SWARNIM START UP & INNOVATION UNIVERSITY

Swarrnim Institute of Technology

INDEX

BRANCH:

SUBJECT: ELECTRICAL & ELECTRONICS WORKSHOP

SEMESTER: 1st **ENROLLMENT NO__________________**

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07	To study and observe Digital Storage oscilloscope (DSO).			
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EXPERIEMNT NO.: 01

AIM: To study & observe resistor color code.

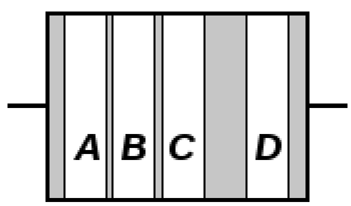
Equipment(s): Resistors, DMM.

INTRODUCTION

The electronic color code is used to indicate the values or ratings of electronic components, very commonly for resistors, but also for capacitors, inductors, and others. A separate code, the 25-pair color code, is used to identify wires in some telecommunications cables.

The electronic color code was developed in the early 1920s by the Radio Manufacturers Association (now part of Electronic Industries Alliance (EIA)), and was published as EIA-RS-279. The current international standard is IEC 60062.

Colorbands were commonly used (especially on resistors) because they were easily printed on tiny components, decreasing construction costs. However, there were drawbacks, especially for color blind people. Overheating of a component, or dirt accumulation, may make it impossible to distinguish brown from red from orange. Advances in printing technology have made printed numbers practical for small components, which are often found in modern electronics.



To distinguish left from right there is a gap between the C and D bands.

- Band A is the first significant figure of component value (left side)
- Band B is the second significant figure (Some precision resistors have a third significant figure, and thus five bands.)
- Band C is the decimal multiplier
- Band D if present, indicates tolerance of value in percent (no band means 20%)

For example, a resistor with bands of yellow, violet, red, and gold will have first digit 4 (yellow in table below), second digit 7 (violet), followed by 2 (red) zeros: 4,700 ohms. Gold signifies that the tolerance is ±5%, so the real resistance could lie anywhere between 4,465 and 4,935 ohms.

Resistors manufactured for military use may also include a fifth band which indicates component failure rate (reliability); refer to MIL-HDBK-199 for further details.

Tight tolerance resistors may have three bands for significant figures rather than two, or an additional band indicating temperature coefficient, in units of ppm/K.

All coded components will have at least two value bands and a multiplier; other bands are optional.

The standard color code per EN 60062:2005 is as follows:

Color	Significant figures	Multiplier	Tolerance		Temp. Coefficient (ppm/K)	
Black	0	$\times10^{0}$	–		250	U
Brown	1	$\times10^{1}$	±1%	F	100	S
Red	2	$\times10^{2}$	±2%	G	50	R
Orange	3	$\times10^{3}$	–		15	P
Yellow	4	$\times10^{4}$	(±5%)	–	25	Q
Green	5	$\times10^{5}$	±0.5%	D	20	Z
Blue	6	$\times10^{6}$	±0.25%	C	10	Z
Violet	7	$\times10^{7}$	±0.1%	B	5	M
Gray	8	$\times10^{8}$	±0.05% (±10%)	A	1	K
White	9	$\times10^{9}$	–		–	
Gold	–	$\times10^{-1}$	±5%	J	–	
Silver	–	$\times10^{-2}$	±10%	K	–	
None	–	–	±20%	M	–	

Resistors use preferred numbers for their specific values, which are determined by their tolerance. These values repeat for every decade of magnitude: 6.8, 68, 680, and so forth. In the E24 series the values are related by the 24th root of 10, while E12 series are related by the 12th root of 10, and E6 series by the 6th root of 10. The tolerance of device values is arranged so that every value corresponds to a preferred number, within the required tolerance.

Zero ohm resistors are made as lengths of wire wrapped in a resistor-shaped body which can be substituted for another resistor value in automatic insertion equipment. They are marked with a single black band.

The 'body-end-dot' or 'body-tip-spot' system was used for radial-lead (and other cylindrical) composition resistors sometimes still found in very old equipment; the first band was given by the body color, the second band by the color of the end of the resistor, and the multiplier by a dot or band around the middle of the resistor. The other end of the resistor was colored gold or silver to give the tolerance, otherwise it was 20%.

EXAMPLES

Sr. No.	Colour Code	Ω as per Colour code	Ω as per DMM
1	Green,Yellow,Red,Gold	**$47x10^2$ Ω**	
2			
3			
4			
5			

Conclusion:

EXPERIEMNT NO.: 02

AIM: To study about multi meter (DMM and AVAM).

Equipment(s): AMM, DMM, resistor.

INTRODUCTION

A **multimeter** or a **multitester**, also known as a **VOM** (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic features such as the ability to measure voltage, current, and resistance. **Analog multimeters** use a micro-ammeter whose pointer moves over a scale calibrated for all the different measurements that can be made. **Digital multimeters** (DMM, DVOM) display the measured value in numerals, and may also display a bar of a length proportional to the quantity being measured. Digital multimeters are now far more common than analog ones, but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value.

A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

The first moving-pointer current-detecting device was the galvanometer in 1820. These were used to measure resistance and voltage by using a Wheatstone bridge, and comparing the unknown quantity to a reference voltage or resistance. While useful in the lab, the devices were very slow and impractical in the field. These galvanometers were bulky and delicate.

A multimeter is a combination of a multirange DC voltmeter, multirange AC voltmeter, multirange ammeter, and multirange ohmmeter. An un-amplified analog multimeter combines a meter movement, range resistors and switches.

Digital instruments, which necessarily incorporate amplifiers, use the same principles as analog instruments for range resistors. For resistance measurements, usually a small constant current is passed through the device under test and the digital multimeter reads the resultant voltage drop; this eliminates the scale compression found in analog meters, but requires a source of significant current. An auto-ranging digital multimeter can automatically adjust the scaling network so that the measurement uses the full precision of the A/D converter.

To measure resistance, a small battery within the instrument passes a current through the device under test and the meter coil. Since the current available depends on the state of charge of the battery, a multimeter usually has an adjustment for the ohms scale to zero it. In the usual circuit found in analog multimeters, the meter deflection is inversely proportional to the resistance; so full-scale is 0 ohms, and high resistance corresponds to smaller deflections. The ohms scale is compressed, so resolution is better at lower resistance values.

Digital multimeters (DMM or DVOM)

Modern multimeters are often digital due to their accuracy, durability and extra features. In a digital multimeter the signal under test is converted to a voltage and an amplifier with electronically controlled gain preconditions the signal. A digital multimeter displays the quantity measured as a number, which eliminates parallax errors.

