN & PNP Transistor?**
3. **Write application of Diode, Transistor, FET.**

SIGNATURE OF FACULTY WITH DATE

EXPERIMENT NO. 2

AIM: Study of Digital Multimeter and Measurement of voltage, current, frequency, phase difference, power, power factor for single phase supply using Digital Multimeter.

APPARATUS:

THEORY:

Introduction

A Multimeter is an instrument which measures electrical parameters such as AC or DC voltage, cur- rent, and resistance. A Multimeter combines a voltmeter, an ammeter, and an ohmmeter. The two main kinds of a Multimeter are analog and digital.

A digital Multimeter has an LCD screen that displays the value of the parameter being measured. In analog Multimeter, a needle moves through a graduated scale the pointer reading shows the value of the parameter measured.

Digital Multimeters

Digital Multimeter (DMM) has a digital or liquid crystal display (LCD), where measurement readings appears numerical values. The DMM has a rotatory knob or selector switch allows to select the unit and range of measurement. We must first set the dial to the appropriate measurement. There are three or four terminals available on the multi-meter, one is common, second is volt or resistance, third and fourth terminal is for current measurement.

The various electrical parameters can be measured by selecting the required function and selecting the proper range. Key process that occurs within a digital multimeter for any measurement that takes place is that of voltage measurement. All other measurements are derived from this basic measurement. One of the most widely used ADC in digital multimeter is known as the successive approximation register or SAR. Some SAR ADCs may only have resolution levels of 12 bits, but those used in test equipment including DMMs generally have 16 bits or possibly more dependent upon the application.

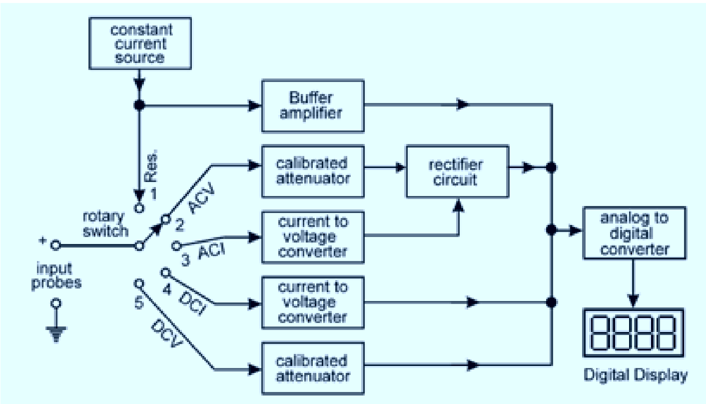

Fig 1. Block Diagram of Digital Multimeter

For the measurement of resistance Connect an unknown resistor across its input probes. Keep rotary switch in the position-1The proportional current flows through the resistor, from constant current source. According to Ohm's law voltage is produced across it. This voltage is directly proportional to its resistance. This voltage is buffered and fed to A-D converter, to get digital display in Ohms

To measure AC voltage Connect an unknown AC voltage across the input probes. Keep rotary switch in position-2. The voltage is attenuated, if it is above the selected range and then rectified to convert it into proportional DC voltage. It is then fed to A-D converter to get the digital display in Volts.AC current is indirectly measured by converting it into proportional voltage. Connect an unknown AC current across input probes. Keep the switch in position-3. The current is converted into voltage proportionally with the help of I-V converter and then rectified. Now the voltage in terms of AC current is fed to A-D converter to get digital display in Amperes.

The DC current is also measured indirectly. Connect an unknown DC current across input probes. Keep the switch in position-4. The current is converted into voltage proportionally with the help of I- V converter. Now the voltage in terms of DC current is fed to A-D converter to get the digital display in Amperes.

To measure DC voltage Connect an unknown DC voltage across input probes. Keep the switch in position-5. The voltage is attenuated, if it is above the selected range and then directly fed to A-D con- verter to get the digital display in Volts.

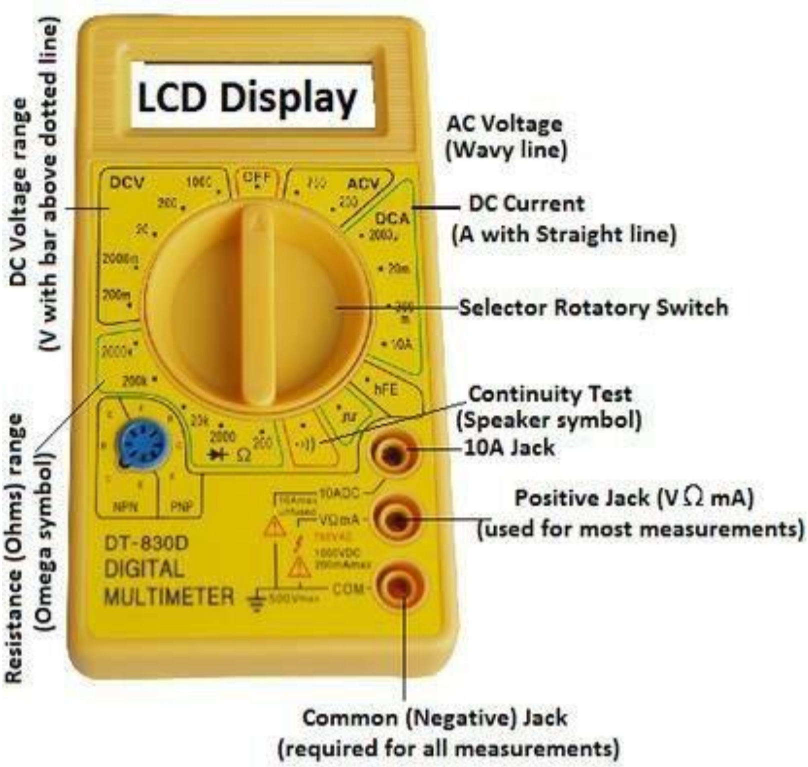

Fig 2. Front Panel of Digital Multimeter

Front Panel Description of Digital Multimeter:

Probes:- All the multimeters has two probes, one of Red colour and another of Black colour. The Black colour probe is used as common or negative probe while Red probe is used as Positive probe.

Common (Negative) Jack: - This jack has mark with term 'COM' and used to connect the Black probe as shown in diagram above. This probe is required for all measurements and test.

Positive Jack: - This jack is marked with sign of Voltage (V), Resistance ( ) and Current (mA) and used to connect the Red probe.

Selector/ Rotatory Switch: - This switch or knob perform two important functions of Multimeter

(a) On/ off switch of Multimeter. (b) Selection of unit and range for the measurement and test.

LCD Display:-The display panel is used to display the measured values in numeric figures. The LCD display also displays some warning and alert symbols.

ACV: - While moving clockwise (may be different with different models of Multimeter) the first unit is ACV; which means A.C. Voltage it is represented by wavy line.

DCA: - This part of digital Multimeter specified for measurement of D.C. Current; the range of cur- rent can be selected with rotatory knob. Next two blocks are used for special test related to amplification and frequency.

Continuity Test: - the continuity test block is used for testing of some electrical and electronics de- vices. It simple shows that the two terminals allows the flow of electric current or not.

Resistance Range: - A sign of Omega is used to represent the block of multimeter used for measurement of resistance. In this block Omega sing is termed as Ohm and 'k' represents range of Kilo- ohm.

DCV: - This block of multimeter is used to measure the D.C. Voltage represented by a bad above the dotted line.

Measurement of AC Voltage

The ac voltage is first converted into dc using rectifier. This dc voltage is converted into small signal using voltage limiter. This small dc voltage signal is given to the Analog to Digital converter. It converts the analog signal into the digital signal. Then it will be displayed on the display.

Measurement of DC Voltage

The dc voltage is given to the voltage limiter to convert into equivalent small signal. Then it is given to A to D converter. It converts the analog signal into Digital signal. Then it will be dis- played on the display.

Measurement of Current

The unknown current is passed through I to V converter (i.e. current to voltage converter) in which it will flow through the low shunt resistance. It produces the voltage drop which is proportional to the current. This voltage drop is converted into digital signal using A to D converter. It con- verts the analog signal into digital signal. The reading will be displayed on the display.

Measurement of Resistance

To measure the resistance, the known current is passed through the unknown resistance using constant current source. The voltage drop across the resistance is applied to the A to D converter. It converts the analog signal into digital signal. Then it will be displayed on the display.

General Specifications of DMM:

Ranges:

For digital multimeters ranges varies according to the manufacturing company and also according to the parameter measured.

In multimeters ranges for AC / DC voltage, AC /DC current (mA & A) ranges, resistance ranges are mentioned. Auto and manual option is also present to read out parameters.

Accuracy:

In digital multimeters accuracy is usually specified in terms of percentage of reading plus a percent- age of full-scale value, sometimes expressed in counts rather than percentage terms. Standard port-

able digital multimeters are specified to have an accuracy of typically 0.5% on the DC voltage rang- es.

