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UNIT-IV

Electronic Instrumentation

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Syllabus

Unit IV Electronic Instrumentation [6L]

- Electronic Instruments: Principles and block diagram of digital multimeter, Function Generator,
- Digital Storage Oscilloscope (DSO) Power scope, AC/DC power supply,
- Auto transformer, Analog ammeter and voltmeter.

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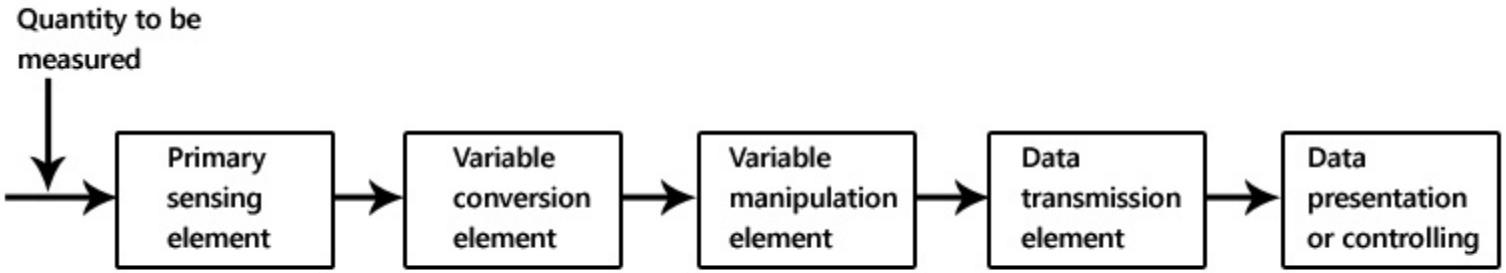
Instrumentation system



The block diagram shown above is of basic instrumentation system. It consist of primary sensing element, variable manipulation element, data transmission element and data presentation element.

Primary sensing element

The primary sensing element is also known as sensor. Basically transducers are used as a primary sensing element. Here, the physical quantity (such as temperature, pressure etc.) are sensed and then converted into analogues signal.

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Instrumentation system

Variable conversion element

It converts the output of primary sensing element into suitable form without changing information. Basically these are secondary transducers.

Variable manipulation element

The output of transducer may be electrical signal i.e. voltage, current or other electrical parameter. Here, manipulation means change in numerical value of signal. This element is used to convert the signal into suitable range.

Data transmission element

Sometimes it is not possible to give direct read out of the quality at a particular place (Example – Measurement of temperature in the furnace). In such a case, the data should transfer from one place to another place through channel which is known as data transmission element. Typically transmission path are pneumatic pipe, electrical cable and radio links. When radio link is used, the electronic instrumentation system is called as telemetry system.

Data presentation or controlling element

Finally the output is recorded or given to the controller to perform action. It performs different functions like indicating, recording or controlling

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- # Digital Multimeter:

Introduction, Block Diagram, Operating Principles and Applications .

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What is a digital multimeter?

- A digital multimeter or DMM is one of the most widely used pieces of test equipment. DMMs are available very cheaply and these digital multimeters can provide very high degrees of accuracy when measuring the parameters within an electronics or electrical circuit. As a result, DMMs are one of the most indispensable pieces of test equipment available today.
- It is a standard diagnostic tool for technicians in the electrical/electronic industries.
- Digital multimeters long ago replaced needle-based analog meters due to their ability to measure with greater accuracy, reliability and increased impedance. Fluke introduced its first digital multimeter in 1977.
- Digital multimeters combine the testing capabilities of single-task meters—the voltmeter (for measuring volts), ammeter (amps) and ohmmeter (ohms). Often, they include several additional specialized features or advanced options.
- Many of them include functions such as frequency, continuity (with a buzzer to facilitate easy measurements when looking at the circuit board), capacitance, temperature and often a number of other measurements as well

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- The face of a digital multimeter typically includes four components:
- Display: Where measurement readouts can be viewed.
- Buttons: For selecting various functions; the options vary by model.
- Dial (or rotary switch): For selecting primary measurement values (volts, amps, ohms).
- Input jacks: Where test leads are inserted.

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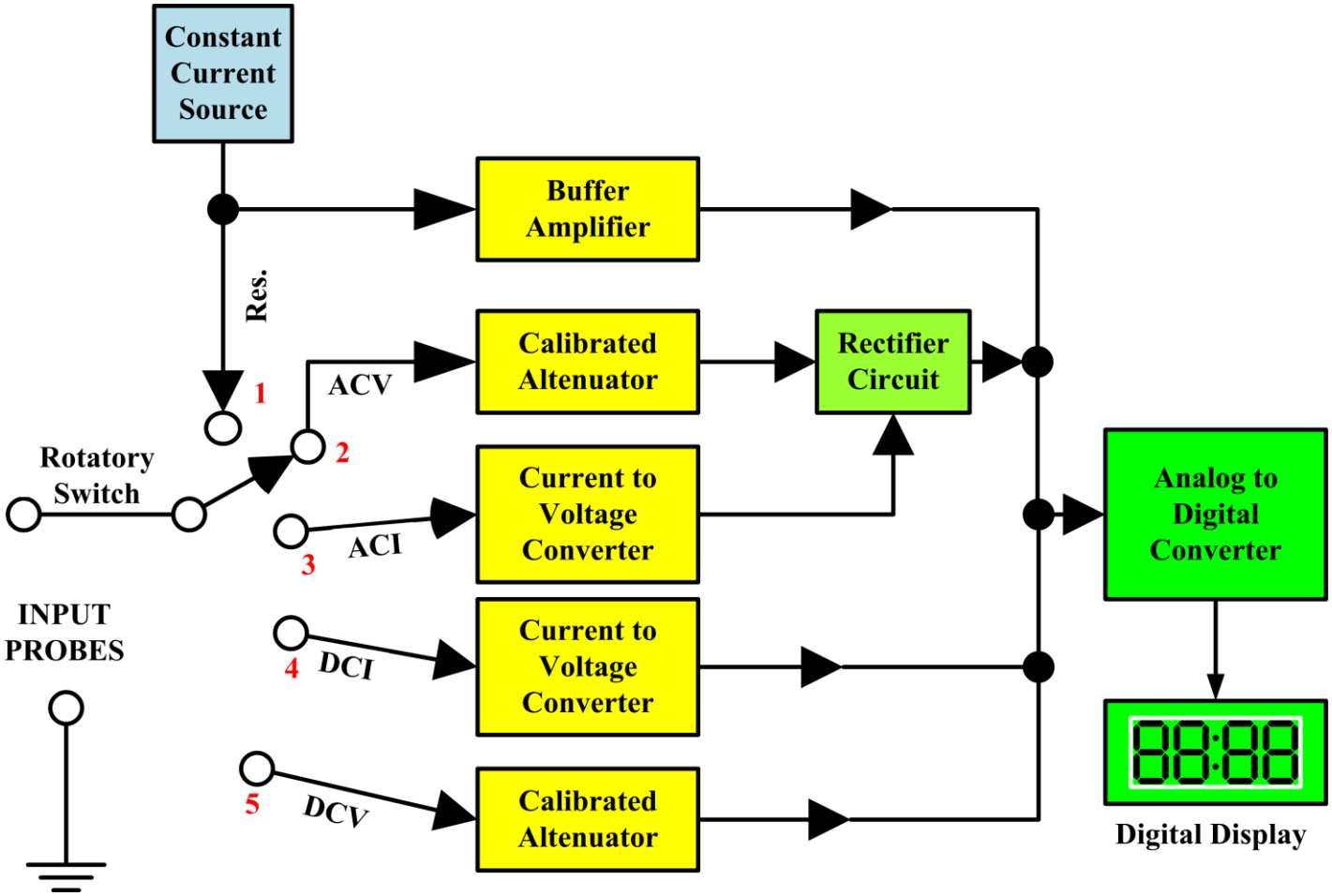
Block Diagram of DMM