Modern digital multimeters may have an embedded computer, which provides a wealth of convenience features. Measurement enhancements available include:

- **Auto-ranging**, which selects the correct range for the quantity under test so that the most significant digits are shown. For example, a four-digit multimeter would automatically select an appropriate range to display 1.234 instead of 0.012, or overloading. Auto-ranging meters usually include a facility to hold the meter to a particular range, because a measurement that causes frequent range changes can be distracting to the user.
- **Auto-polarity** for direct-current readings, shows if the applied voltage is positive (agrees with meter lead labels) or negative (opposite polarity to meter leads).
- **Sample and hold**, which will latch the most recent reading for examination after the instrument is removed from the circuit under test.
- Current-limited tests for voltage drop across semiconductor junctions. While not a replacement for a transistor tester, this facilitates testing diodes and a variety of transistor types.
- A **graphic representation** of the quantity under test, as a bar graph. This makes go/no-go testing easy, and also allows spotting of fast-moving trends.
- A low-bandwidth **oscilloscope**.
- Automotive circuit testers, including tests for automotive timing and dwell signals.
- Simple data acquisition features to record maximum and minimum readings over a given period, or to take a number of samples at fixed intervals.
- Integration with tweezers for surface-mount technology.
- A combined LCR meter for small-size SMD and through-hole components.

Modern meters may be interfaced with a personal computer by IrDA links, RS-232 connections, USB, or an instrument bus such as IEEE-488. The interface allows the computer to record measurements as they are made. Some DMMs can store measurements and upload them to a computer. The first digital multimeter was manufactured in 1955 by Non Linear Systems.

Analog multimeters

A multimeter may be implemented with a galvanometer meter movement, or less often with a bar graph or simulated pointer such as an LCD or vacuum fluorescent display. Analog multimeters are common; a quality analog instrument will cost about the same as a DMM. Analog multimeters have the precision and reading accuracy limitations described above, and so is not built to provide the same accuracy as digital instruments.

Analog meters are also useful in situations where it is necessary to pay attention to something other than the meter, and the swing of the pointer can be noticed without looking directly at it. This can happen when accessing awkward locations, or when working on cramped live circuitry. Analog meter movements are inherently more fragile physically and electrically than digital meters. Many analog meters have been instantly broken by connecting to the wrong point in a circuit, or while on the wrong range, or by dropping onto the floor. Many analog multimeters feature a switch position marked "transit" to protect the meter movement during transportation. This feature works by placing a low resistance across the movement winding, resulting in dynamic braking. Sensitive meter movements may be protected in the same manner by connecting a shorting or jumper wire between the terminals when not in use. Meters which feature a shunt across the winding such as an ammeter may not require further resistance to arrest uncontrolled movements of the meter needle because of the low resistance of the shunt.

Resolution and accuracy

The resolution of a multimeter is the smallest part of the scale which can be shown. The resolution is scale dependent. On some digital multimeters it can be configured, with higher resolution measurements taking longer to complete. For example, a multimeter that has a 1 mV resolution on a 10 V scale can show changes in measurements in 1mV increments.
Absolute accuracy is the error of the measurement compared to a perfect measurement. Relative accuracy is the error of the measurement compared to the device used to calibrate the multimeter. Most multimeter datasheets provide relative accuracy. To compute the absolute accuracy from the relative accuracy of a multimeter adds the absolute accuracy of the device used to calibrate the multimeter to the relative accuracy of the multimeter.

- **Digital**

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

  By convention, if the most significant digit can be either 0 or 1, it is termed a half-digit; if it can take higher values without reaching 9 (often 3 or 5), it may be called three-quarters of a digit. A 5½ digit multimeter would display one "half digit" that could only display 0 or 1, followed by five digits taking all values from 0 to 9. Such a meter could show positive or negative values from 0 to 199,999. A 3¾ digit meter can display a quantity from 0 to 3,999 or 5,999, depending on the manufacturer.

- **Analog**

Analog meters are older and still preferred by many engineers. One reason for this is that analog meters are more sensitive to what is happening in the circuit that is being measured. A digital multimeter samples the quantity being measured at a particular time and displays it. Analog multimeters sample a quantity as it is happening. If there are slight changes in DC voltage, the needle of an analog multimeter will track them -- the needle moves -- while digital multimeters often miss them.

Probes

A multimeter can utilize a variety of test probes to connect to the circuit or device under test. Crocodile clips, retractable hook clips, and pointed probes are the three most common attachments. Tweezers probes are used for closely spaced test points, as in surface-mount devices. The connectors are attached to flexible, thickly insulated leads that are terminated with connectors appropriate for the meter. Probes are connected to portable meters typically by shrouded or recessed banana jacks, while bench top meters may use banana jacks or BNC connectors. 2mm plugs and binding posts have also been used at times, but are less common today.

The banana jacks are typically placed with a standardized center-to-center distance of 0.75" (19.05mm), to allow standard adapters or devices such as voltage multiplier or thermocouple probes to be plugged in.

Power Supply

Analog meters can measure voltage and current using power from the test circuit but require internal power for resistance testing; electronic meters always require an internal power supply. Hand-held meters use batteries while bench meters usually use mains power allowing the meter to test devices not connected to a circuit. Such testing usually requires that the component be isolated from the circuit as otherwise other current paths may distort measurements.

Figure: Analog V/I meter

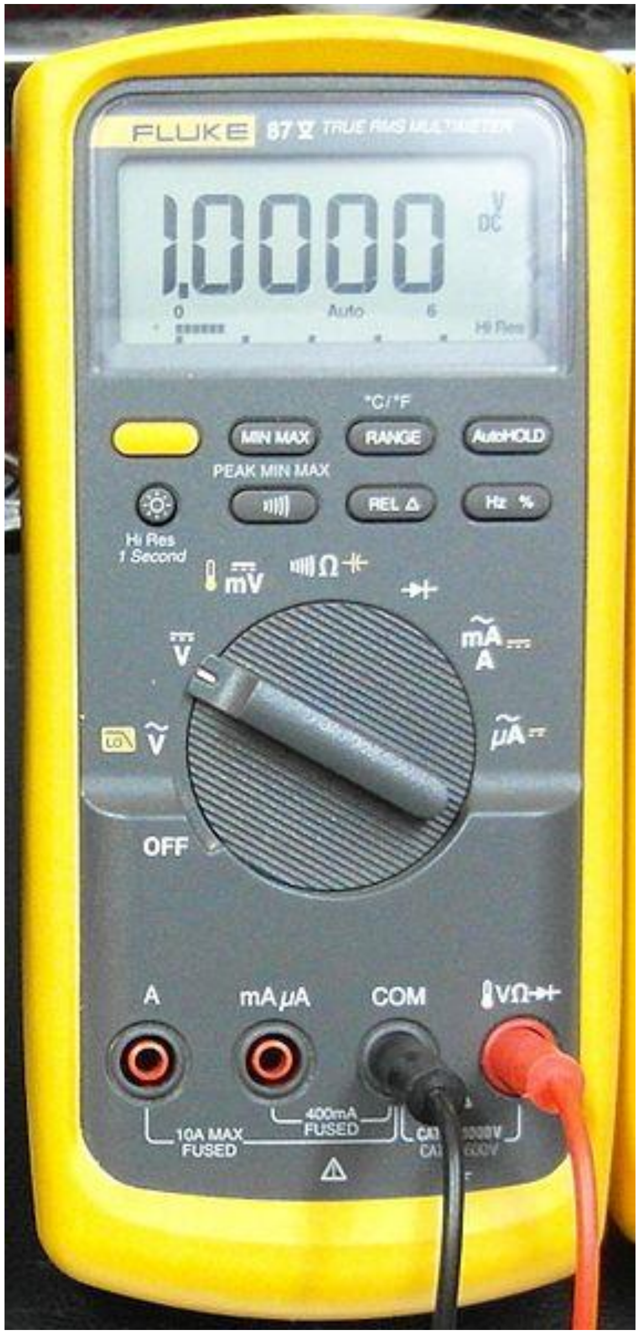


Figure: Digital Multi Meter (DMM)

EXPERIEMNT NO.: 03

AIM: To study about cathode ray oscilloscope (CRO).

