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V-Skills

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1. ELECTRONICS BASICS

1.1 Electricity versus Electronics

Electricity is the energy we use for day to day use. It involves generation and distribution of electrical energy to users and is produced by power plants and sent over transmission lines.

Principles of electricity also apply to electronics. Electrical components such as resistors, capacitors, inductors, transformers and other similar devices are also used in electronics.

Electronics is control of electricity to produce television or computer, by transistors. Transistors are now miniaturized as integrated circuits to perform specific electronic functions like generating or amplifying signals, or some control function. It is the transistors and the circuits that they comprise that make electronics. Transistors form circuits which perform all of the various functions required to produce electronic devices.

1.2 Electricity Basics

Current and Voltage

Electricity is a flow of electrons.

If we can measure the electricity, we must therefore be able to say how many electrons are in the flow. We measure amount of electricity, as a charge in coulombs.

Electron flow rate is similar to volume of water which flow through a water pipe during a defined period of time. Electron flow rate is called current (denoted as 'I'). Electric current is measured in amperes (short form is 'amps', or 'A'), where one amp is defined as a quantity of one coulomb passing a point in one second.

With electricity the flow pressure is defined by the difference in numbers of electrons between two points called as potential difference or Voltage (denoted by 'V' and units are volts). Voltage is simply a way of expressing electrical pushing power.

If you know the amps and volts involved, you can determine the amount of electricity consumed, which we measure in watts

Ohm's Law

There is a relationship between pushing power in volts and the rate of electron flow in amps. After all, the higher the voltage, the more pushing power the electrons have behind them so faster they should flow. This relationship is known as Ohm's law. It may be summarized as
"The current through a conductor between two points is directly proportional to the potential difference across the two points, and inversely proportional to the resistance between them."

The mathematical equation is $$I = \frac{V}{R}$$

where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms. More specifically, Ohm's law states that the R in this relation is constant, and the constant is

commonly called the substance's resistance (as, it is a measure of the amount the substance resists the flow of current through it) and is given the unit: Ω (pronounced ohm).
Power

AC and DC

In direct current (DC) the flow of electric charge is only in one direction i.e. possessing a voltage with constant polarity over time. It is produced by batteries, thermocouples and solar cells.

In alternating current (AC) the movement of electric charge periodically reverses direction so, voltage alternates in polarity i.e. reversing positive and negative over time.

AC is the form in which electric power is delivered. The usual waveform of an AC power circuit is a sine wave.

Phase, neutral and ground

Phase wire is an electrically charged, conductive wire that provides power to the load. The phase wire is usually covered with red insulation.

Neutral wire is the wire that conducts the power back to the source and completes the circuit and is the return path for current supplied by the phase wire. The neutral wire is usually covered with white insulation.

The ground wire is the extra wire in an electrical system that provides a low-resistance path to ground for stray current. It is not supposed to carry any current at all until a fault of some kind occurs and covered with green insulation.

Grounding

Grounding of equipment refers to connecting the non-current-carrying metal parts of the wiring system or equipment to ground so, the resistance of the path through the grounding conductor will usually be much less than the resistance through the stray path, and not much current will flow through the stray path. Sufficient current will usually flow through the grounded path to blow the circuit fuse or trip the circuit breaker and thus open the circuit. On the other hand, if the equipment is not grounded, sufficient current will flow through the stray path to be a shock hazard.

1.3 Analog electronics

Analog electronics are electronic systems with continuously variable signal i.e. small changes in input result in small changes in output. Analog signal invariably include noise; that is, random disturbances or variations.

The term "analogue" describes the proportional relationship between a signal and a voltage or current that represents the signal.

Voltage Rise and Voltage Drop

There are two kinds of voltage or potential difference. One is voltage Rise and voltage.

Voltage Rise: The energy introduced or added into a circuit is called a Voltage Vise.

Voltage Drop: The energy removed from the circuit by the load is called a Voltage Drop.

Thus, Voltage Rise=Voltage Drop.