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Operation of DMM

A digital multimeter (DMM) is a multifunctional meter that displays its electrical quantitative values on an LCD screen. A digital multimeter much like an analog meter, it is able to read voltage, current, and resistance. What makes a digital multimeter differ from the analog meter is its ability to display measured electrical values quickly without any computations.

There two types of digital multimeters (DMM): **scalable digital multimeter** and **auto-ranging digital multimeter** as shown in Figure 1. When working with the scalable digital multimeter you need to have an idea of the value of voltage, current, or resistance that you are attempting to measure. Failure to observe these values will result in inaccurate readings and possible damage to the meter. **The auto-ranging digital multimeter is more widely used due to its ease, high functionality, and quick display readings achieved without the user completing the calculations.**

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Operation of DMM

The block diagram shows that the input terminal is connected to a mode selector switch. The other input terminal is a common terminal, generally referred as ground or negative terminal. The mode selector switch has five positions. Each position of the switch is marked with its function.

In the first position of the switch the input goes to ohms select. ln this mode the input to the multimeter is an unknown resistance. As the unknown resistance has to form a part of the potential divider with the internal constant current source and range multiplier resistor, it is shown to be connected to the buffer amplifier. At the same time the block constant current generator is linked with the input terminal. Therefore the buffer amplifier will amplify only the voltage that is developed across the unknown resistance. The unknown resistance and the internal range resistor form a potential divider using the current from the constant current source. Hence the resistance to voltage conversion is complete and the D.V.M. reads the resistance.

The second position of the range switch is marked as Volts (A.C.). The input signal as an unknown alternating voltage will go to the calibrated attenuator. The output of the attenuator will go to the precision AC to DC converter. The output of the AC/DC convener will go, to the DVM module. Selecting the proper range we can measure alternating voltage.

The third position of the switch is marked as current (A.C.). Hence the unknown current is to be measured. The internal shunt carries unknown current and the voltage developed across it will be converted in to steady voltage D.C.(voltage), by the AC/DC converter. As the converter's output is given to the D.V.M, module the current is displayed. Different shunts will be selected by a range selector used with the shunt circuit.

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Operation of DMM

In the fourth position the direct current can be measured. The unknown current flows through the selected shunt (range selector is used). The voltage developed across this shunt goes to D.V.M. module. So in the fourth position of the mode selector we will be able to measure direct current.

The fifth position is marked as volts D.C. The input is the unknown voltage. This voltage passes through a calibrated attenuator.

The range selection is done. The output of the attenuator goes to the D. V M. Thus the steady voltage or D.C. voltage can be measured. The other blocks that are not shown in the above simple block diagram are auto range circuit, auto polarity circuit, power supply, component testing circuit.

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- Function Generator:

Introduction, Block Diagram, Operating Principles and Applications .

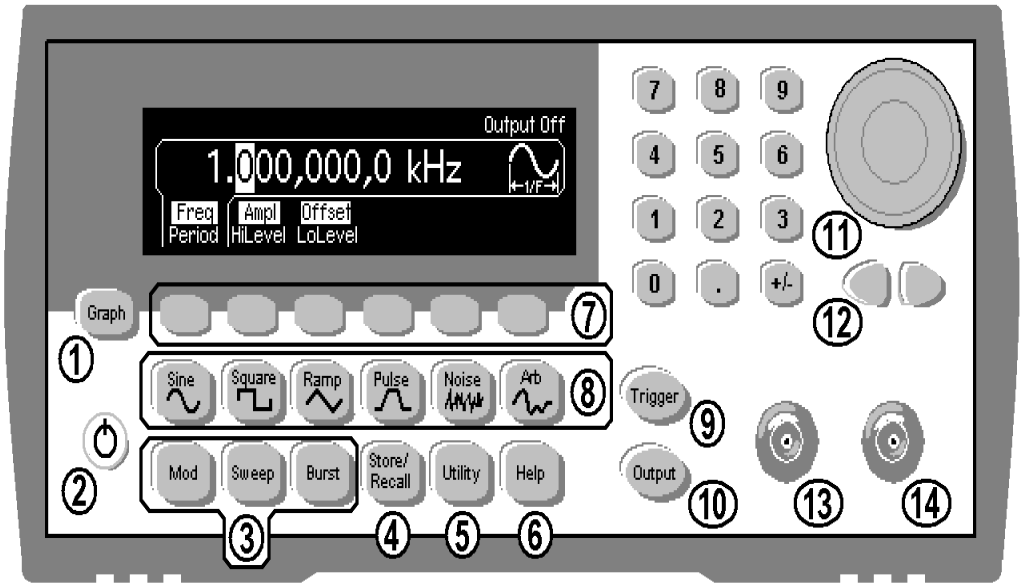

fig.: function generator

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Introduction

A function generator is a specific form of signal generator that is able to generate waveforms with common shapes. Unlike RF generators and some others that only create sine waves, the function generator is able to create repetitive waveforms with a number of common shapes.