Equipment(s): CRO

INTRODUCTION

An oscilloscope, previously called an oscillograph, and informally known as a scope, CRO (for cathode-ray oscilloscope), or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that allows observation of constantly varying signal voltages, usually as a two-dimensional plot of one or more signals as a function of time. Non-electrical signals (such as sound or vibration) can be converted to voltages and displayed.

Oscilloscopes are used to observe the change of an electrical signal over time, such that voltage and time describe a shape which is continuously graphed against a calibrated scale. The observed waveform can be analyzed for such properties as amplitude, frequency, rise time, time interval, distortion and others. Modern digital instruments may calculate and display these properties directly. Originally, calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument.

The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. A storage oscilloscope allows single events to be captured by the instrument and displayed for a relatively long time, allowing human observation of events too fast to be directly perceptible.

Oscilloscopes are used in the sciences, medicine, engineering, and telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system or to display the waveform of the heartbeat as an electrocardiogram.

Before the advent of digital electronics, oscilloscopes used cathode ray tubes (CRTs) as their display element (hence were commonly referred to as CROs) and linear amplifiers for signal processing. Storage oscilloscopes used special storage CRTs to maintain a steady display of a single brief signal. CROs were later largely superseded by digital storage oscilloscopes (DSOs) with thin panel displays, fast analog-to-digital converters and digital signal processors. DSOs without integrated displays (sometimes known as digitizers) are available at lower cost and use a general-purpose digital computer to process and display waveforms.

DESCRIPTION

The basic oscilloscope, as shown in the illustration, is typically divided into four sections: the display, vertical controls, horizontal controls and trigger controls. The display is usually a CRT or LCD panel which is laid out with both horizontal and vertical reference lines referred to as the graticule. In addition to the screen, most display sections are equipped with three basic controls: a focus knob, an intensity knob and a beam finder button.

The vertical section controls the amplitude of the displayed signal. This section carries a Volts-per-Division (Volts/Div) selector knob, an AC/DC/Ground selector switch and the vertical (primary) input for the instrument. Additionally, this section is typically equipped with the vertical beam position knob.

The horizontal section controls the time base or "sweep" of the instrument. The primary control is the Seconds-per-Division (Sec/Div) selector switch. Also included is a horizontal input for plotting dual X-Y axis signals. The horizontal beam position knob is generally located in this section.

The trigger section controls the start event of the sweep. The trigger can be set to automatically restart after each sweep or it can be configured to respond to an internal or external event. The principal controls of this section will be the source and coupling selector switches. An external trigger input (EXT Input) and level adjustment will also be included.

In addition to the basic instrument, most oscilloscopes are supplied with a probe as shown. The probe will connect to any input on the instrument and typically has a resistor of ten times the oscilloscope's input impedance. This results in a .1 (-10X) attenuation factor, but helps to isolate the capacitive load presented by the probe cable from the signal being measured. Some probes have a switch allowing the operator to bypass the resistor when appropriate.

Size and portability

Most modern oscilloscopes are lightweight, portable instruments that are compact enough to be easily carried by a single person. In addition to the portable units, the market offers a number of miniature battery-powered instruments for field service applications. Laboratory grade oscilloscopes, especially older units which use vacuum tubes, are generally bench-top devices or may be mounted into dedicated carts. Special-purpose oscilloscopes may be rack-mounted or permanently mounted into custom instrument housing.

Inputs

The signal to be measured is fed to one of the input connectors, which is usually a coaxial connector such as a BNC or UHF type. Binding posts or banana plugs may be used for lower frequencies. If the signal source has its own coaxial connector, then a simple coaxial cable is used; otherwise, a specialised cable called a "scope probe", supplied with the oscilloscope, is used. In general, for routine use, an open wire test lead for connecting to the point being

observed is not satisfactory, and a probe is generally necessary. General-purpose oscilloscopes usually present an input impedance of 1 megohm in parallel with a small but known capacitance such as 20 picofarads. This allows the use of standard oscilloscope probes. Scopes for use with very high frequencies may have 50-ohm inputs, which must be either connected directly to a 50-ohm signal source or used with Z_0 or active probes.
Less-frequently-used inputs include one (or two) for triggering the sweep, horizontal deflection for X-Y mode displays, and trace brightening/darkening, sometimes called *z'-axis inputs.*

Probes

Open wire test leads (flying leads) are likely to pick up interference, so they are not suitable for low level signals. Furthermore, the leads have a high inductance, so they are not suitable for high frequencies. Using a shielded cable (i.e., coaxial cable) is better for low level signals. Coaxial cable also has lower inductance, but it has higher capacitance: a typical 50 ohm cable has about 90 pF per meter. Consequently, a one meter direct (1X) coaxial probe will load a circuit with a capacitance of about 110 pF and a resistance of 1 megohm.

Front panel controls

- **Focus control**

  This control adjusts CRT focus to obtain the sharpest, most-detailed trace. In practice, focus needs to be adjusted slightly when observing quite-different signals, which means that it needs to be an external control. Flat-panel displays do not need focus adjustments and therefore do not include this control.

- **Intensity control**

  This adjusts trace brightness. Slow traces on CRT oscilloscopes need less, and fast ones, especially if not often repeated, require more. On flat panels, however, trace brightness is essentially independent of sweep speed, because the internal signal processing effectively synthesizes the display from the digitized data.

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- **Vertical position control**

The vertical position control moves the whole displayed trace up and down. It is used to set the no-input trace exactly on the center line of the graticule, but also permits offsetting vertically by a limited amount. With direct coupling, adjustment of this control can compensate for a limited DC component of an input.

- **Horizontal position control**

The horizontal position control moves the display sidewise. It usually sets the left end of the trace at the left edge of the graticule, but it can displace the whole trace when desired. This control also moves the X-Y mode traces sidewise in some instruments, and can compensate for a limited DC component as for vertical position.

- **Dual-trace controls**

Each input channel usually has its own set of sensitivity, coupling, and position controls, although some four-trace oscilloscopes have only minimal controls for their third and fourth channels.

Dual-trace oscilloscopes have a mode switch to select either channel alone, both channels, or (in some) an X-Y display, which uses the second channel for X deflection. When both channels are displayed, the type of channel switching can be selected on some oscilloscopes; on others, the type depends upon timebase setting. If manually selectable, channel switching can be free-running (asynchronous), or between consecutive sweeps. Some Philips dual-trace analog oscilloscopes had a fast analog multiplier, and provided a display of the product of the input channels. Multiple-trace oscilloscopes have a switch for each channel to enable or disable display of that trace's signal.