Resolution:

The resolution of a multimeter is the smallest part of the scale which can be shown, which is scale dependent. For example, a multimeter that has a 1 mV resolution on a 10 V scale can show changes in measurements in 1mV increments.

The resolution of a multimeter is often specified in the number of decimal digits resolved and dis- played. If the most significant digit cannot take all values from 0 to 9 is often termed a fractional dig- it. For example, a multimeter which can read up to 19999 (plus an embedded decimal point) is said to read 4½ digits.

CIRCUIT DIAGRAM:

OBSERVATION TABLE:

- **Measurement of Resistor**

Sr. No.	Theoretical Value	Practical Value

- **Measurement of Voltage:**

	Theoretical Value	Practical Value
Va		
Vb		
Vc		

- **Measurement of Current:**

	Theoretical Value	Practical Value
Ia		
Ib		
Ic		

- **Testing of Transistor:**

Transistor IC number	PNP/NPN

- **Continuity Check:**

Observation:

CONCLUSION:

Questions:

1. **Why does my multimeter not go to zero in the ac volts mode?**
2. **In the accuracy specification (1% of reading + 3 counts), what does the counts mean?**
3. **What is the difference in the Min/Max and Peak modes on multimeters?**
4. **When I short my test leads together in the resistance mode, it does not read zero. Why not?**

SIGNATURE OF FACULTY WITH DATE

EXPERIMENT NO. 3

AIM: Understanding of working and specifications of CRO and Function generator.

APPARATUS:

THEORY:

Introduction to CRO

The cathode ray oscilloscope is a versatile laboratory instrument. If a laboratory has only CRO in it, other measuring instruments may not be required. This is the importance of CRO in scientific laboratories. With it we can measure, AC/DC voltage, AC/DC current, resistance, phase and phase difference between two or more waveforms, relative frequency of a waveform, observe the amount of noise present on a signal, etc.

In addition, CRO is also useful to observe the shape of waveform or signal and observe its real time progression on time axis. The waveform displayed on it, is observed with respect to x-y axes or co- ordinate system. The screen of CRO is plotted in terms of a measuring scale, known as graticule. Us- ing this scale, the amplitude and wavelength of waveform can be accurately measured in centimetres and then converted into required unit.

Basic working principle of CRO

The cathode ray is a beam of electrons which are emitted by the heated cathode (negative electrode) and accelerated toward the fluorescent screen. The assembly of the cathode, intensity grid, focus grid, and accelerating anode (positive electrode) is called an electron gun. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen are two pair of metal plates - one oriented to provide horizontal deflection of the beam and one pair oriented to give vertical deflection to the beam. These plates are thus referred to as the horizontal and vertical deflection plates. The combination of these two deflections allows the beam to reach any portion of the fluorescent screen. Wherever the electron beam hits the screen, the phosphor is excited and light is emitted from that point. This conversion of electron energy into light allows us to write with points or lines of light on an otherwise darkened screen. Some important terms before going into the details of functional block diagram of CRO.

Y-input: It is the main input of CRO, to which the input signal is connected. The waveform of this input signal is displayed on the screen of CRT.

Vertical attenuator1: It consists of RC voltage divider, which is marked on the CRO front panel as Volt/div control knob. Thus the ‘gain’ of CRO can be controlled with Volt/div knob.

Vertical amplifier: It is a set of preamplifier and main vertical amplifier. The input attenuator sets up the gain of vertical amplifier.

Delay line: The delay line delays the striking of electron beam on the screen. It synchronizes the arrival of the beam on screen when time base generator signal starts sweeping the beam horizontally. The propagation delay2 produced is about 0.25msec.

Trigger circuit: It takes the sample of input voltage connected at y-input of CRO and feeds it to the input of time base generator. So the TBG starts only when input signal is present at y-input.

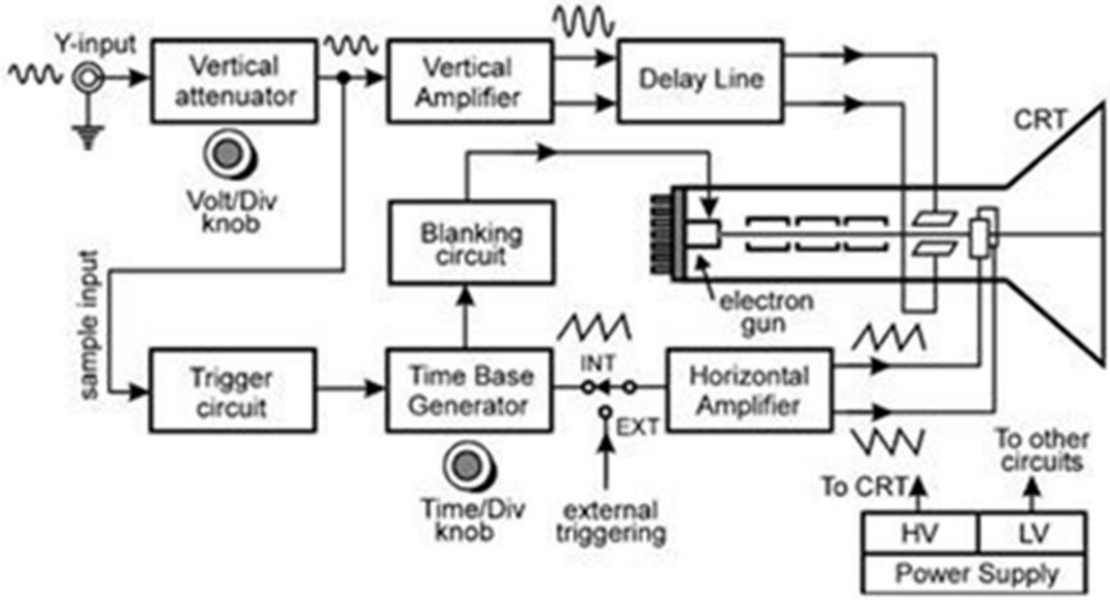

Fig 1. Block Diagram of Cathode Ray Oscilloscope

Time base generator: It produces a saw tooth wave. The waveform is used to sweep (move) the electron beam horizontally on the screen. The rate of rise of positive going edge of saw tooth wave- form is controlled by Time/div control knob. Thus, the saw tooth wave controls the horizontal deflec- tion of electron beam along x-axis. A switch known as INT/EXT is also connected after the output of TBG. When the switch is in INT position, the output of TBG is connected to H-plates through hori- zontal amplifier. When it is in EXT position, internal saw tooth is cut-off and some external signal can be connected to horizontal plates.

Horizontal amplifier: It amplifies the saw tooth waveform coming from TBG. It contains phase in- verter circuit also. Due to this circuit, two outputs are produced. One output produces positive going saw tooth and other output produces negative going saw tooth. The first output is connected to right side H-plate and the second output is connected to left side H-plate. So the electron beam moves properly from left to right of the screen.

Blanking circuit: It is necessary to eliminate the retrace, which would produce when the spot on screen moves from right to left. This retrace can produce confusion with the original wave. So when the electron beam reaches right end of screen, the negative blanking voltage is produced by TBG. It is fed to control grid of CRT, to stop the electron beam completely.

HV/LV power supply: The high voltage section is used to power the electrodes of CRT and the low voltage section is used to power the electronic circuits of the CRO.

Front Panel Controls:

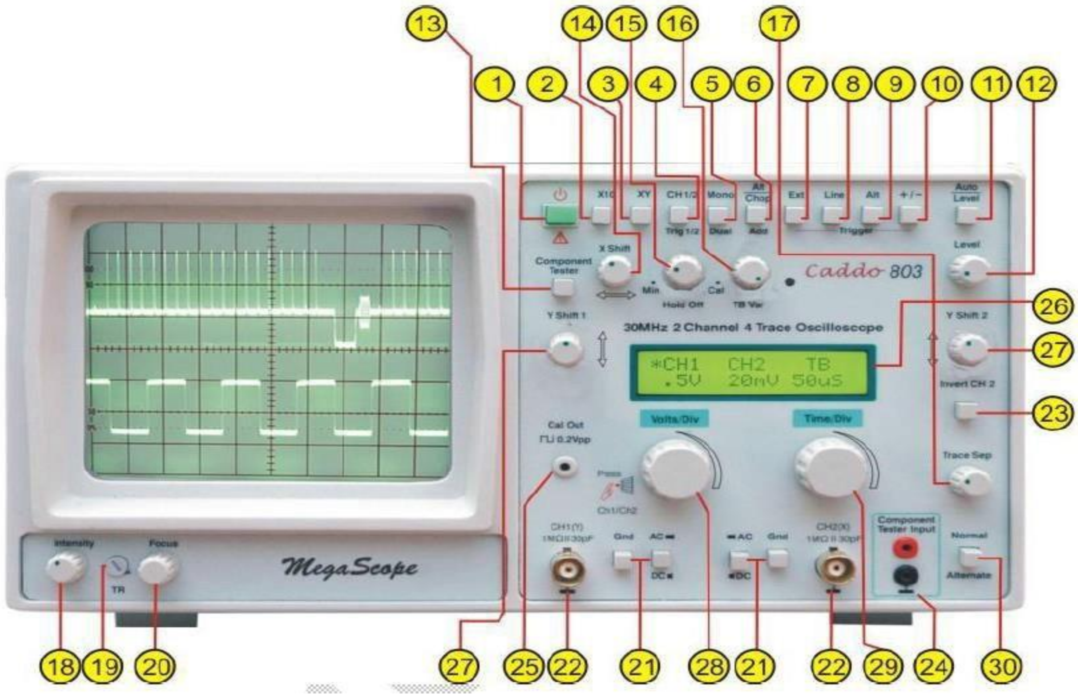

Figure 2 Front Panel of CRO

Sr. No.	Control	Function
1	Power 'On/Off':	Push buttons switch for sup30plying power to instrument.
2	x10	Switch when pushed gives 10 times magnification of the X signal.
3	XY	Switch when pressed cuts off the time base & allows access to the external horizontal signal to be fed through CH2 (used for X-Y dis- play).
4	CH 1/2	Switch selects channel & trigger source (released Trig 1/2 CH1 & pressed CH2).
5	Mono/ Dual	Switch selects Mono or Dual trace operation.
6	Alt/ Chop/ Add	Switch selects alternate or chopped in Dual mode. If Mono is select- ed then this switch enables addition or subtraction of channel i.e.CH1 ± CH2.
7	Ext	Switch when pressed allows external triggering signal to be fed from the socket marked Trigger Input (20).
8	Line	Switch when pressed displayed signal synchronized with mains line frequency.
9	Alt	Selects alternate trigger mode from CH1 & CH2. In this mode both

		the signals are synchronized.
10	Slope (+/-)	Switch selects the slope of triggering, whether positive going or negative going.
11	Auto/Level	Switch selects Auto/Level position. Auto is used to get trace when no signal is fed at the input. In Level position the trigger level can be varied from the positive peak to negative peak with Level Con- trol.
12	Level	Controls the trigger level from peak to peak amplitude of signal.
13	Component	Switch when pressed starts CT operation.
14	X Shift	Controls horizontal position of the trace.
15	TB Var	Controls the time speed in between two steps of Time/Div switch. For calibration put this pot fully anticlockwise at Cal position. Lamp glows for uncalibrated position.
16	Trace Sep	Trace Separator x1 & x10 in 4 trace operation (Alt).
17	Intensity	Controls the brightness of the trace.
18	TR	Trace Rotation controls the alignment of the trace with graticule (screw driver adjustment).
19	Focus	Controls the sharpness of the trace.
20	DC/AC/GND	Input coupling switch for each channel. In AC the signal is coupled through 0.1MFD capacitor.
21	CH 1 (Y) &	BNC connectors serve as input connection for CH 2 (X): CH1 & CH2.Channel 2 input connector also serves as horizontal external Input.
22	Invert CH2	Switch when pressed invert polarity of CH2.
23	Component Tester Input	To test any components in the CT mode, put one test prod in this socket and connect the other test prod in ground socket
24	Cal Out	Socket provided for square wave output 200mV used for probe
25	Hold off	Controls Hold Off time between sweeps. Used for Stable Triggering of composite signals.
26	Digital Readout	LCD window for displaying Digital Readout for Volt/Div. & Time/Div. settings.
27	Y Pos 1 & 2	Controls provided for vertical deflection of trace for each channel.
28	Volts/Div CH1	Switch selects Volt/Div. step for CH1 & CH2

29	Time /Div	Switch selects Time/Div. steps.
30	Normal/Alternate :	Switch selects Normal (x1) or Alternately expanded (x1 & x10) simultaneous positions.

Product Features of a typical analog CRO are as under:

- Dual channel
- Bandwidth up-to 30MHz.
- Invert facility in both channels.
- Vertical deflection coefficients: 5mV to 20 V / div.
- Time base: 20ns-0.2 s / div.
- Variable Hold –Off.
- X10 magnification.
- Triggering capability.
- Saw tooth output (5Vpp approx.)

Measurements using CRO

The primary uses of the cathode ray oscilloscope (CR0) are to measure voltage, to measure frequency and to measure phase.

Measuring voltage

Because of its effectively infinite resistance, the CR0 makes an excellent voltmeter. It has a relatively low sensitivity, but this can be improved by the use of an internal voltage amplifier. The oscilloscope must first be calibrated by connecting a d.c. source of known

e.m.f. to the Y-plates and measuring the deflection of the spot on the screen. This should be repeated for a range of values, so that the linearity of the deflection may be checked. The known e.m.f. is then connected and its value found from the deflection produced. Most oscilloscopes have a previously calibrated screen giving the deflection sensitivity in volts per cm or volts per scale di- vision. In this case a calibration by a d.c. source may be considered unnecessary.

Measuring frequency

Using the calibrated time base the input signal of unknown frequency may be 'frozen', and its fre- quency found directly by comparison with the scale divisions. Alternatively the internal time base may be switched off and a signal of known frequency applied to the X-input. If the signal of un- known frequency is applied to the Y-input, Lissajous figures are formed on the screen. Analysis of the peaks on the two axes enables the unknown frequency to be found.

Measuring phase

The internal time base is switched off as above and two signals are applied as before. The frequency of the known signal is adjusted until it is the same as that of the unknown signal. An ellipse will then be formed on the screen and the angle of the ellipse will denote the phase difference between the two signals.

Function generator

Signal generators, also known variously as function generators, RF and microwave signal generators, pitch generators, arbitrary waveform generators, digital pattern generators or frequency generators are electronic devices that generate repeating or non-repeating electronic signals (in either the analog or digital domains). They are generally used in designing, testing, troubleshooting, and repairing electronic or electro acoustic devices.

Fig 3. Function Generator

A function generator is a device which produces simple repetitive waveforms. Such devices contain an electronic oscillator, a circuit that is capable of creating a repetitive waveform refer figure 4. The most common waveform is a sine wave, but saw tooth, step (pulse), square, and triangular waveform oscillators are commonly available as are arbitrary waveform generators (AWGs). If the oscillator operates above the audio frequency range (>20 kHz), the generator will often include some sort of modulation function such as amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM) as well as a second oscillator that provides an audio frequency modulation waveform.

Arbitrary waveform generators

Arbitrary waveform generators, or AWGs, are sophisticated signal generators which allow the user to generate arbitrary waveforms, within published limits of frequency range, accuracy, and output level. Unlike function generators, which are limited to a simple set of waveforms; an AWG allows the user to specify a source waveform in a variety of different ways. AWGs are generally more expensive than function generators, and are often more highly limited in available band- width; as a result, they are generally limited to higher-end design and test applications. Some of the signal generators are RF, Analog, AF, Logic, Pitch and audio signal generators.

Working of Function Generator

Simple function generators usually generate triangular waveform whose frequency can be controlled smoothly as well as in steps. This triangular wave is used as the basis for all of its other outputs. The triangular wave is generated by repeatedly charging and discharging a capacitor from a constant current source. This produces a linearly ascending or descending voltage ramp. As the output voltage reaches upper and lower limits, the charging and discharging is reversed using a comparator, producing the linear triangle wave. By varying the current and the size of the capacitor, different frequencies may be obtained. Saw tooth waves can be produced by charging the capacitor slowly, using a current, but using a diode over the current source to discharge quickly - the polarity of the diode changes the polarity of the resulting saw tooth, i.e. slow rise and fast fall, or fast rise and slow fall.

A 50% duty cycle square wave is easily obtained by noting whether the capacitor is being charged or discharged, which is reflected in the current switching comparator output. Other duty cycles (theoretically from 0% to 100%) can be obtained by using a comparator and the saw tooth or triangle signal. Most function generators also contain a non-linear diode shaping circuit that can convert the triangle wave into a reasonably accurate sine wave by rounding off the corners of the triangle wave in a process similar to clipping in audio systems.

A typical function generator can provide frequencies up to 20 MHz RF generators for higher frequencies are not function generators in the strict sense since they typically produce pure or modulated sine signals only.

Function generators, like most signal generators, may also contain an attenuator, various means of modulating the output waveform, and often the ability to automatically and repetitively "sweep" the frequency of the output waveform (by means of a voltage- controlled oscillator) between two operator-determined limits. This capability makes it very easy to evaluate the frequency response of a given electronic circuit.

Specifications

Typical specifications for a general-purpose function generator are:

- Produces sine, square, triangular, saw-tooth (ramp), and pulse output. Arbitrary waveform generators can produce waves of any shape.
- It can generate a wide range of frequencies.
- Good frequency stability analogue generators & digital generators.
- Maximum sine wave distortion of about 1% for analogue generators.
- AM or FM modulation may be supported.
- Output amplitude up to 10 V peak-to-peaks.
- Amplitude can be modified, usually by a calibrated attenuator with decade steps and continuous adjustment within each decade.
- Some generators provide a DC offset voltage, e.g. adjustable between -5V to +5V.
- An output impedance of 50 Ω.