It is a electronics instrument that used to produce different kinds of electrical waveform, over a wide range of frequencies.

function generator waveforms may be either repetitive or single-shot, in which case some kind of triggering source is necessary (internal or external).

we can say that in other words ,A function generator produces waveform that is produced by the repetitive charging and discharging of the capacitor to which a constant energy source is connected.

As we know that, Function Generators are used in testing of electronics circuits and repair of electronic equipment, to test amplifiers and development, , or to introduce an error signal into a control loop.

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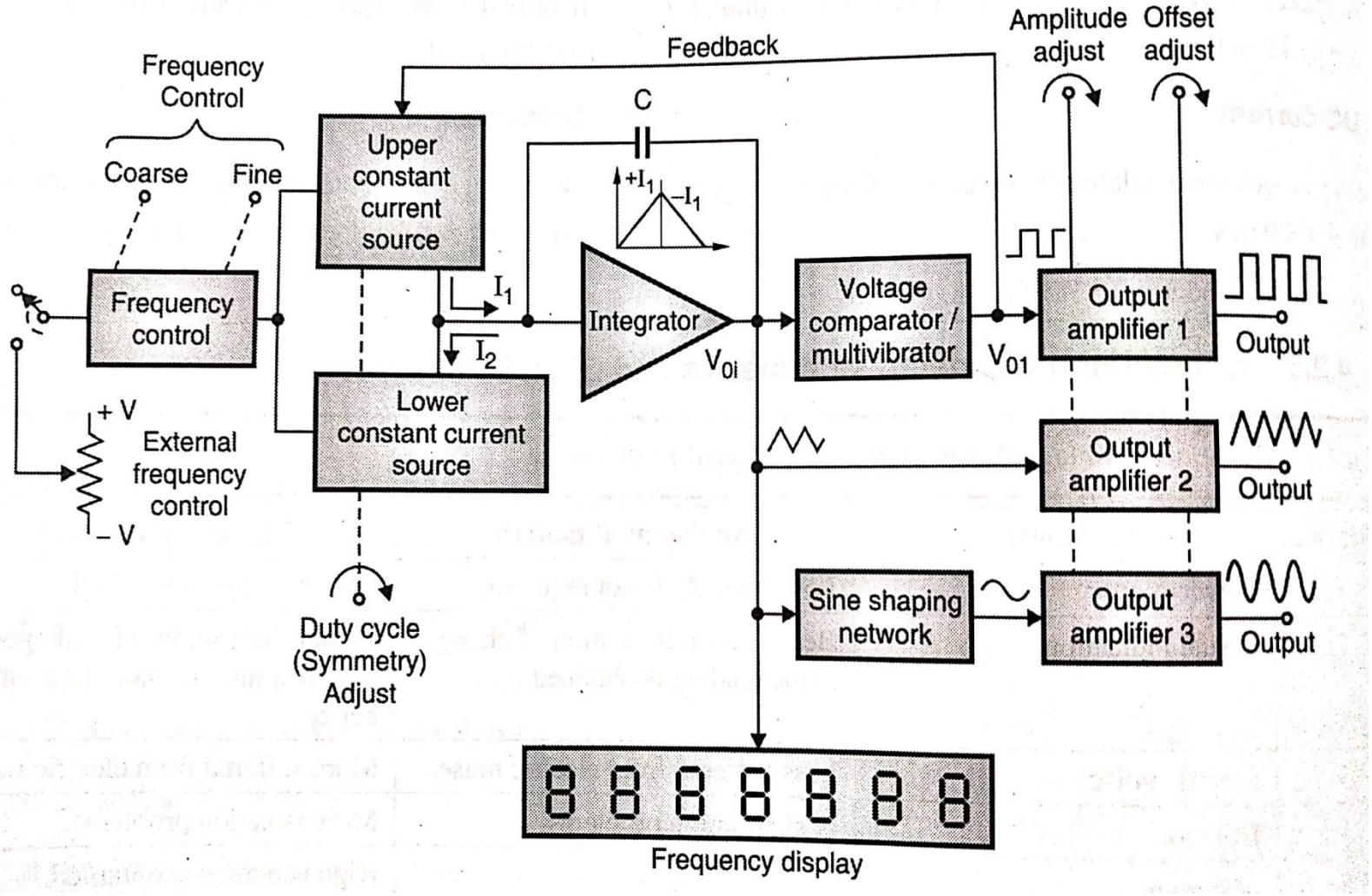

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Working of FG

Working :

following parts as,

1- frequency control network

2- Upper constant current source

3-Lower constant current source

4-Integrator

5-Compartor

6-Resistance diode shaping circuit

7-Amplifier

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features:

standard function generator have following features as,

-It accuracy, about +/- 0.01% in the low frequency range.

-less than 1%,The distortion produced in the output signal is for sine wave.

-it can be phase locked to an external signal source or another function generator.

-it can be phase locked to a standard frequency, so all the output waveforms of the generator will have the same accuracy and stability as that of the standard source.

-It gives the availability of a continuous adjustable d.c. offset voltage between -5V to +5V.

That can be used to produce different waveforms like sine wave, square wave, triangular wave, saw-tooth wave, etc.

It may generate a wide range of frequencies ranging from 0.01 Hz to 2 MHZ

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Cathode Ray Oscilloscope (CRO)

- The CRO working principle depends on the electron ray movement because of the electrostatic force.
- Once an electron ray hits a phosphor face, then it makes a bright spot on it.
- A Cathode Ray Oscilloscope applies the electrostatic energy on the electron ray from two ways viz vertically and horizontally.
- The spot on the phosphor monitor turns due to the effect of these two electrostatic forces which are mutually perpendicular. It moves to make the necessary waveform of the input signal.
- Vertical movement of the spot is due to external signal to be analyzed
- Horizontal movement of the spot is due to internal time base signal

Cathode ray

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- Digital Storage Oscilloscope:

  Introduction, Block Diagram, Operating Principles and Applications .

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Introduction

Definition: The digital storage oscilloscope is defined as the oscilloscope which stores and analysis the signal digitally, i.e. in the form of 1 or 0 , preferably storing them as analogue signals. The digital oscilloscope takes an input signal, store them and then display it on the screen. The digital oscilloscope has advanced features of storage, triggering and measurement. Also, it displays the signal visually as well as numerically.