- **Trigger Source**

A switch selects the Trigger Source. It can be an external input, one of the vertical channels of a dual or multiple-trace oscilloscope, or the AC line (mains) frequency. Another switch enables or disables Auto trigger mode, or selects single sweep, if provided in the oscilloscope. Either a spring-return switch position or a pushbutton arms single sweeps.
A Level control varies the voltage on the waveform which generates a trigger, and the Slope switch selects positive-going or negative-going polarity at the selected trigger level.

- **X-Y mode**

Most modern oscilloscopes have several inputs for voltages, and thus can be used to plot one varying voltage versus another. This is especially useful for graphing I-V curves (current versus voltage characteristics) for components such as diodes, as well Lissajous patterns. Lissajous figures are an example of how an oscilloscope can be used to track phase differences between multiple input signals. This is very frequently used in broadcast engineering to plot the left and right stereophonic channels, to ensure that the stereo generator is calibrated properly. Historically, stable Lissajous figures were used to show that two sine waves had a relatively simple frequency relationship, a numerically-small ratio. They also indicated phase difference between two sine waves of the same frequency.

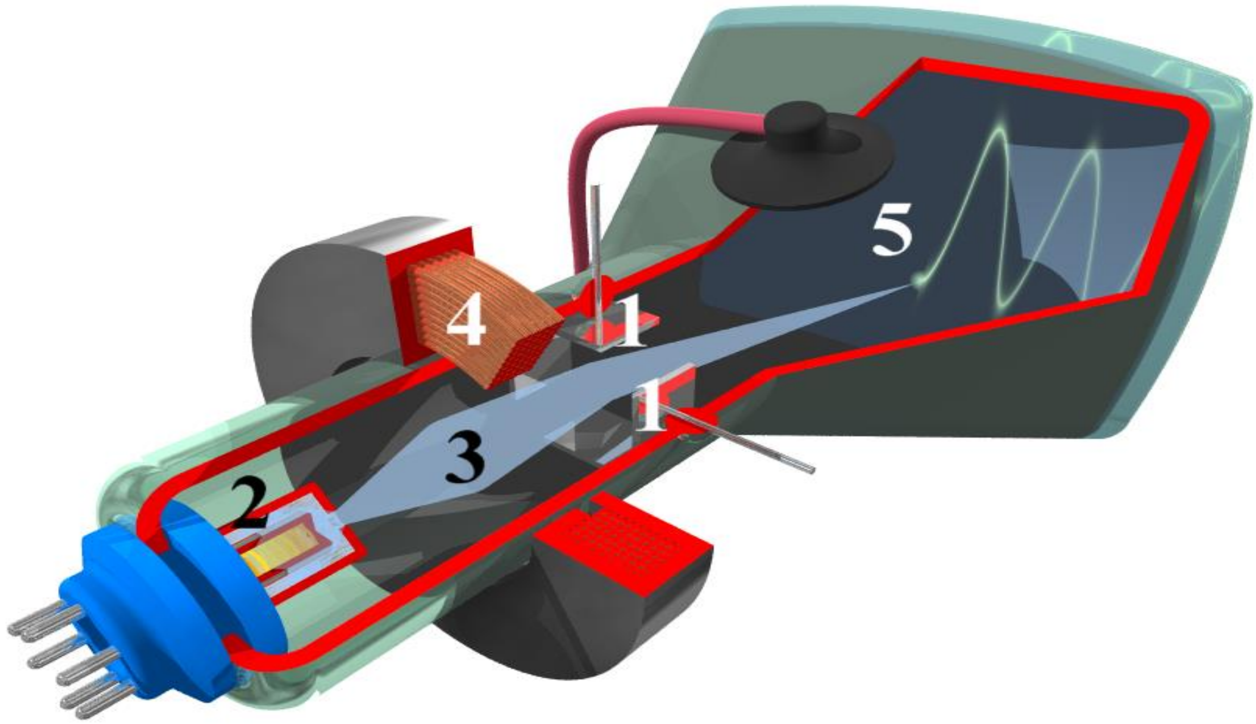
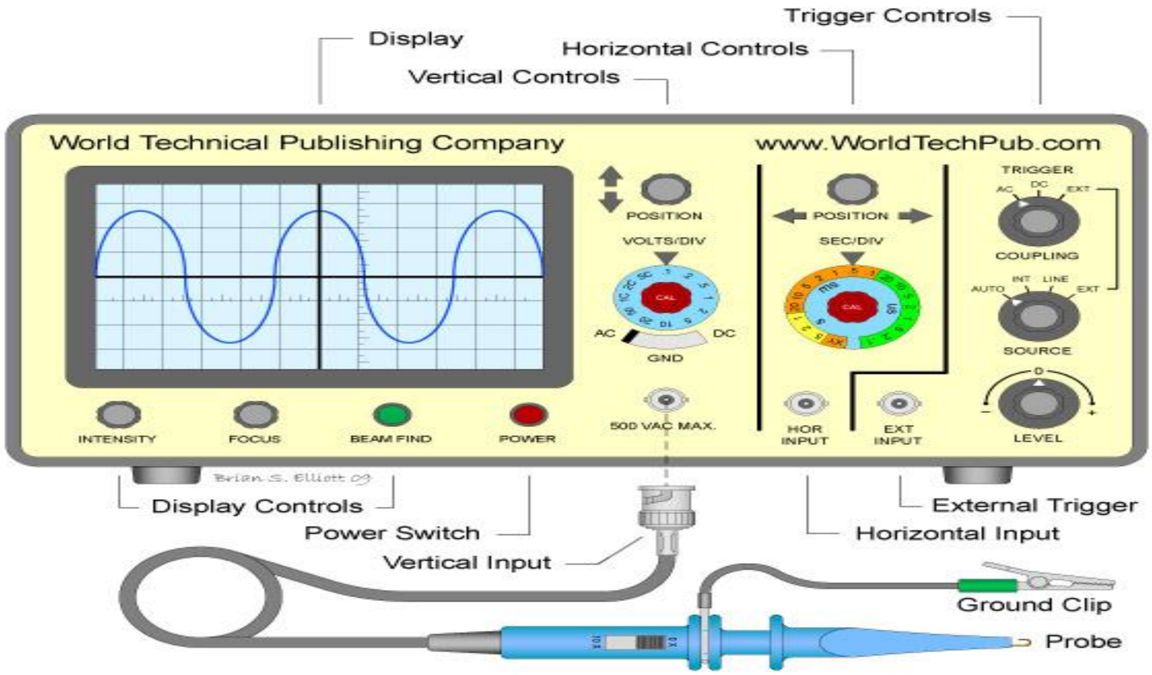


Figure: Interior of a cathode-ray tube for use in an oscilloscope. Numbers in the picture indicate: 1. Deflection voltage electrode; 2. Electron gun; 3. Electron beam; 4. Focusing coil; 5. Phosphor-coated inner side of the screen.