PROCEDURE:

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OBSERVATION TABLE:

Input Signal	Input value (from Function generator)			Measured value (from CRO)		
	Amplitude	Time	Frequency	Amplitude	Time	Frequency
Sine wave						
Square wave						
Triangular wave						

To Observe & Draw waveform of Lissajous Pattern:

Draw the Output pattern using Component Tester in CRO:

Short Circuit	
Open Circuit	
Resistor	

Capacitor	
Diode	
Zener Diode	

CALCULATION:

CONCLUSION:

Questions:

1. **What is Lissajous Pattern.**
2. **Compare analog & Digital CRO.**
3. **Write specifications of Function Generator & CRO.**

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EXPERIMENT NO. 4

AIM: To understand working and specifications of DC regulated Power supply.

APPARATUS:

THEORY:

Introduction

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters.

Some types of power supplies are:-

- D.C. power supply
- A.C. power supply.
- Switched-mode power supply
- Uninterruptible power supply.

D.C power supply

1) Linear regulator

The function of a linear voltage regulator is to convert a varying DC voltage to a constant, often specific, lower DC voltage. In addition, they often provide a current limiting function to protect the power supply and load from over current (excessive, potentially destructive current).

A constant output voltage is required in many power supply applications, but the voltage will vary with changes in load impedance and will also vary with changing input voltage. To overcome this, some power supplies use a linear voltage regulator to maintain the output voltage at a steady value, independent of fluctuations in input voltage and load impedance. Linear regulators can also reduce the magnitude of ripple and noise present appearing on the output voltage.

2) Regulated A.C.to D.C. power supply

A regulated power supply is an embedded circuit; it converts unregulated AC into a constant DC. With the help of a rectifier it converts AC supply into DC. Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC.

Construction and working of regulated D.C power supply

The basic components of dc power supply are transformer, rectifier, filter and voltage regulator. Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage,

then filtering to a dc level and, finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remain s the same even if the input dc voltage varies or the output load connected to the dc voltage changes.

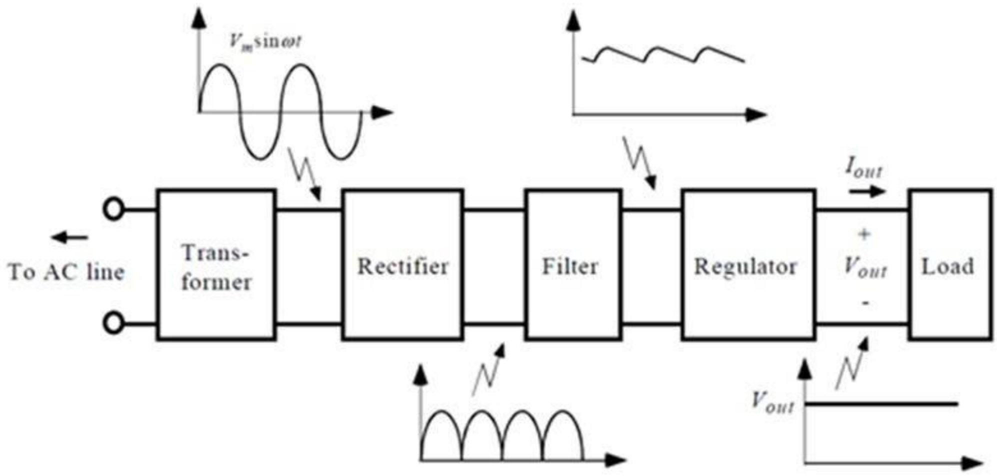

Fig 1. Components of a typical linear power supply

A block diagram containing the parts of a typical power supply and the voltage at various points in the unit is shown in above figure 1. The ac voltage, typically 120 Vrms, is connected to a transformer, which steps that ac voltage down to the level for the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage variessome- what or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of a number of popular voltage regulator IC units.

Ripple factor: (Vac (rms) / Vdc) x 100% Voltage Regulation

Another factor of importance in a power supply is the amount the dc output voltage changes over a range of circuit operation. The voltage provided at the output under no- load condition (no current drawn from the supply) is reduced when load current is drawn from the supply (under load). The amount the dc voltage changes between the no -load and load conditions is described by a factor called voltage regulation.

$$\text{Voltage Regulation} = \frac{\text{No- load voltage} - \text{Full load voltage}}{\text{Full load voltage}} \qquad \text{....Eq 1}$$

%VR = VNL-VFL ---------- X 100% VFL

Filters: It filter out’s the ac component at the output stage after the ac is rectified.

Capacitor Filter

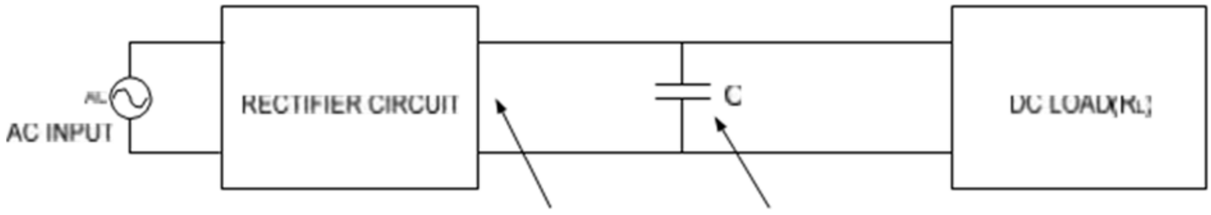

Fig 2. Simple Capacitor Filter

A very popular filter circuit is the capacitor-filter circuit shown in figure 2. A capacitor is connected at the rectifier output, and a dc voltage is obtained across the capacitor.

Figure 3 (a) shows the output voltage of a full-wave rectifier before the signal is filtered; while figure 3 (b) shows the resulting waveform after the filter capacitor is connected at the rectifier output. Notice that the filtered waveform is essentially a dc voltage with some ripple (or ac variation).

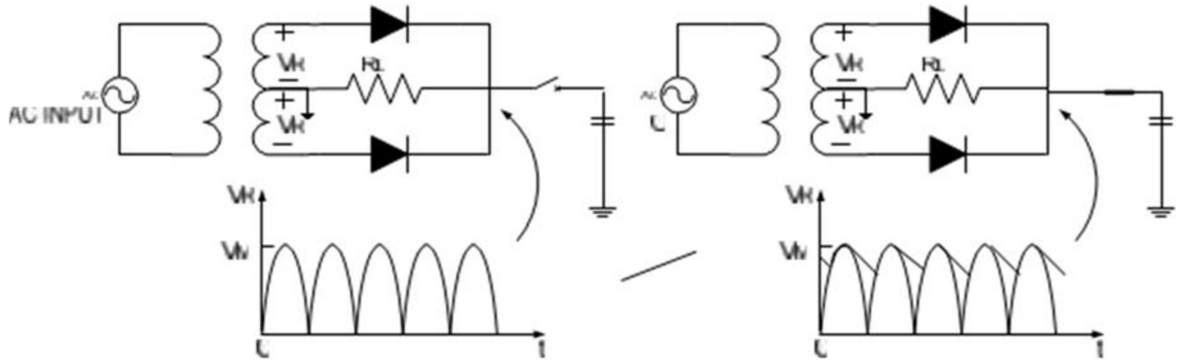

Fig 3 (a) Full wave rectified voltage (b) Filtered output voltage.

IC Voltage Regulators

Voltage regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC.IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.

A power supply can be built using a transformer connected to the ac supply line to step the ac volt- age to a desired amplitude, then rectifying that ac voltage, filtering with a capacitor and RC fil- ter, if desired, and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milliamperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts.

PROCEDURE:

OBSERVATION TABLE:

IC	IDEAL VALUE	PRACTICAL VALUE
7805		
7905		
7812		
7912		

CONCLUSION:

Questions:

1. **What is the use of filter circuit in voltage regulator?**
2. **What is Heat Sink?**
3. **What is SMD component?**

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EXPERIMENT NO. 5

AIM: Understanding soldering techniques and practicing proper soldering and de-soldering.

APPARATUS:

THEORY:

PROCEDURE OF SOLDERING:

Soldering is a process in which two or more metal items are joined together by melting and then flowing a filler metal into the joint—the filler metal having a relatively low melting point. Soldering is defined as "the joining of metals by a fusion of alloys which have relatively low melting points". In other words, you use a metal that has a low melting point to adhere the surfaces to be soldered together. Soldering is more like gluing with molten metal than anything else. Soldering in electronics is a method of joining components permanently to a printed circuit board (PCB). Soldering is also a must have skill for all sorts of electrical and electronics work.

Tools required for soldering

1) Soldering Iron

A temperature controlled soldering iron with stand and sponge is required. It may be between 15-40Watts.Soldering iron & gun are shown in figure 1.