A *digital storage oscilloscope* digitises the input signal, so that all subsequent signals are digital. A conventional CRT is used, and storage occurs in electronic digital memory. The figure below shows a constructional block diagram of a basic digital storage oscilloscope. The input signal is digitised and stored in memory in digital form. In this state it is capable of being analysed to produce a variety of different information. o view the display on the CRT the data from memory is again constructed in analog form.

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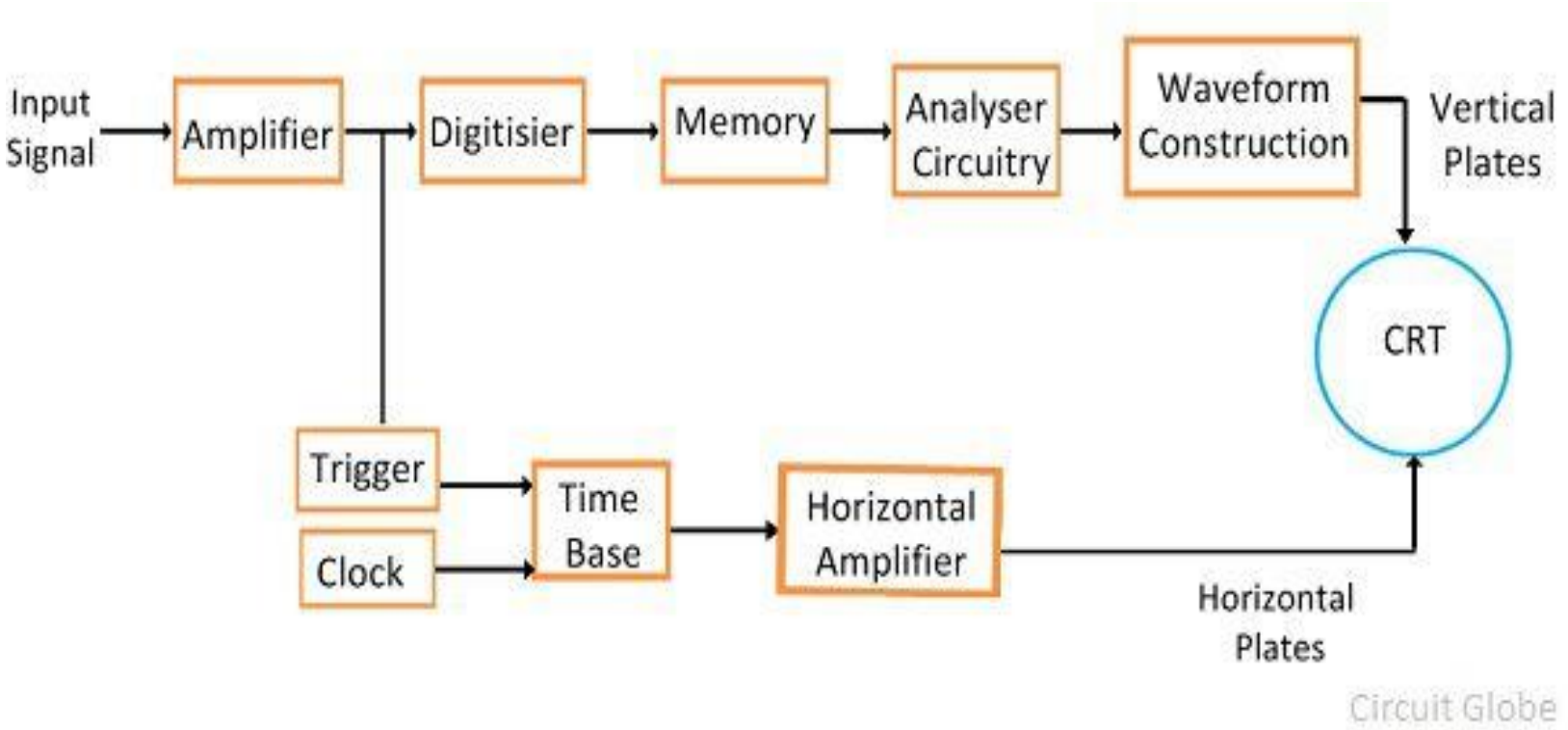
Block Diagram of DSO



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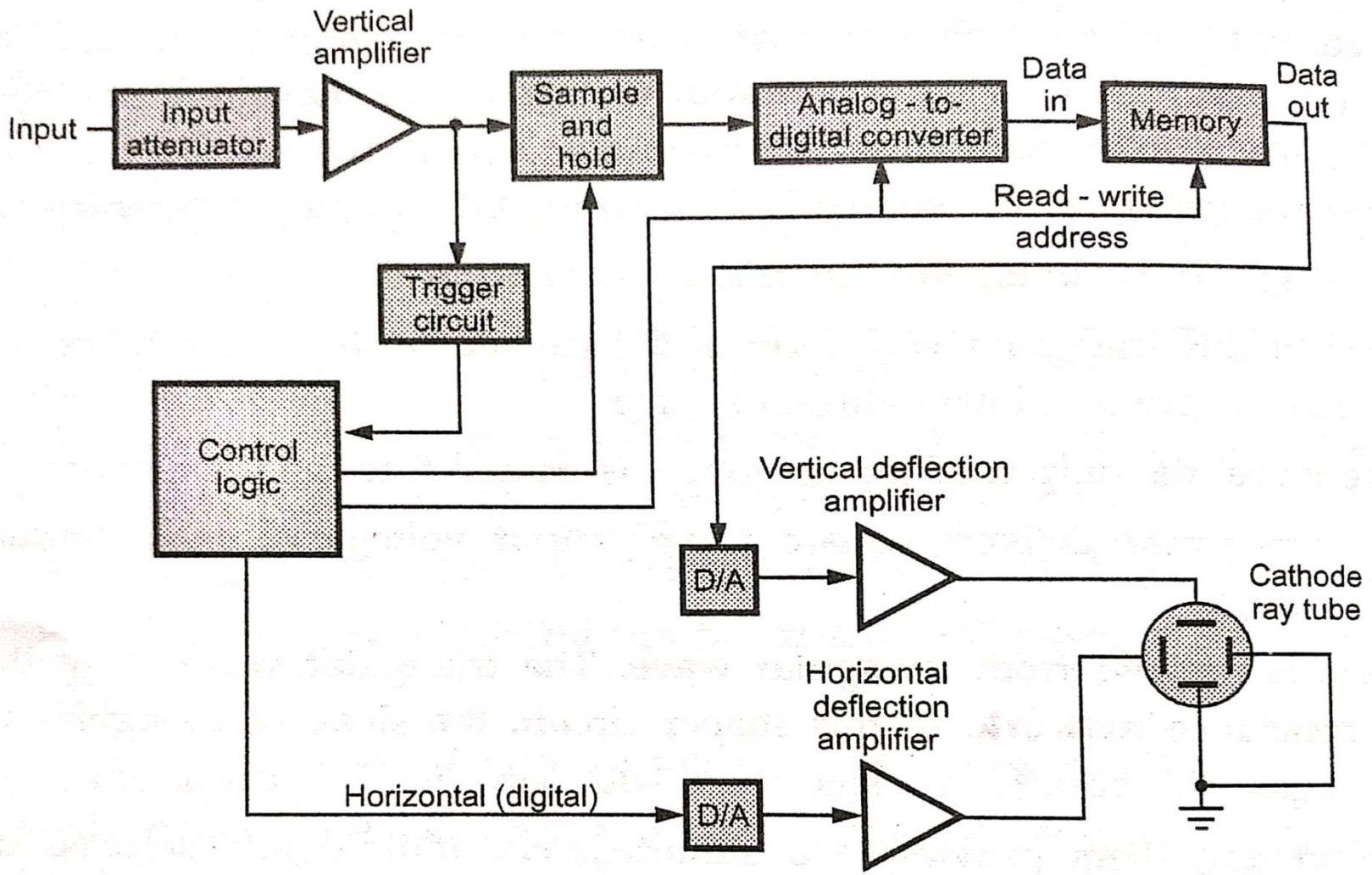
Block Diagram of DSO