Trigger Controls
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Vertical Controls
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POSITION
VOLTS/DIV
AC
DC
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POSITION
SEC/DIV
TRIGGER
COUPLING
SOURCE
LEVEL
INTENSITY
FOCUS
BEAM FIND
POWER
500 VAC MAX.
HOR INPUT
EXT INPUT
Display Controls
Power Switch
Vertical Input
External Trigger
Horizontal Input
Ground Clip
Probe

Figure: CRO.

EXPERIEMNT NO.: 04

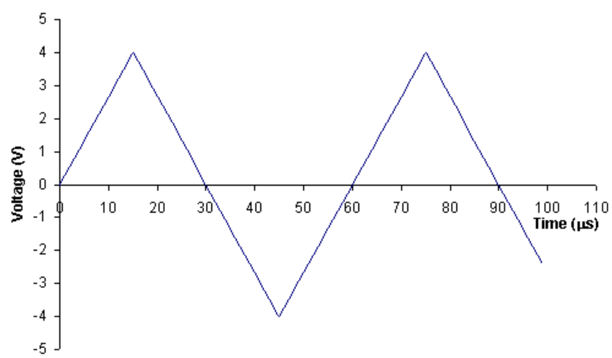
AIM: To study & measure waveform using CRO.

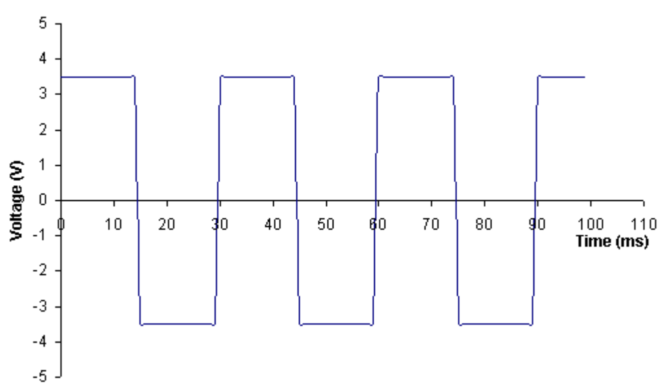
Equipment(s): CRO, FG.

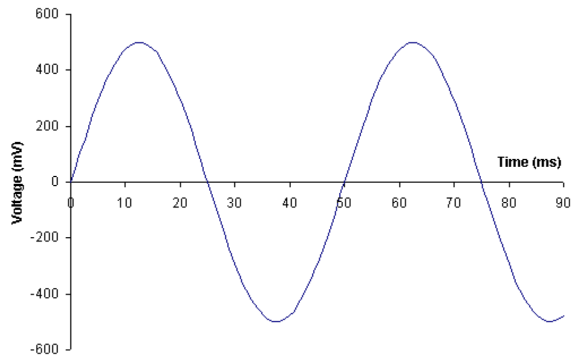
INTRODUCTION

In most **dc** circuits, current and voltage remain constant as time passes. But in **ac** circuits the voltage and current change as time passes.
It's possible to write down mathematical expressions that describe how the values change in time, but a simpler and more common way is to draw diagrams showing how the voltage or current changes in time.
Such a plot, or graph, of a current or voltage versus time is called a **waveform**.

Examples: Below are diagrams of three of the most common waveforms we'll deal with: a **triangle wave**, a **square wave**, and a **sine wave**. Notice that each of these diagrams plots voltage (measured in volts or millivolts) on the vertical axis, and time (measured in microseconds or milliseconds) on the horizontal axis.







Periodic waveform

A **periodic waveform** is a waveform whose values are repeated at regular intervals.
All three of the waveforms shown above are periodic waveforms.

Cycle

The plot of a periodic waveform shows a regularly repeating pattern of values, each of which is called a **cycle**.

Example: In the picture of the sine wave shown just above, we see a little less than two full cycles. The first cycle extends from 0 ms to 50 ms, and the second (incomplete) cycle extends from 50 ms to the edge of the chart, where it is cut off.

Period:

The time required for the values to rise and fall through one complete cycle is called the **period** of the waveform.
The symbol for period is ***T***.
Period is measured in units of seconds, abbreviated **s**.
Example: The sine wave shown above has a period of 50 ms.

Frequency

The **frequency** of a periodic waveform is the number of cycles that occur in 1 second.
The symbol for frequency is ***f***.
Frequency is measured in units of cycles per second, or Hertz, abbreviated **Hz**.

Relation between period and frequency

Period and frequency are the reciprocal of each other:

$$f = 1 \div T$$

and

$$T = 1 \div f$$

Example: The sine wave shown earlier has a period of 50 ms. Therefore, its frequency is 20 Hz.

EXPERIEMNT NO.: 05

AIM: To study about Function generator.

Equipment(s): Function generator, CRO/DSO.

INTRODUCTION

A function generator is usually a piece of electronic test equipment or software used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular and sawtooth shapes. These waveforms can be either repetitive or single-shot (which requires an internal or external trigger source). Integrated circuits used to generate waveforms may also be described as function generator ICs.

Although function generators cover both audio and RF frequencies, they are usually not suitable for applications that need low distortion or stable frequency signals. When those traits are required, other signal generators would be more appropriate.

Some function generators can be phase-locked to an external signal source (which may be a frequency reference) or another function generator. Function generators are used in the development, test and repair of electronic equipment. For example, they may be used as a signal source to test amplifiers or to introduce an error signal into a control loop.

WORKING

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. Sawtooth 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 sawtooth, 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 sawtooth 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.