Fig 1. Soldering iron & Soldering gun

2)Solder Wire

An alloy of tin and lead called solder (63% tin and 37% lead), is normally used to bind a component pin/leg to the copper track of a circuit. Some modern solders do not contain lead, due to environmental concerns and its potential toxic nature. Lead is poisonous under certain circumstances. However, lead free solders require a higher melting point, as they have an increased tin content. Solder wire is shown in figure 2.

Fig 2. Solder wire

3)Flux

It is a paste used while soldering. Figure 3 shows soldering paste available in markets used during sol- dering.

Fig 3. Flux

4)Flux removal solvent and brush

The PCB is to be cleaned after soldering. The flux used while soldering spreads on the PCB area this is to be also clean. So for cleaning the PCB we require solvent such as isopropyl alcohol. Brush is to dipped in the solvent and the soldered area of PCB is to be cleaned up.

Soldering Procedure:

1) Clean the surface to be soldered.

2) Switch ON the soldering iron and let is heat (@ 350˚C), and also keep the sponge should be damp.

3) The pin or the leads of the components to be soldered are to be kept nearer, if needed apply the flux at joint area.

4) Heat the joint area with soldering iron. The angle of soldering iron should be 45˚.

5) Apply solder at the joint and remove when sufficient solder has flown down to the joint points.

6) Take away the solder wire and soldering iron after the joint is made. Then allow the soldered joints to cool down.

7) Clean the PCB with the solvent using brush

Precautions during soldering:

1) The temperature of soldering iron is @ 350˚C, so care is to be taken that the soldering iron is handled properly while soldering. When not in use it is to be kept in holder.

2) While soldering the fumes are released. These fumes are harmful to lungs and eyes.

So soldering work is to be performed in ventilated place. Also wear safety glasses for protec- tion of eyes against fumes.

3) Keep flammable materials away from the hot soldering iron.

De Soldering

De-soldering is extremely difficult compare to soldering. The parts and circuit board must be in the good shape to re-use them. The tool we use is De-soldering Gun or

De - soldering pump, refer figure 4.

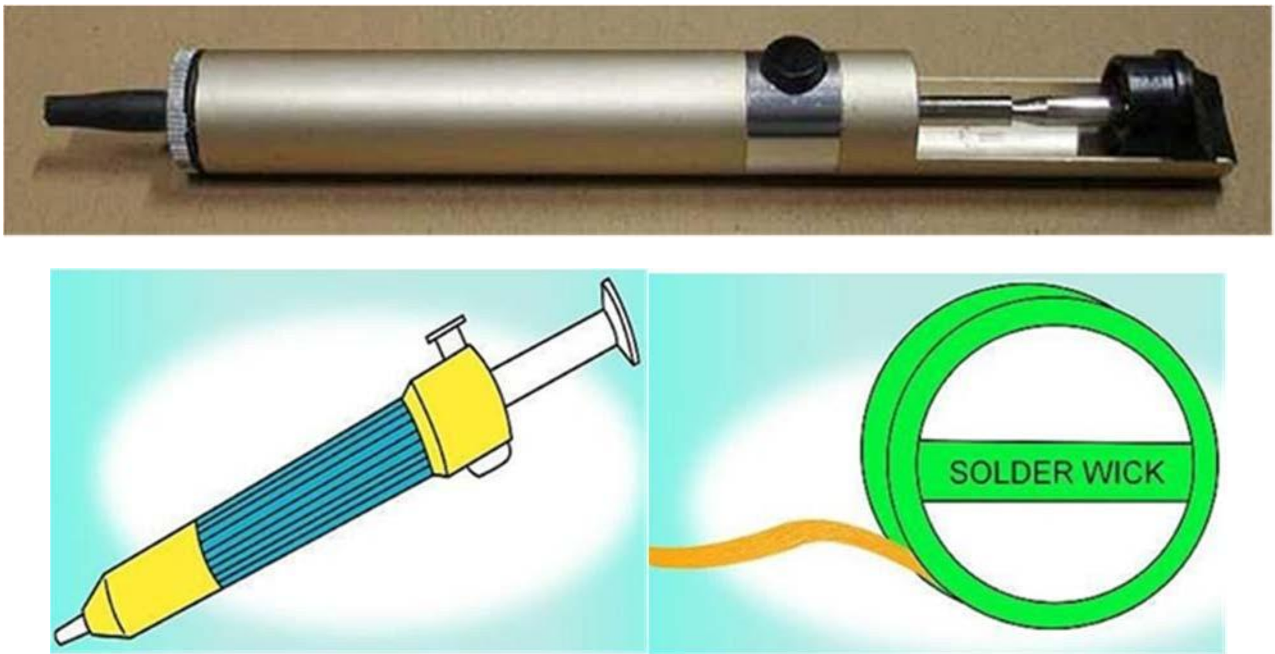

Fig 4. De-soldering pump & Desoldering Wick

This device has vacuum pump built in with heater tip. Process of de-soldering itself is very simple, but there are some tricks to do clean and safe de - soldering job.

General Procedure for De-Soldering

1)Put the de-soldering gun’s tip over to the soldering joint. Make sure nozzle is 90° angle from circuit board.

2)Apply the enough heat to melt entire solder. Multi-layer board or ground pin may take while to transfer heat.

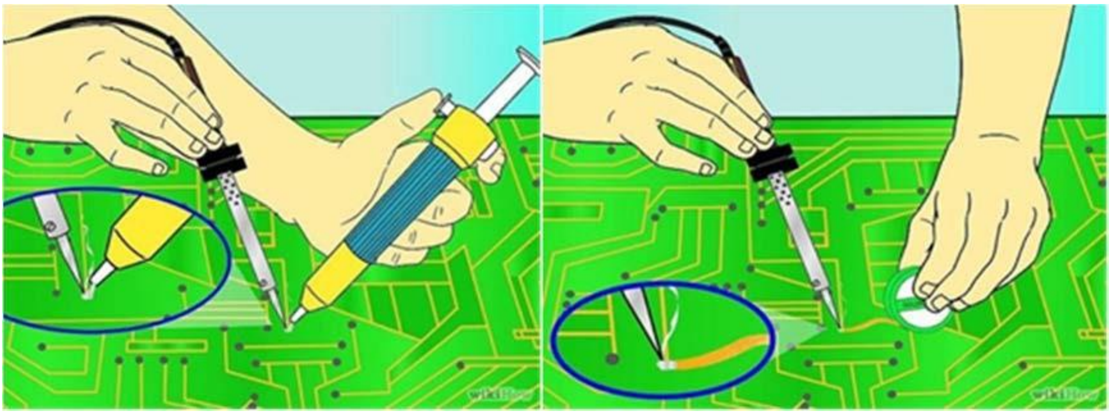

Fig 6. De-soldering Process

3) While applying vacuum, move the tip around the pin to get all the solder of around the pin out. At this time, you can also feel pin moves freely, so you know pin is free from circuit board.

4) When you can hear air flow sound from hole, you should be done. Stop applying vacuum and remove the gun from the pin. Inspect hole and pin.

5) When de-soldering is done, the parts to be removed should move freely. If it doesn't, find which pin is still has solder left, and re-apply fresh solder to it and try de- soldering process again.

CONCLUSION:

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Questions:

1. **Which metal is used in solder wire? Why?**
2. **What is temperature when we perform soldering.**
3. **Is there any other form of flux is available?**

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EXPERIMENT NO. 6

AIM: Demonstrate the working of Temperature Sensor

APPARTUS:

THEORY:

A Temperature Sensor is a piece of electronic equipment that detects the temperature of its surroundings and transforms the incoming data into electronic output data to control record or signal temperature variations. There are several types of temperature sensors. Some of them need direct contact with the physical target that is being identified, which is introduced as contact temperature sensors. In contrast, others sense the temperature of the targets indirectly, which is described as non-contact temperature sensors.

Temperature Sensor Working

The fundamental working of this sensor is based on the voltage in its diode. The temperature variation is directly related to the resistance of this diode. The resistance of the diode is detected and transformed into simple and readable values of temperature such as Fahrenheit, Kelvin, or Centigrade and demonstrated in meaningful formats instead of readout values. These temperature sensors are employed to sense the internal temperature of various structures like power plants.

The fundamental principle of the temperature sensors operation is the voltage modification in the MOSFET terminals. If the voltage reduces, the temperature also decreases, according to the voltage drop between the emitter in the MOSFET and terminals of the base sensor.

LM35:

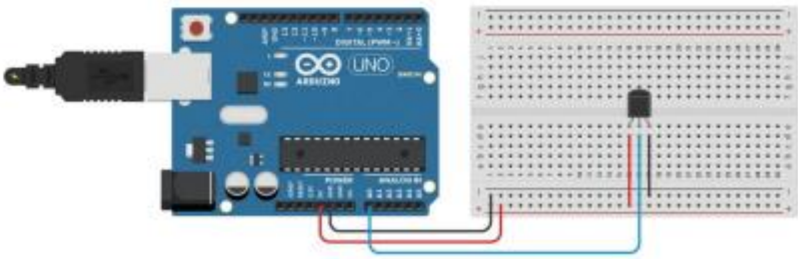
- LM35 is a temperature measuring device having an analog output voltage proportional to the temperature.
- It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry.
- The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases.
- It is a 3-terminal sensor used to measure surrounding temperature ranging from -55 °C to 150 °C.
- LM35 gives temperature output which is more precise than thermistor output.