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Working of DSO

Figure shows the block diagram of DSO as consists of,

1. Data acquisition
2. Storage
3. Data display.

Data acquisition is earned out with the help of both analog to digital and digital to analog converters, which is used for digitizing, storing and displaying analog waveforms. Overall operation is controlled by control circuit which is usually consists of microprocessor.

Data acquisition portion of the system consist of a Sample-and-Hold (S/H) circuit and an analog to digital converter (ADC) which continuously samples and digitizes the input signal at a rate determined by the sample clock and transmit the digitized data to memory for storage. The control circuit determines whether the successive data points are stored in successive memory location or not, which is done by continuously updating the memories.

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Working of DSO

When the memory is full, the next data point from the ADC is stored in the first memory location writing over the old data.

The data acquisition and the storage process is continues till the control circuit receive a trigger signal from either the input waveform or an external trigger source. When the triggering occurs, the system stops and enters into the display mode of operation in which all or some part of the memory data is repetitively displayed on the cathode ray tube.

In display operation, two DACs are used which gives horizontal and vertical deflection voltage for the CRT Data from the memory gives the vertical deflection of the electron beam, while the time base counter gives the horizontal deflection in the form of staircase sweep signal.

The screen display consist of discrete dots representing the various data points but the number of dot is very large as 1000 or more that they tend to blend together and appear to be a smooth continuous waveform.

The display operation ends when the operator presses a front-panel button and commands the digital storage oscilloscope to begin a new data acquisition cycle.

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DSO Operation Modes

The digital storage oscilloscope works in three modes of operations they are

roll mode, store mode, and hold or save mode.

Roll Mode: In roll mode, very fast varying signals are displayed on the display screen.

Store Mode: In the store mode the signals are stored in memory.

Hold or Save Mode: In hold or save mode, some part of the signal will hold for some time and then they will be stored in memory.

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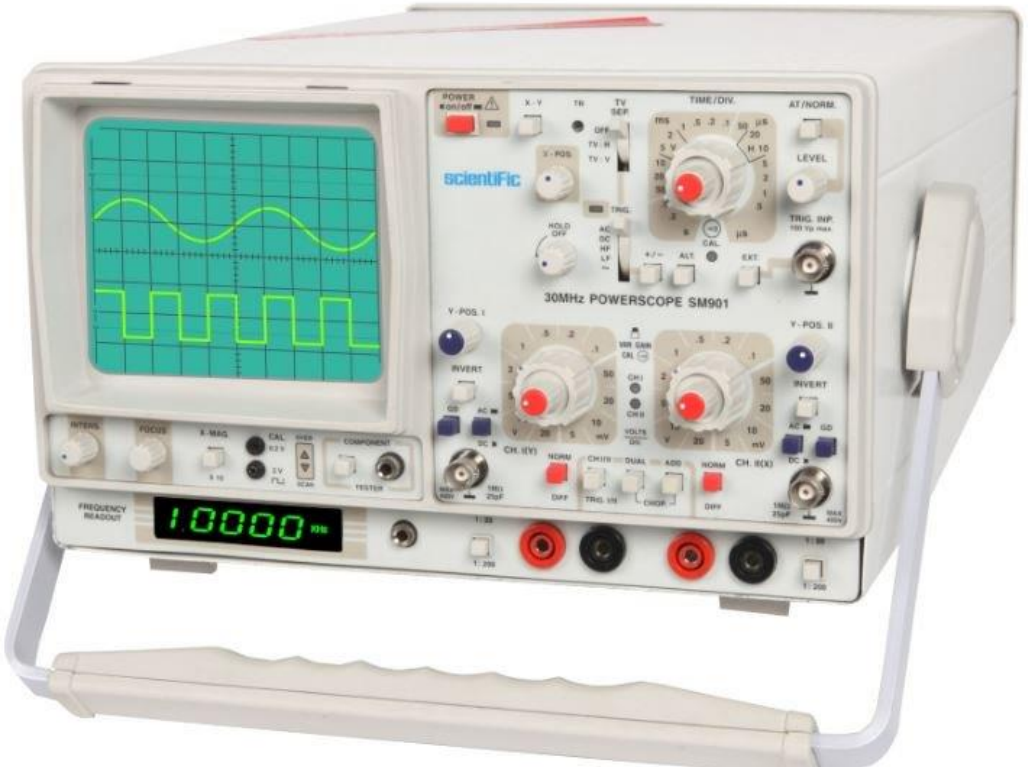
- Power Scope And Auto Transformer :

  Introduction, Block Diagram, Operating Principles and Applications .



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Auto-Transformer

Introduction :

An auto transformer is the one which consists of a single winding, part of which acts as the primary winding of the transformer, and some part of which acts the secondary winding, which can be varied by switching between the contacts of the transformer.