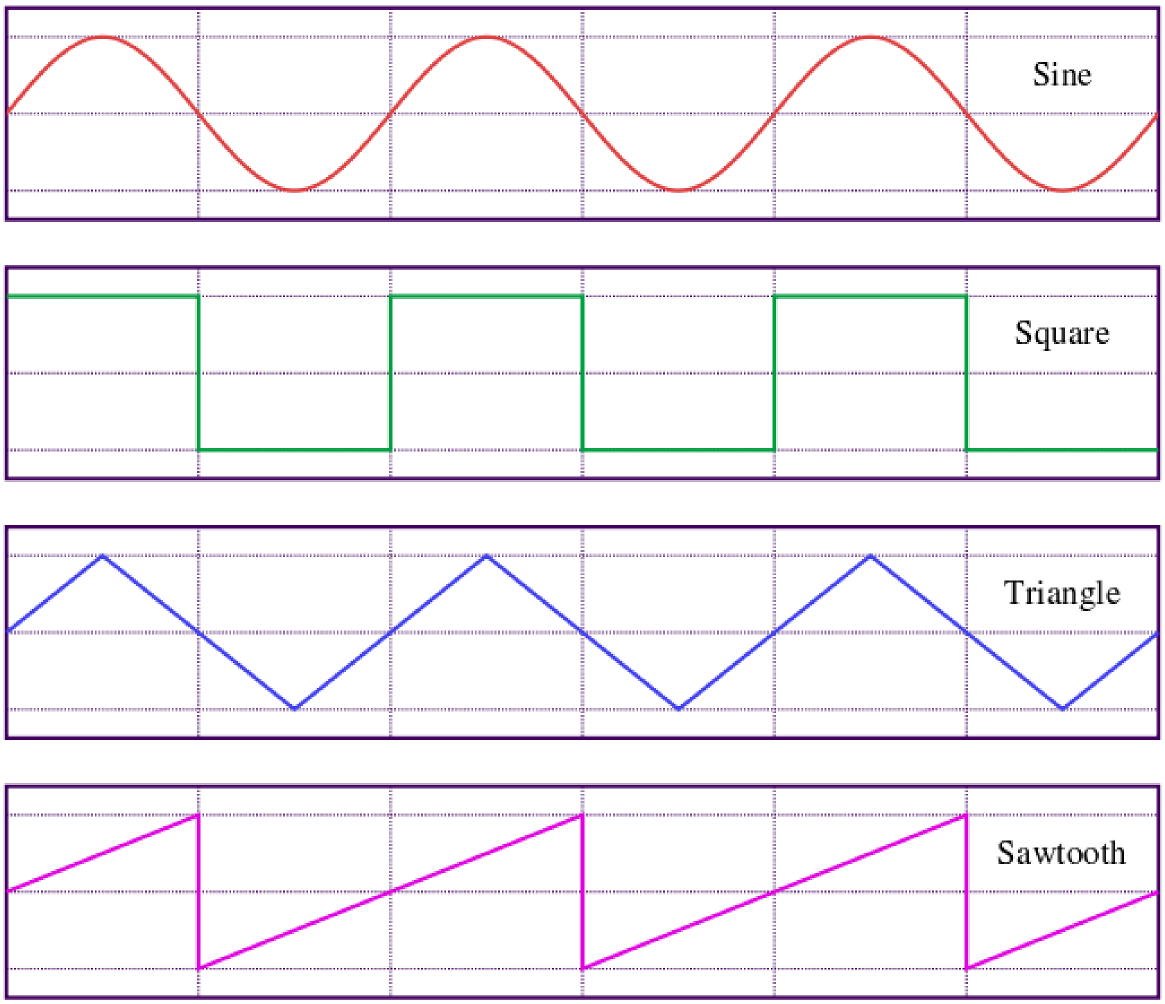
Function generators, like most signal generators, may also contain an attenuator, various means of modulating the output waveform, and often the ability to automatically and repetitively "sweep" the frequency of the output waveform (by means of a voltage-controlled oscillator) between two operator-determined limits. This capability makes it very easy to evaluate the frequency response of a given electronic circuit. More advanced function generators are called arbitrary waveform generators (AWG). They use direct digital synthesis (DDS) techniques to generate any waveform that can be described by a table of amplitudes.

SPECIFICATIONS

Typical specifications for a general-purpose function generator are:

- Produces sine, square, triangular, sawtooth (ramp), and pulse output. Arbitrary waveform generators can produce waves of any shape.
- It can generate a wide range of frequencies. For example, the Tektronix FG 502 (ca 1974) covers 0.1 Hz to 11 MHz
- Frequency stability of 0.1 percent per hour for analog generators or 500 ppm for a digital generator.
- Maximum sine wave distortion of about 1% (accuracy of diode shaping network) for analog generators. Arbitrary waveform generators may have distortion less than -55 dB below 50 kHz and less than -40 dB above 50 kHz.
- Some function generators can be phase locked to an external signal source, which may be a frequency reference or another function generator.
- AM or FM modulation may be supported.
- Output amplitude up to 10 V peak-to-peak.
- 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.


KENWOOD
POWER
COUNTER


Sine
Square
Triangle
Sawtooth

EXPERIEMNT NO.: 06

AIM: To study and observe the art of soldering.

Equipment(s): Soldering Iron, soldering wire, electronic component.

INTRODUCTION

Soldering is used in nearly every phase of electronic con- struction. A soldering tool must be hot enough to do the job and lightweight enough for agility and comfort. A 100-W sol- dering gun is overkill for printed-circuit work, for example. A temperature-controlled iron works well, although the cost is not justified for occasional projects. Get an iron with a small conical or chisel tip.

You may need an assortment of soldering irons to do a wide variety of soldering tasks. They range in size from a small 25-W iron for delicate printed-circuit work to larger 100 to 300-W sizes used to solder large surfaces. Several manufacturers also sell soldering guns. Small “pencil” butane torches are also available, with optional soldering-iron tips.

Keep soldering tools in good condition by keeping the tips well tinned with solder. Do not run them at full temperature for long periods when not in use. After each period of use, remove the tip and clean off any scale that may have accumulated. Clean an oxidized tip by dipping the hot tip in sal ammoniac (ammonium chloride) and then wiping it clean with a rag. Sal ammoniac is somewhat corrosive, so if you don’t wipe the tip thoroughly, it can contaminate electronic soldering.

If a copper tip becomes pitted, file it smooth and bright and then tin it immediately with solder. Modern soldering iron tips are nickel or iron clad and should not be filed. The secret of good soldering is to use the right amount of heat. Many people who have not soldered before use too little heat, dabbing at the joint to be soldered and making little sol- der blobs that cause unintended short circuits.

The secret of good soldering is to use the right amount of heat. Many people who have not soldered before use too little heat, dabbing at the joint to be soldered and making little solder blobs that cause unintended short circuits.

Solders have different melting points, depending on the ratio of tin to lead. Tin melts at 450µF and lead at 621µF. Solder made from 63% tin and 37% lead melts at 361�F, the lowest melting point for a tin and lead mixture. Called 63-37 (or eu- tectic), this type of solder also provides the most rapid solid- to-liquid transition and the best stress resistance.

Solders made with different lead/tin ratios have a plastic state at some temperatures. If the solder is deformed while it is in the plastic state, the deformation remains when the sol- der freezes into the solid state. Any stress or motion applied to “plastic solder” causes a poor solder joint.

Never use acid-core solder for electrical work. It should be used only for plumbing or chassis work. For circuit construction, only use fluxes or solder-flux combinations that are labeled for electronic soldering.

The resin or the acid is a *flux*. Flux removes oxide by suspending it in solution and floating it to the top. Flux is not a cleaning agent! Always clean the work before soldering. Flux is not a part of a soldered connection—it merely aids the soldering process. After

soldering, remove any remaining flux. Resin flux can be removed with isopropyl or denatured alcohol. A cotton swab is a good tool for applying the alcohol and scrubbing the excess flux away. Commercial flux-removal sprays are available at most electronic-part distributors.
The two key factors in quality soldering are time and tem- perature. Generally, rapid heating is desired, although most unsuccessful solder jobs fail because insufficient heat has been applied. Be careful; if heat is applied too long, the compo- nents or PC board can be damaged, the flux may be used up and surface oxidation can become a problem. The soldering- iron tip should be hot enough to readily melt the solder with- out burning, charring or discoloring components, PC boards or wires. Usually, a tip temperature about 100�F above the solder melting point is about right for mounting components on PC boards. Also, use solder that is sized appropriately for the job. As the cross section of the solder decreases, so does the amount of heat required to melt it. Diameters from 0.025 to 0.040 inches are good for nearly all circuit wiring.
Here’s how to make a good solder joint. This description assumes that solder with a flux core is used to solder a typical
PC board connection such as an IC pin.