- The LM35 temperature sensor uses the basic principle of a diode to measure known temperature value. As we all know from semiconductor physics, as the temperature increases the voltage across a diode increases at a known rate. By accurately amplifying the voltage change, we can easily generate a voltage signal that is directly proportional to the surrounding temperature. The screenshot below shows the internal schematic of LM35 temperature sensor IC according to the datasheet.

- The main advantages of the thermistor are large temperature coefficient of resistance, high sensitivity, small heat capacity, fast response; but the main disadvantages are poor interchangeability and non-linearity of thermoelectric characteristics which is to expand the measurement.

Arduino LM35 Temperature Sensor Circuit

- Connecting the LM35 sensor to the Arduino is really simple. We just need to connect 5V power to the sensor and we need to connect the output of the sensor to the A0 pin of the Arduino. Once the connection is done we need to write the code to convert the output voltage of the sensor to temperature data. For that, first, we need to convert the ADC values to voltage and multiply that voltage to 10 and we will get the output in temperature.



PERFORMANCE RESULT:

CONCLUSION:

Q/A:

1. How does LM35 works?

2. What is the operational range of LM35 sensor?

3. What are the pins of LM35 and how do we interface it with Arduino?

4. Write the formula of converting the ADC value into Actual temperature in Celsius?

5. How accurate is the LM35 sensor?

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EXPERIMENT NO. 7

AIM: Verify the functionality of water flow sensor

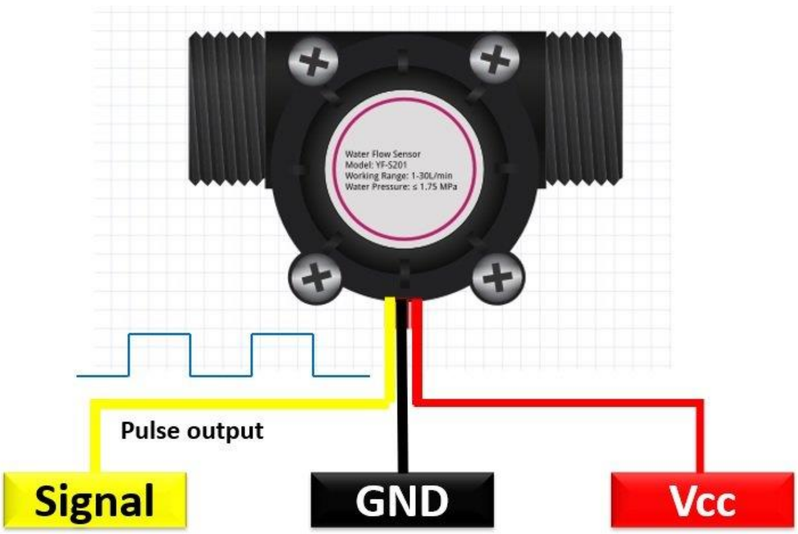
APPARTUS:

THEORY: A water flow sensor is an electronic device that is used to measure water flow rate. Furthermore, the flow rate means the volume of water passes through a sensor per unit of time. There are many types of water flow rate measurement sensors available in the market such as YF-B1, YF-B2, YF-B3, YF-B4, YF-B5, YF-B6, G1&2, G3&4, G1&8, and YF-S201.All these sensors are almost the same except for the difference in flow rate range, operating voltage range, length, size, and material used. But their working principle and the procedure to interface with microcontrollers such as Arduino remains the same.

YF-S201 Water Flow Sensor Introduction

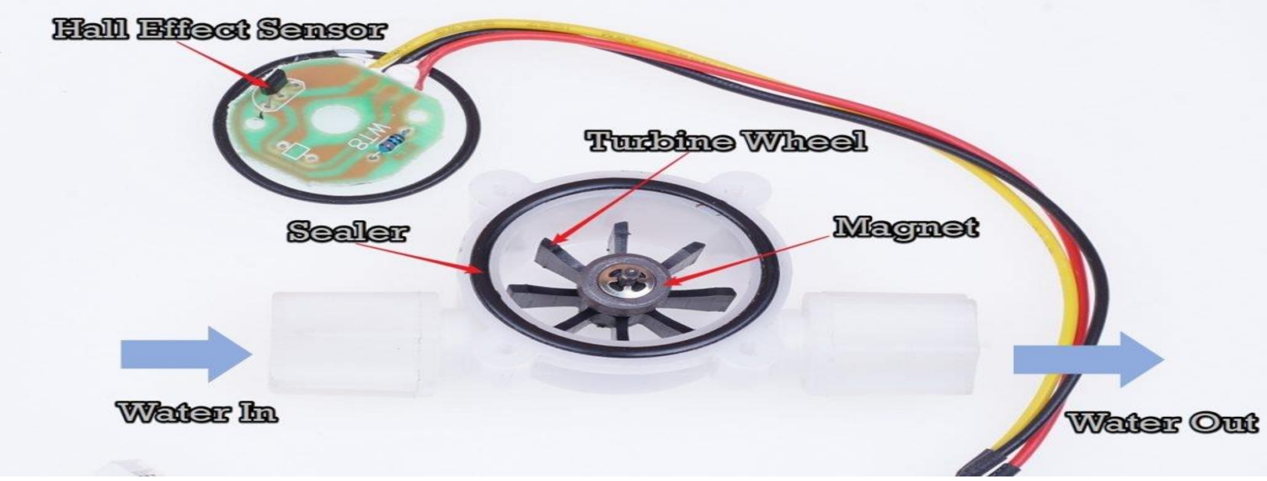
YF-S201 is a water sensor technically designed to measure the flow rate and volume of the desired fluid through the pipelines. It is a low-cost water flow sensor that consists of a copper body and water rotor.

It also contains an internal circuit of the Hall effect sensor that works on the principle of electromagnetism and provides pulses at the output pin. It is a power-friendly and MCU compatible device with a flow rate of a maximum of 30 litres per minute. A small device with high accuracy finds its application from DIY projects to the industry for flow measurement.



- **How does Water Flow Sensor work?**

This water flow sensor consists of a water rotor (turbine wheel) and a Hall effect sensor. Water enters through of end and leaves through the other end of the sensor. When water flows through the flow sensor, it strikes the turbine wheel and the turbine wheel rotates. The speed of the turbine wheel has a direct relation with the speed of the flow of water through the water flow sensor. On each complete rotation of the turbine wheel, a hall effect sensor also produces a pulse that appears on the signal output pin. In other words, the number of pulses that appear on the signal output pin is directly proportional to the rotational speed of the turbine.

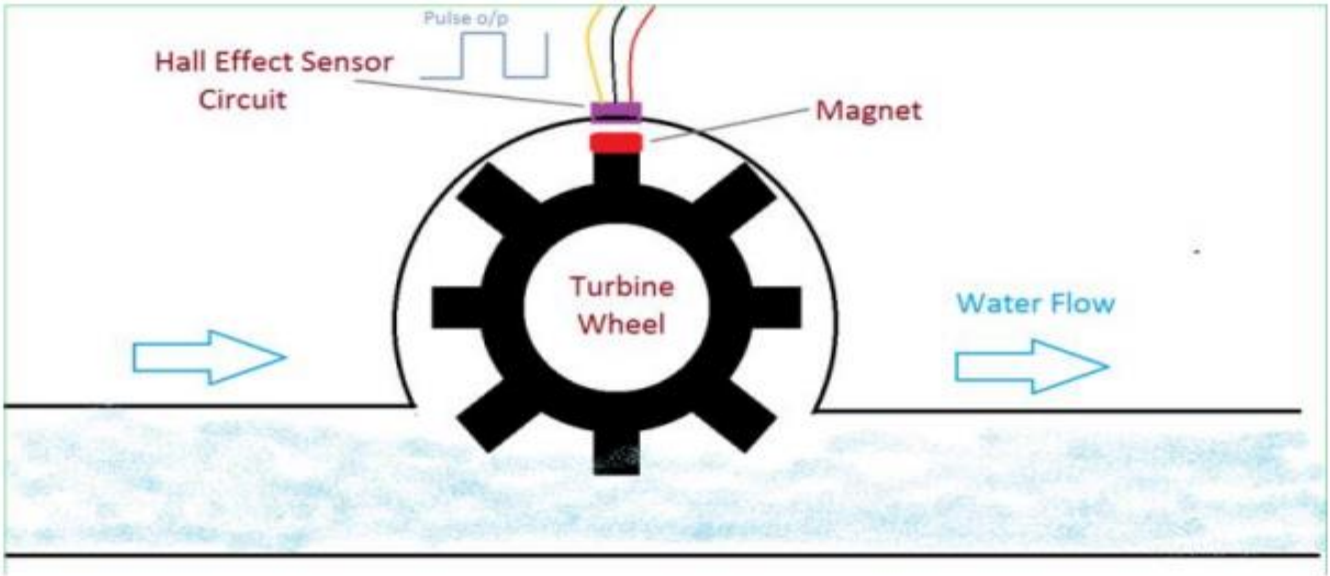


The YF-S201 is known as a Hall effect sensor because it operates on the Hall effect.