By varying the contact of the switch we can change the number of turns which are accommodated in the secondary winding. Since the output voltage depends upon the number of turns of the secondary winding, so in this way the voltage output can also be varied. For this reason, an auto transformer is also known as a “Variac” because it is mostly used to vary (step up or step down) the output voltage which has to be supplied to the circuit.

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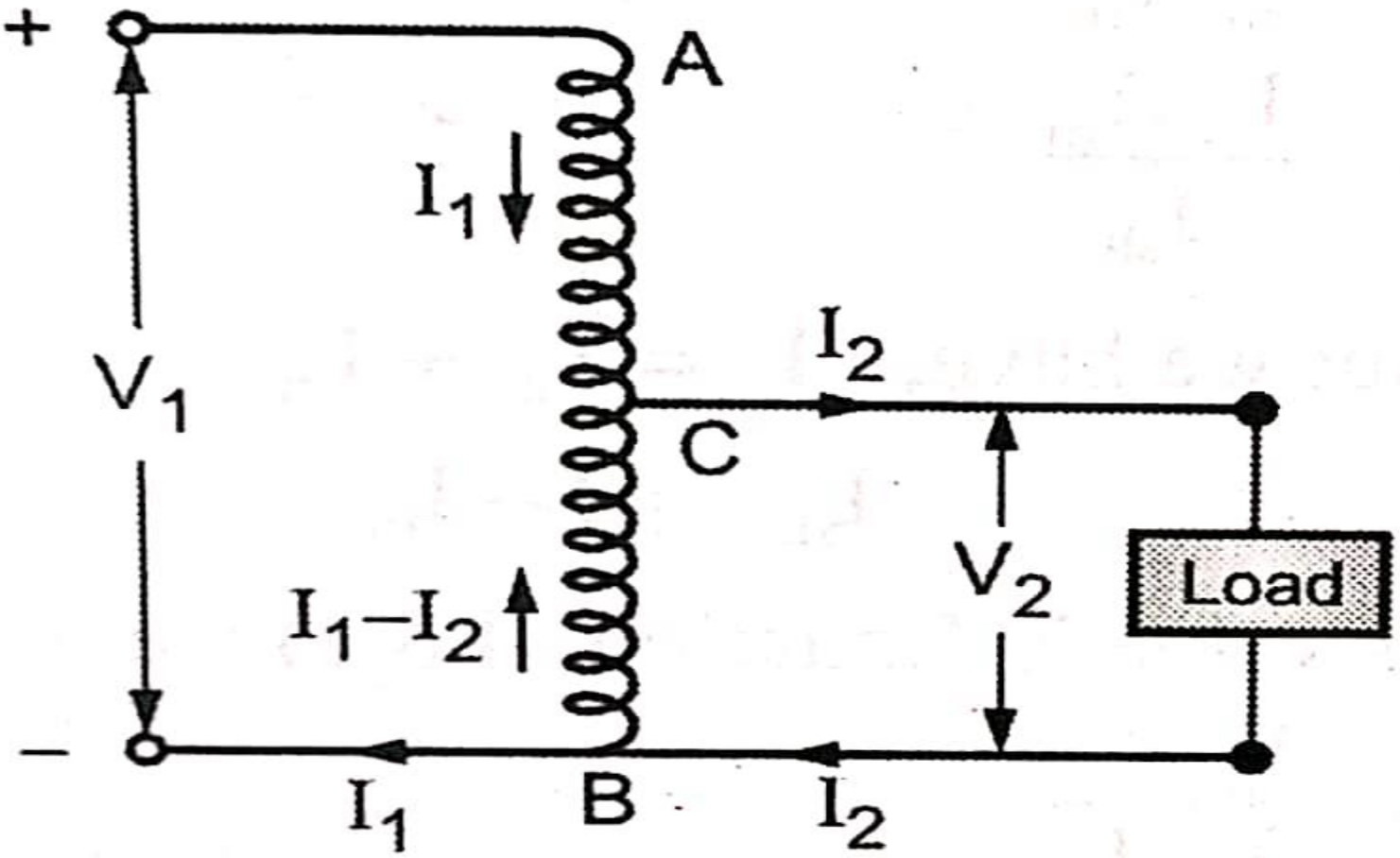
Construction and working



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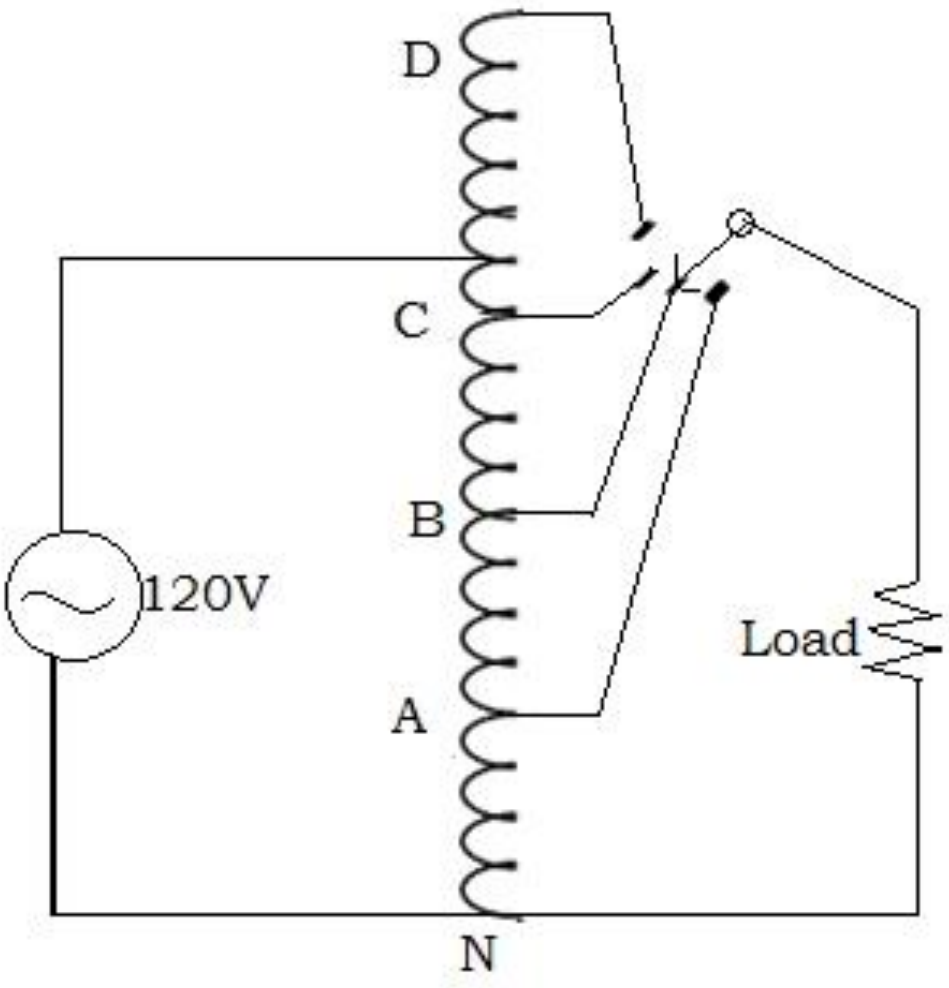
Construction and working



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Construction and working

Here it can be seen that there is only a single winding, on which a number of points have been marked, and each point has equal number of turns, i.e. 40 turns between two consecutive points on the winding, which means 40 volts between those two points.