✔ Prepare the joint. Clean all conductors thoroughly with fine steel wool or a plastic scrubbing pad. Do the circuit board at the beginning of assembly and individual parts such as resistors and capacitors immediately before soldering. Some parts (such as ICs and surface-mount components) cannot be easily cleaned; don’t worry unless they’re exceptionally dirty.

✔ Prepare the tool. It should be hot enough to melt solder applied to its tip quickly (half a second when dry, instantly when wet with solder). Apply a little solder directly to the tip so that the surface is shiny. This process is called “tinning” the tool. The solder coating helps conduct heat from the tip to the joint.

✔ Place the tip in contact with one side of the joint. If you can place the tip on the underside of the joint, do so. With the tool below the joint, convection helps transfer heat to the joint.

✔ Place the solder against the joint directly opposite the soldering tool. It should melt within a second for normal PC connections, within two seconds for most other connections. If it takes longer to melt, there is not enough heat for the job at hand.

✔ Keep the tool against the joint until the solder flows freely throughout the joint. When it flows freely, solder tends
to form concave shapes between the conductors. With insufficient heat solder does not flow freely; it forms convex shapes blobs. Once solder shape changes from convex to concave, remove the tool from the joint.

✔ Let the joint cool without movement at room temperature. It usually takes no more than a few seconds. If the joint is moved before it is cool, it may take on a dull, satin look that is characteristic of a “cold” solder joint. Reheat cold joints until the solder flows freely and hold them still until cool.

✔ When the iron is set aside, or if it loses its shiny appearance, wipe away any dirt with a wet cloth or sponge. If it remains dull after cleaning, tin it again.

✔ Soldering equipment gets hot! Be careful. Treat a soldering burn as you would any other. Handling lead or breathing soldering fumes is also hazardous. Observe these precautions to protect yourself and others:

✔ properly ventilate the work area. If you can smell fumes, you are breathing them.

✔ Wash your hands after soldering, especially before handling food.
✔ Minimize direct contact with flux and flux solvents

EXPERIEMNT NO.: 7

AIM: To study and observe digital storage oscilloscope (DSO).

Equipment(s): DSO, FG.

INTRODUCTION

A digital storage oscilloscope, also known as a DSO, is an electronic device that is capable of storing a digital copy of the measured waveform. Using analog-to-digital converters to digitize and sample measured voltages, a digital storage oscilloscope stores the results in its memory, which it process further using digital signal processing techniques.

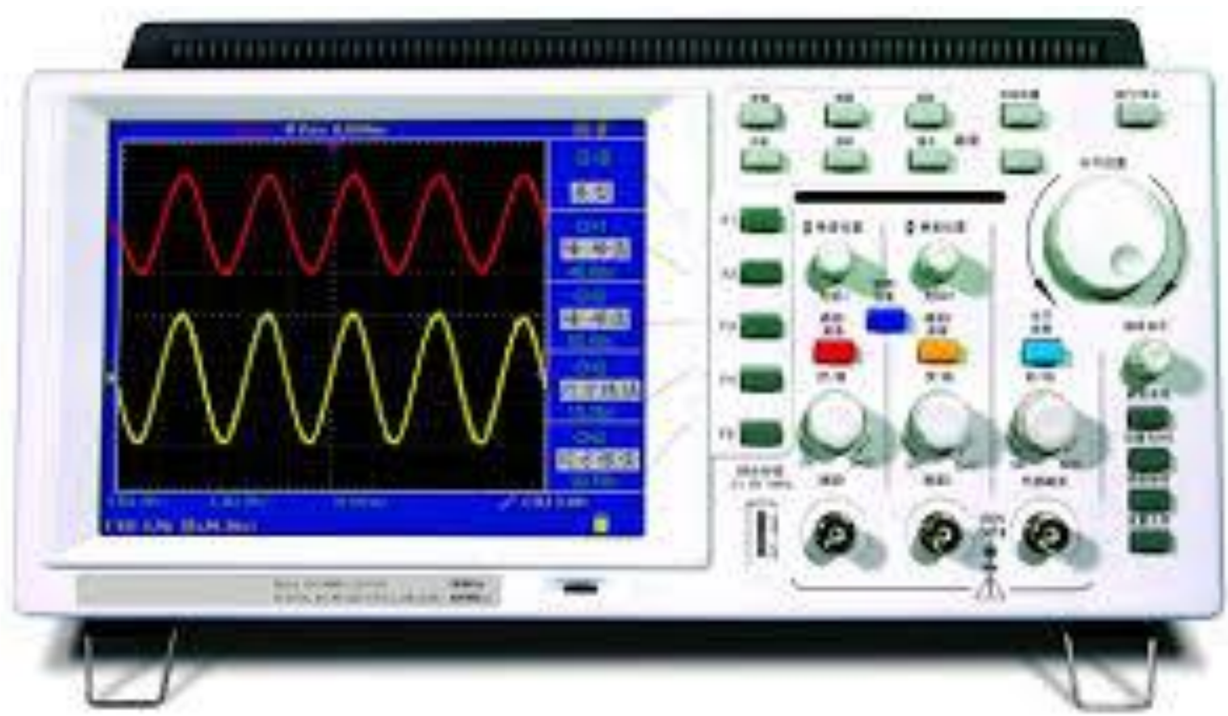
An oscilloscope is a device used for testing signal voltages in fields such as circuit debugging, electronic measurement, testing in manufacturing, designing, general testing and researches. Also known as a scope, an oscilloscope displays the changes in signal voltage over a certain period of time. It usually comes with a rectangular screen, which allows users to view the input voltage on a particular axis over a particular period of time on the other. Instead of displaying time on the other axis, the scope can also display a second signal voltage, while changing the intensity of the screen image using a third waveform allows the scope to display a three dimensional figure. Some scopes can even display multiple waveforms simultaneously, superimposed on each other or separately for comparison purposes.

Just like other kinds of digital oscilloscopes, a DSO converts analog input voltages into digital data. Two factors determine the maximum frequency that the digital storage oscilloscope can measure. One is the sampling rate of the oscilloscope, which is usually measured in millions or billions of samples per second, and the other is the nature of the analog-to-digital converter and the signal amplifier on each input. Upon capturing a signal, the scope stores as many samples as possible in its memory to represent the waveform.

Used in testing signal voltages in electronic devices such as radio broadcasting equipment, televisions and audio recording equipment, a digital storage oscilloscope offers the advantage of capturing and logging electronic events that occurred when no one was watching or which were otherwise impossible to determine.

Not to be confused with a voltmeter, a digital storage oscilloscope displays graphical representations of signal, enabling a more intuitive visual diagnosis of the unexpected voltage's source. A voltmeter, on the other hand, records only the presence of unexpected voltage, requiring further troubleshooting and diagnostics. A DSO can measure the same voltage and show oscillation in the affected circuit. Digital storage oscilloscopes also offer visual display of the precise timing or shape of the pulse.

Acting as a simple signal tracer, a digital storage oscilloscope enables technicians to probe electronic device's individual connections and components, to determine the malfunctioning part. In measuring the functions of the individual component of the device, the DSO locates where an expected signal is incorrect or absent. The DSO can also measure the components' minor variations in operations and alert the technician of the need for fine tuning or replacement. To prevent erroneous replacement of parts, the DSO also helps technicians identify the parts that are still working.