In order to measure the flow or volume of the fluid, we fix the sensor between the water inlet and outlet valves. When the fluid flows through, it rotates the rotor which has a magnet attached to it.

The speed interferes with the magnetic flux which is sensed by the Hall effect sensor and the sensor in returns generates an output signal proportional to the magnetic flux with every revolution that the rotor makes.

As the water flow sensor is compatible with microcontrollers, we can observe the measurements on a computer serial monitor and can also display them on 16×2 LCD



.

In this flow meter, for every liter of liquid passing through it per minute, it outputs about 4.5 pulses. This is due to the changing magnetic field caused by the magnet attached to the rotor shaft.

We measure the number of pulses using an Arduino and then calculate the flow rate in litres per hour (L/hr) and total volume in Litre using a simple conversion formula.

- Pulse frequency= 7.5*flow rate (ltr/min)
- Pulse frequency= [7.5*flow rate (ltr/hr)]

PROCEDURE:

- Open the Arduino IDE.
- Select the type of board from Tools -> Board -> Arduino UNO.
- Select the port from Tools -> Port -> COM.
- Connect the VCC pin YFS201 of to 5V of the Arduino board.
- Connect the GND pin of YFS201to GND of the Arduino board.
- Connect Its Analog Pin To 2 Of Arduino.
- Upload the sketch to the connection diagram

PERFORMANCE RESULT

CONCLUSION:

Q/A:

1. What is YFS201 sensor and how does it work?

2. How do you connect YFS201 sensor with Arduino UNO board?

3. What are the key specifications of the sensor ?

4. How does the YFS201 sensor's measurement range impact the maximum flow rate that it can detect, and how can this be adjusted in the code?

5. What are some potential use of a YFS201 sensor and Arduino UNO in industrial automation or process control applications?

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EXPERIMENT NO. 8

AIM: **Verify the Functionality of Distance Measurement Sensor**

APPARATUS:

THEORY: The Ultrasonic sensor or HC-SRO4 is used to measure the distance of the object using SONAR. It emits the Ultrasound at a frequency of **40KHZ or 40000 Hz**. The frequency travels through the air and strikes the object on its path. The rays bounce back from the object and reach back to the module.

The four terminals of HC-SRO4 are VCC, TRIG, ECHO, and GND. The voltage supply or VCC is +5V.

We can connect the ECHO and TRIG terminal to any of the digital I/O pin on the specific Arduino board.

The Ultrasonic sensors work best for medium ranges.

The resolution is 0.3cm.
The medium ranges of the sensor are 10cm to 3m. It works best at this duration.
The maximum range the sensor may detect is 4.5m.

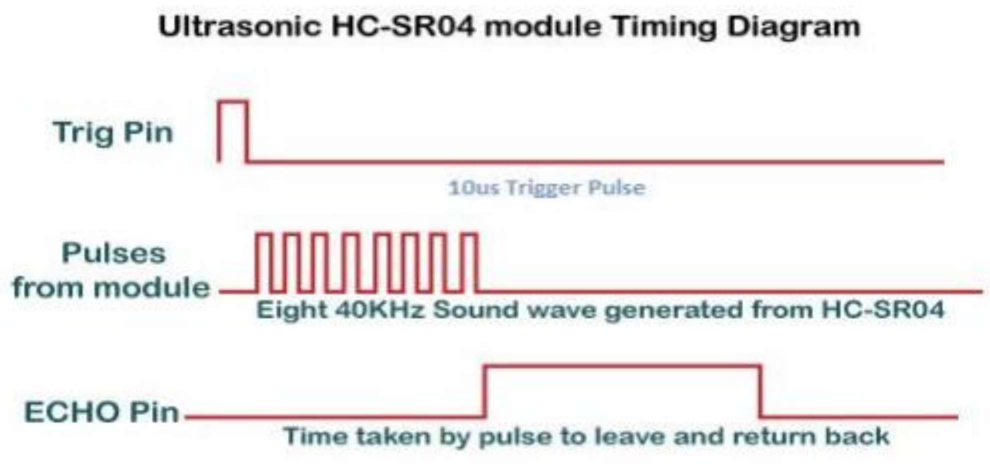
Structure And Timing Diagram Of Ultrasonic Sensor:

We will set the TRIG pin to HIGH for some time (about 3 to 100 microseconds). As soon the TRIG pin is LOW, the Ultrasonic sensor sends the pulses and sets the ECHO pin to HIGH. When the sensor gets the reflected pulses, it sets the ECHO pin to LOW. We need to measure the time for which the ECHO pin was HIGH.

The timing diagram of the ultrasonic sensor HC-SRO4 is shown below:

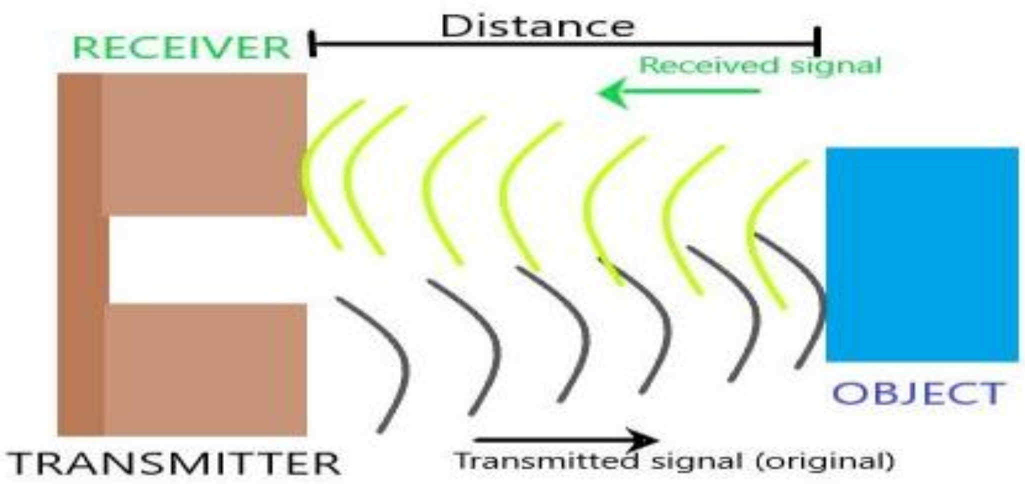
We will set the TRIG pin to HIGH for some time (about 3 to 100 microseconds). As soon the TRIG pin is LOW, the Ultrasonic sensor sends the pulses and sets the ECHO pin to HIGH. When the sensor gets the reflected pulses, it sets the ECHO pin to LOW. We need to measure the time for which the ECHO pin was HIGH

The timing diagram of the ultrasonic sensor HC-SRO4 is shown below:



We need to first set the TRIG (triggered) pin at HIGH. It will send out the burst of 8 cycles called the sonic burst, which will travel at the sound speed. It will be further received by the ECHO pin.

The time travelled by the sound wave is considered the ECHO pin's output time in microseconds.



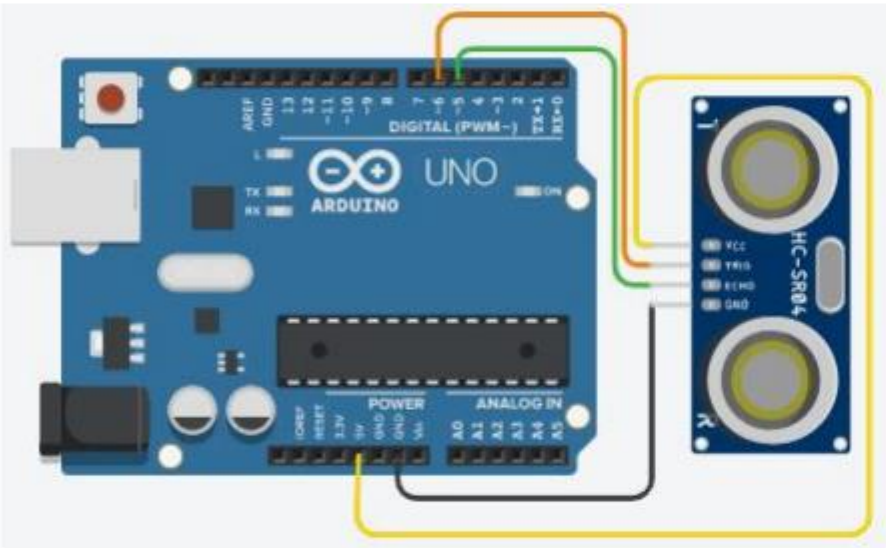
We will use the **PulseIn()** function to read the time from the output of the ECHO pin. It will wait for the specified pin to go HIGH and LOW.