The primary voltage which is of 120 volts in this case, is supplied between the points C and N, as these points accommodate 120 turns as well.

So the winding between point C and N is regarded as the Primary Winding over here. Now the secondary winding will be the one, across which we connect the external load. Since auto transformers have a varying output voltage, so we connect a switch with the load, so that the contacts can be varied to step up or step down the secondary voltage. So as shown in the figure, we make one end of the load as a fixed end and connect it to the point N.

The other end of the load is connected on the switch, and the point to which the switch will be connected; will be the other point of the secondary winding. For example, in this figure, the secondary winding is between B and N.

In the transformer in the figure, a switch is used to switch between the points A, B, C and D. But if this switch is replaced by a sliding Tap, then the voltage could be varied continuously and this transformer could also be known as a “Variac”.

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Auto-Transformer

Applications of an Auto Transformer

As explained by the figure, an auto transformer has the capability to supply a varying secondary voltage to the externally connected load. **So this is mostly used in applications where a continuously varying voltage output is required.**

Some of its applications are listed below:

1. It is used in electronics testing centres where continuously varying voltage supplies are required.
2. In amplifiers or boosters, where high voltages are required.
3. In other audio devices like speakers, these transformers are used for matching the impedance and adapting the device to a continuous voltage supply.
4. At places like power stations which initially need to step down the voltage, then increase it to match the voltage required by the device at the receiving end.

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Auto-Transformer

Advantages of Auto Transformers

1. Since only one winding is requires, so these transformers are cost efficient and relatively smaller.
2. These are more efficient and require lower excitation currents than the conventional transformers.
3. The varying of voltage is more easy and smooth in auto transformers, as compared to the conventional step up and step down transformers.

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- AC/DC Power Supply :

Introduction, Block Diagram, Operating Principles and Applications .

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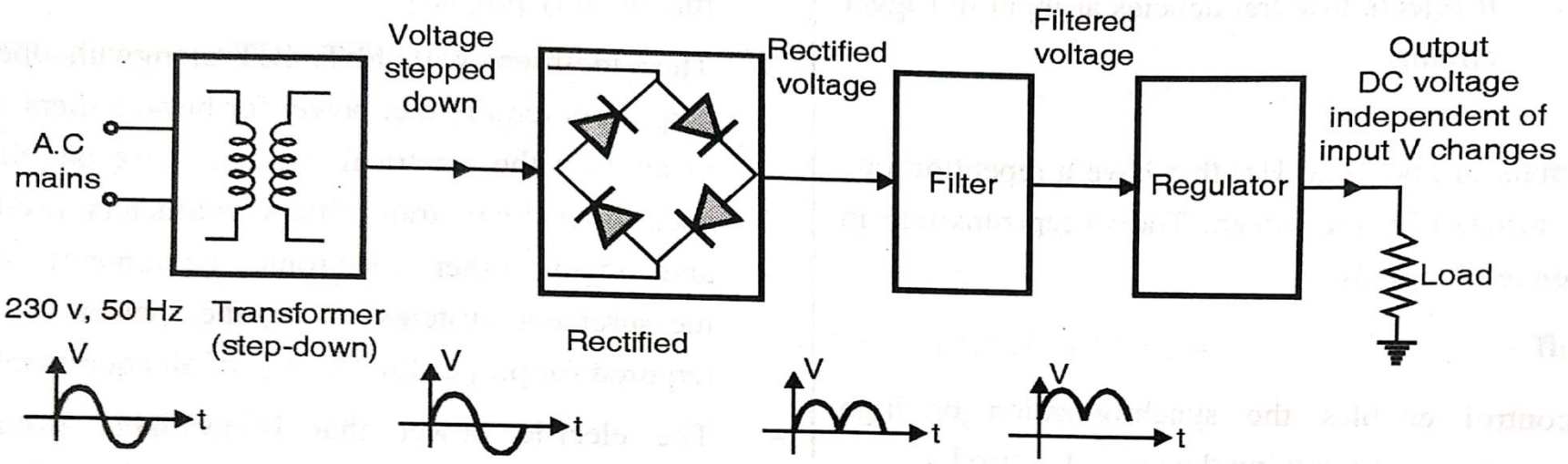
DC Power Supply



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Introduction

• A **power supply** is an electrical device that supplies electric power to an electric load The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Examples of the latter include power supplies found in desktop computer and consumer electronics devices.

• **Other functions that power supplies may perform include :**

• **limiting the current drawn by the load to safe levels**

• **shutting off the current in the event of an electrical fault**

•**power conditioning to prevent electronics noise or voltages surges on the input from reaching the load.**

•**power-factor correction,**

•**storing energy so it can continue to power the load in the event of a temporary interruption in the source power (uninterruptible power supply).**

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Classification

- DC power supply
- AC-to-DC supply
- Switched-mode power supply
- Linear regulator
- AC power supplies
- Programmable power supply
- Uninterruptible power supply
- High-voltage power supply