EXPERIEMNT NO.: 08

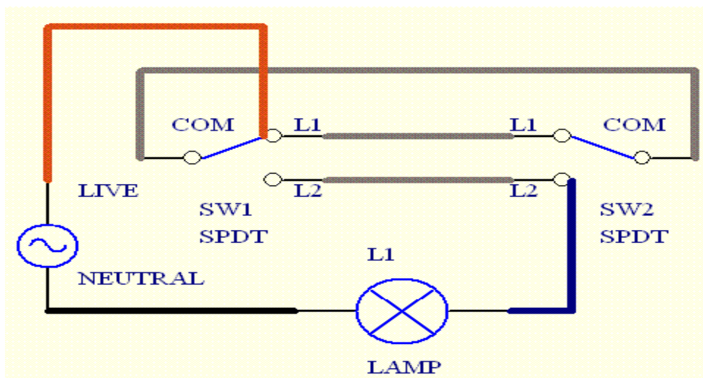
AIM: To study about two way switch.

Equipment(s): Switch, connecting wire, bulb, battery.

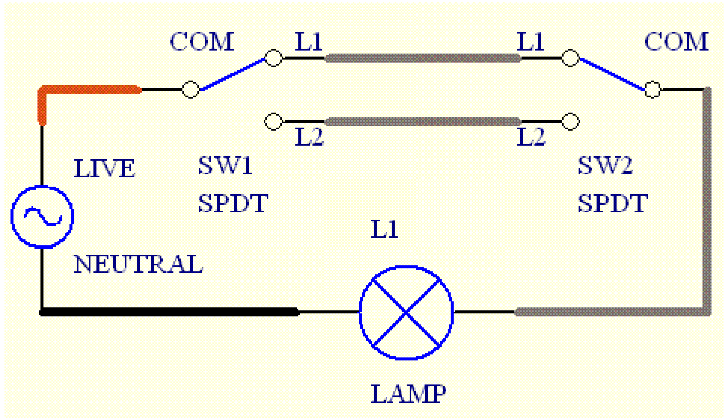
INTRODUCTION

Have you ever wonder how a lamp that is used to light up the stairs of a building is connected to the two switches that controls it from either end? These two way switches have a single pole double throw (SPDT) configuration.

Each has a common terminal (COM) with a pole that can be switched between position L1 or L2. The two way light switch wiring can be implemented by using 2 different methods. Both of the methods used are described below.



The first method as shown in the figure above have the COM, L1 and L2 of both the SPDT switches connected together. For incandescent lamp, the recommended wire gauge used is AWG #18. The LIVE AC Source is connected to L1 of SW1 and one side of the load is connected to L2 of SW2. The other side of the load is then connected to NEUTRAL of the AC Source. With this configuration, the lamp will be turned ON when one switch is at ON position and the other is at OFF position. If both switches are in the same position, the lamp will be OFF.



The other method is as shown in the figure above. In this configuration, the L1 of both SW1 and SW2 are connected together. Similarly, the L2 of both SW1 and SW2 are connected together. The LIVE of the AC Source is connected to COM of SW1 and one side of the load is connected to COM of SW2.

The other side of the load is then connected to the NEUTRAL of the AC Source. With this configuration, the lamp will be turned ON when one switch is ON and the other is also ON. If both switches are in different position, the lamp will be OFF.

EXPERIEMNT NO.: 09

AIM: To study about earth leakage circuit breaker (ELCB).

Equipment(s): Switch, connecting wire, bulb, battery.

INTRODUCTION

An **Earth Leakage Circuit Breaker** (**ELCB**) is a safety device used in electrical installations with high earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. Once widely used, more recent installations instead use residual current circuit breakers which instead detect leakage current directly.

ELCBs were mainly used on TT earthing systems. Nowadays, ELCBs have been mostly replaced by residual-current devices (RCDs). However many ELCBs are still in use.

Early ELCBs responded to sine wave fault currents, but not to rectified fault current. Over time, filtering against nuisance trips has also improved. Early ELCBs thus offer a little less safety and higher risk of nuisance trip. The ability to distinguish between a fault condition and non-risk conditions is called discrimination. There are two types of ELCBs: voltage operated and current operated.

Voltage operated

Voltage-operated ELCBs were introduced in the early 20th century, and provided a major advance in safety for mains electrical supplies with inadequate earth impedance. V-ELCBs have been in widespread use since then, and many are still in operation but are no longer installed in new construction. A voltage-operated ELCB detects a rise in potential between the protected interconnected metalwork (equipment frames, conduits, enclosures) and a distant isolated earth reference electrode. They operate at a detected potential of around 50 volts to open a main breaker and isolate the supply from the protected premises. [1]

A voltage-operated ELCB has a second terminal for connecting to the remote reference earth connection. The earth circuit is modified when an ELCB is used; the connection to the earth rod is passed through the ELCB by connecting to its two earth terminals. One terminal goes to the installation earth CPC (circuit protective conductor, aka earth wire), and the other to the earth rod (or sometimes other type of earth connection). Disadvantages of the voltage-operated ELCB are the requirement for a second connection, and the possibility that any additional connection to earth on the protected system can disable the detector.

Current operated:

Residual-current devices (RCD)s protect against earth leakage using a different method of detection. Both circuit conductors (supply and return) are run through a sensing coil; any imbalance of the currents means the magnetic field does not perfectly cancel. The device detects the imbalance and trips the contact.

When the term ELCB is used it usually means a voltage-operated device. Similar devices that are current operated are called residual-current devices. However, some companies use the term **ELCB** to distinguish high sensitivity current operated 3 phase devices that trip in the milliamp range from traditional 3 phase ground fault devices that operate at much higher currents (traditional earth fault devices are insensitive due to the error inherently associated with the summation of currents from multiple current transformers).

Operation:

An ELCB is a specialised type of latching relay that has a building's incoming mains power connected through its switching contacts so that the ELCB disconnects the power in an earth leakage (unsafe) condition.

The ELCB detects fault currents from live to the earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other earthed body.

Advantage:

ELCBs have one advantage over RCDs: they are less sensitive to fault conditions, and therefore have fewer nuisance trips. (This does not mean they always do, as practical performance depends on installation details and the discrimination enhancing filtering in the ELCB.) Therefore by electrically separating cable armour from the cable circuit protective conductor, an ELCB can be arranged to protect against cable damage only, and not trip on faults in downline installations.

Disadvantages:

- They do not detect faults that don't pass current through the CPC to the earth rod.
- They do not allow a single building system to be easily split into multiple sections with independent fault protection, because earthing systems are usually bonded to pipework.
- They may be tripped by external voltages from something connected to the earthing system such as metal pipes, a TN-S earth or a TN-C-S combined neutral and earth.
- As with RCDs, electrically leaky appliances such as some water heaters, washing machines and cookers may cause the ELCB to trip.
- ELCBs introduce additional resistance and an additional point of failure into the earthing system.