Inductor and Capacitor

An inductor (or reactor) can store energy in a magnetic field created by the electric current passing through it. An inductor's ability to store magnetic energy is measured, in units of henries. It is a conducting wire shaped as a coil; the loops help to create a strong magnetic field inside the coil. Inductors are used where current and voltage change with time, to delay and reshape alternating currents. Inductors called chokes are used as parts of filters in power supplies or to block AC signals from passing through a circuit.

A capacitor is a device for storing electric charge. Capacitors consist of a pair of conductors separated by a dielectric (insulator) for example; consist of metal foils separated by a layer of insulating film. When voltage is applied across the conductors, a static electric field develops across the dielectric, causing positive charge to collect on one plate and negative charge on the other plate. Energy is stored in the electrostatic field.
Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

Multimeter

It is also called VOM(Volt-Ohm meter) or a multitester, is an electronic measuring instrument to measure voltage, current and resistance. They may use analog or digital circuits.

It is usually hand-held device used for basic fault finding and field service as it can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems.

Transformer

A transformer transfers electrical energy from one circuit to another through inductively coupled conductors—it's coils to efficiently raise or lower AC voltages. It cannot increase power so that if the voltage is raised, the current is proportionally lowered and vice versa.

Transformers can be a thumbnail-size inside a microphone to huge units used to interconnect portions of power grids. They are used in many different things like Computer network interface cards, modems and power amplifiers.

Semiconductor

They are a class of crystalline solids with electrical conductivity between that of a conductor and an insulator. Such materials can be treated chemically to allow transmission and control of an electric current. Semiconductors are used in the diodes, transistors, and integrated circuits.

Diodes

A diode is an electronic component that conducts electric current in only one direction. The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking current in the opposite direction (the reverse direction). Thus, the diode can be thought of as an electronic version of a check valve.

A modern semiconductor diode is made of a crystal of semiconductor usually p–n junction diode which is formed by joining P-type and N-type semiconductors together in very close contact.

Transistor

A transistor is a semiconductor device used to amplify and switch electronic signals. It is made of three layer of semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal.

Resistor

It limits the amount of current that can flow, in a circuit and it protects from overload or to control the current in circuit. They are color-coded to indicate the intensity of resistance.

1.4 Digital electronics

In digital electronics signals usually take only two different levels.

Logic gate

A logic gate is an idealized or physical device implementing a Boolean function like AND or OR, to perform a logical operation on one or more logic inputs and produces a single logic output.

Logic gates are primarily implemented using diodes or transistors

Flip flop

A flip-flop or latch is a circuit that has two stable states and can be used to store state information. The circuit can be made to change state by signals applied to one or more control inputs and will have one or two outputs. Flip-flops and latches are a fundamental building block of digital electronics systems used in computers, communications, and many other types of systems.

Flip-flops and latches are used as data storage elements. Such data storage can be used for storage of state. The output and next state depend not only on its current input, but also on its current state (and hence, previous inputs.)

Multiplexer and De-multiplexer

A multiplexer or mux is a device that selects one of several input signals and forwards the selected input into a single line. They convert multiple inputs to a single output and are used to increase the amount of data that can be sent over the network within a certain amount of time and bandwidth. It makes possible for several signals to share one device or resource, for example one communication line, instead of having one device per input signal.

A demultiplexer (or demux) is a device which takes a single input signal and selects one of many data-output-lines, which is connected to the single input. A multiplexer is often used with a complementary demultiplexer on the receiving end.

An electronic multiplexer can be considered as a multiple-input, single-output switch, and a demultiplexer as a single-input, multiple-output switch

Both are made using logic gates and using Boolean algebra.

Self Assessment Questions

Q.1 What is constant in Ohm's law
A. Current
B. Voltage
C. Resistance
D. None

Q.2 Multimeter is also called
A. OVM meter
B. MOV meter
C. Both
D. None

Q.3 Does Voltage rise equals voltage fall
A. True
B. False
C. Can not say
D. None

Answers: 1-C, 2-D, 3-A