The function would return the timing at the end. The TRIG pin is set LOW for 4 microseconds and then HIGH for 15 microseconds. The timing will be calculated in microseconds.

PROCEDURE:

- Open the Arduino IDE.
- Select the type of board from Tools -> Board -> Arduino UNO.
- Select the port from Tools -> Port -> COM.
- Connect the VCC pin of HC-SRO4 to 5V of the Arduino board.
- Connect the GND pin of HC-SRO4 to GND of the Arduino board.
- Connect the TRIG pin of HC-SRO4 to pin 9 of the Arduino board.
- Connect the ECHO pin of HC-SRO4 to pin 8 of the Arduino board.
- Upload the sketch to the sketch to the connection diagram.

CONNECTION DIAGRAM:



PERFORMANCE RESULT:

CONCLUSION:

Q/A:

1. What is Ultrasonic Sensor and how does it works with Arduino?

2. Describe the pins of the Ultrasonic Sensor.

3. What is the maximum range of Ultrasonic sensor and can it detect multiple objects at once?

4. What exactly does the Ultrasonic sensor measures and how can we convert that parameter into the distance?

5. Can Ultrasonic sensor detect the height of the object or just the distance?

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EXPERIMENT NO. 9

AIM: Demonstrate the working of Rain detector Sensor

APPARATUS:

THEORY: In everyone's life, water is a basic need but conserving water as well as its proper maintenance is very important. So here is a rain sensor to detect the rain in the agriculture field & generates an alarm whenever there is rain so that we can take some proper actions to conserve the water as well as crops.

Consequently, we can enhance the underground water levels through a recharge technique used underwater. This sensor detects the rain and gives an alert to concerned persons in different fields like irrigation, automobile communication, home automation, etc.

A sensor that is used to notice the water drops or rainfall is known as a rain sensor. This kind of sensor works like a switch.

Working Principle

The rain sensor working principle is pretty simple. The sensing pad includes a set of uncovered copper traces which mutually work like a variable resistor or a potentiometer. Here, the sensing pad resistance will be changed based on the amount of water falling on its surface. So, here the resistance is inversely related to the amount of water.

When the water on the sensing pad is more, the conductivity is better & gives less resistance. Similarly, when the water on the surface pad is less, the conductivity is poor & gives high resistance. So the output of this sensor mainly depends on the resistance.

Rain Detection Sensor - Parts

The entire rain detection sensor module consists of two parts: the **rain detection sensor PCB** and the signal processing module. The module processes the incoming data from the sensor PCB and it can output both analog and digital data simultaneously.

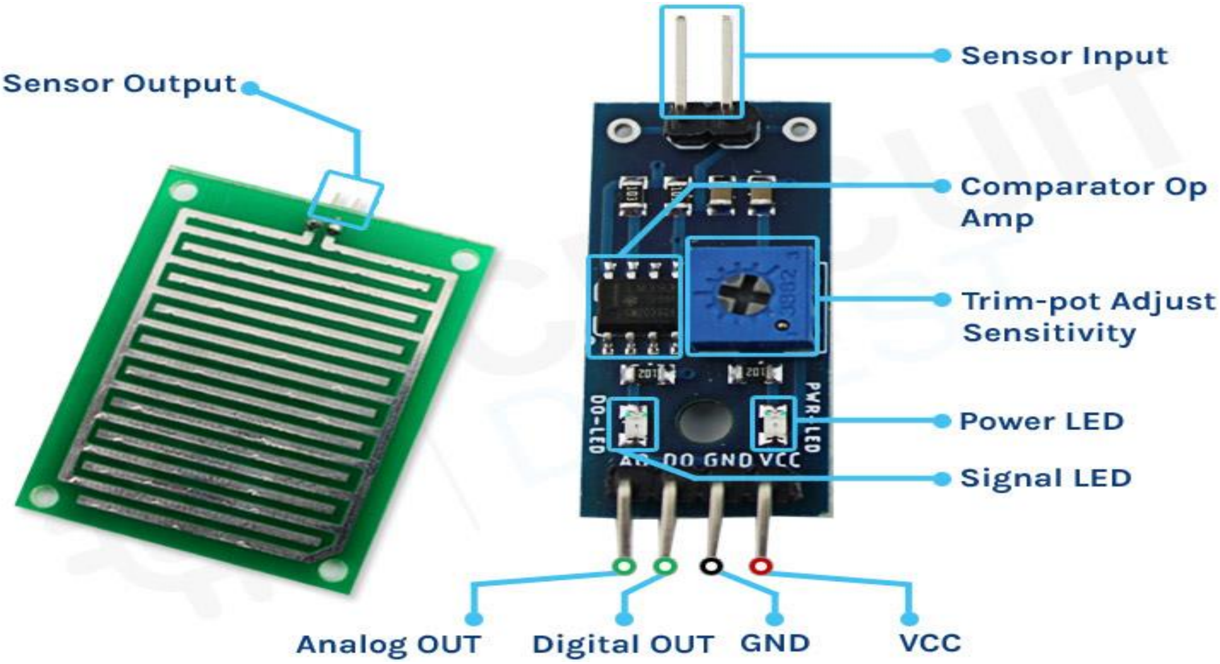
The sensor module has four pins, two of which are for VCC and Gnd and the other two can simultaneously output analog and digital data.

As you can see in the image above the module has two onboard LEDs.

The power led turns on when power is applied to the board and another one turns on when the set value by the potentiometer is reached.

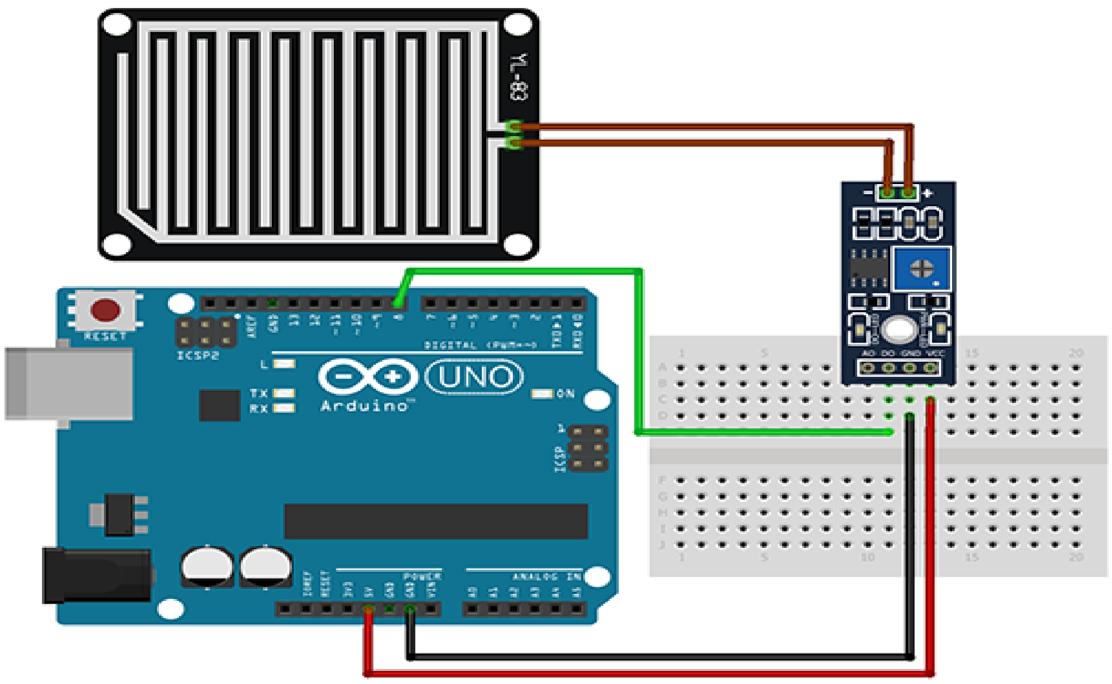
This board also has a comparator OP-Amp onboard that is responsible for converting the incoming analog signal from the photodiode to a digital signal.

We also have a sensitivity adjustment potentiometer, with that, we can adjust the sensitivity of the device. And finally, we have the rain detection PCB together with the signal processing module that makes the rain detection sensor.



Interfacing the Rain Sensor with Arduino

For the digital interface part, we are also using the +5V and Ground from the Arduino to power the sensor module.



PERFORMANANCE RESULT

CONCLUSION:

Q/A:

1. **What are the Applications of rain detector sensor circuit?**

2. **Write down the Advantages of Rain Detector sensor**

3. **Explain working principle of Rain Detector sensor**

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EXPERIMENT NO. 10

AIM: Project based on electronics components and sensors

Title:

Apparatus:

Circuit diagram:

Working principle:

Performance Result:

Applications:

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