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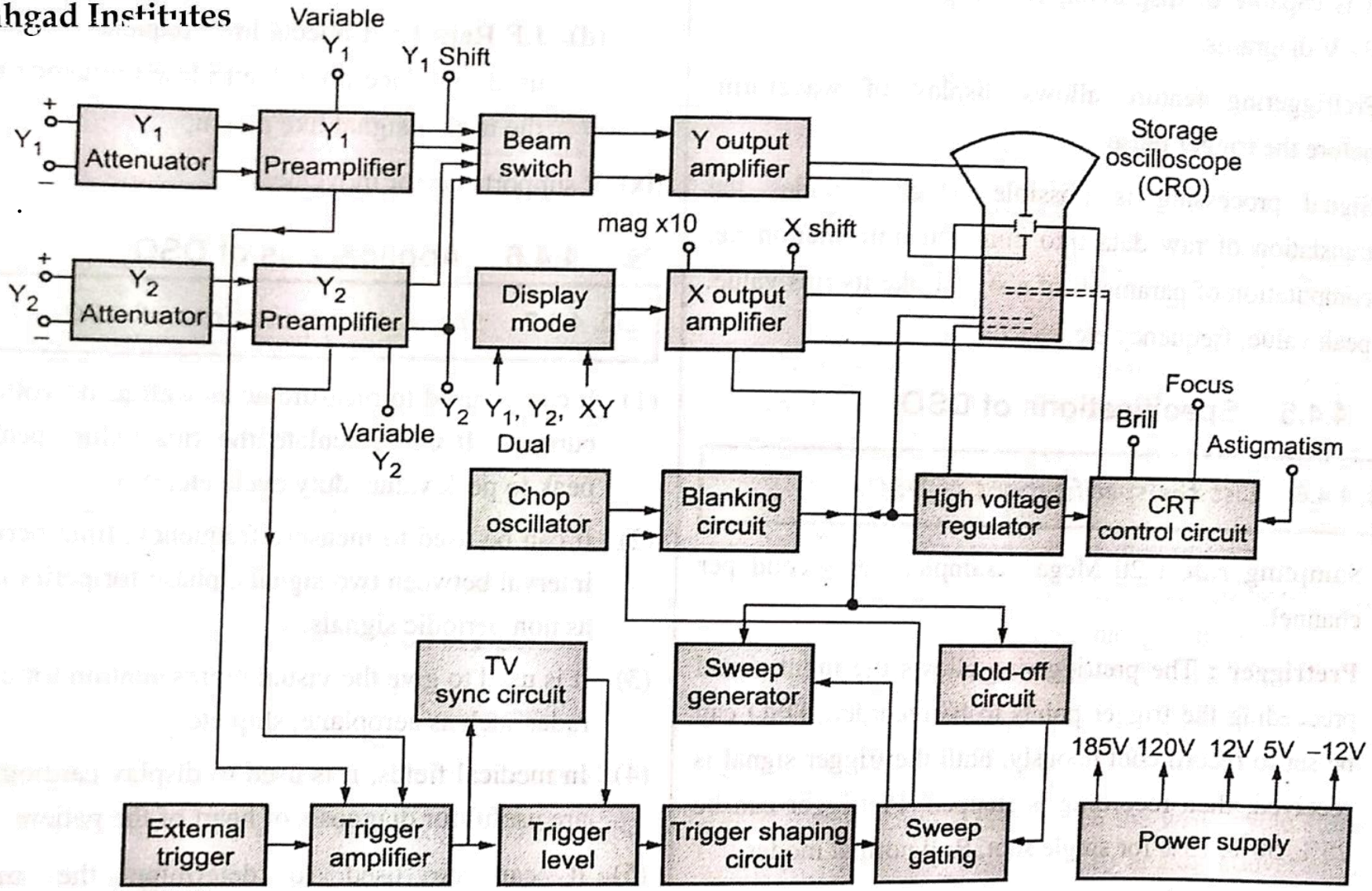
Block Diagram of Power Scope



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- Analog Ammeter and voltmeter:

Introduction, Diagram, Operating Principles and

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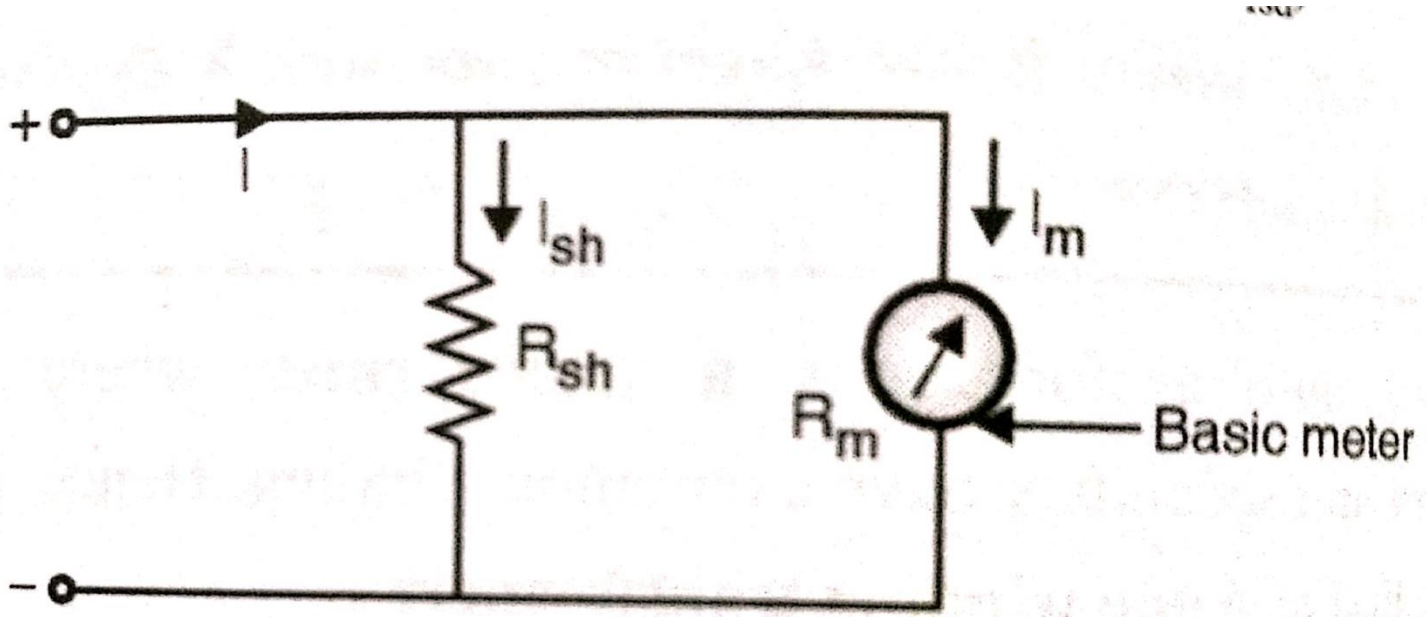
Basic D.C. Ammeter



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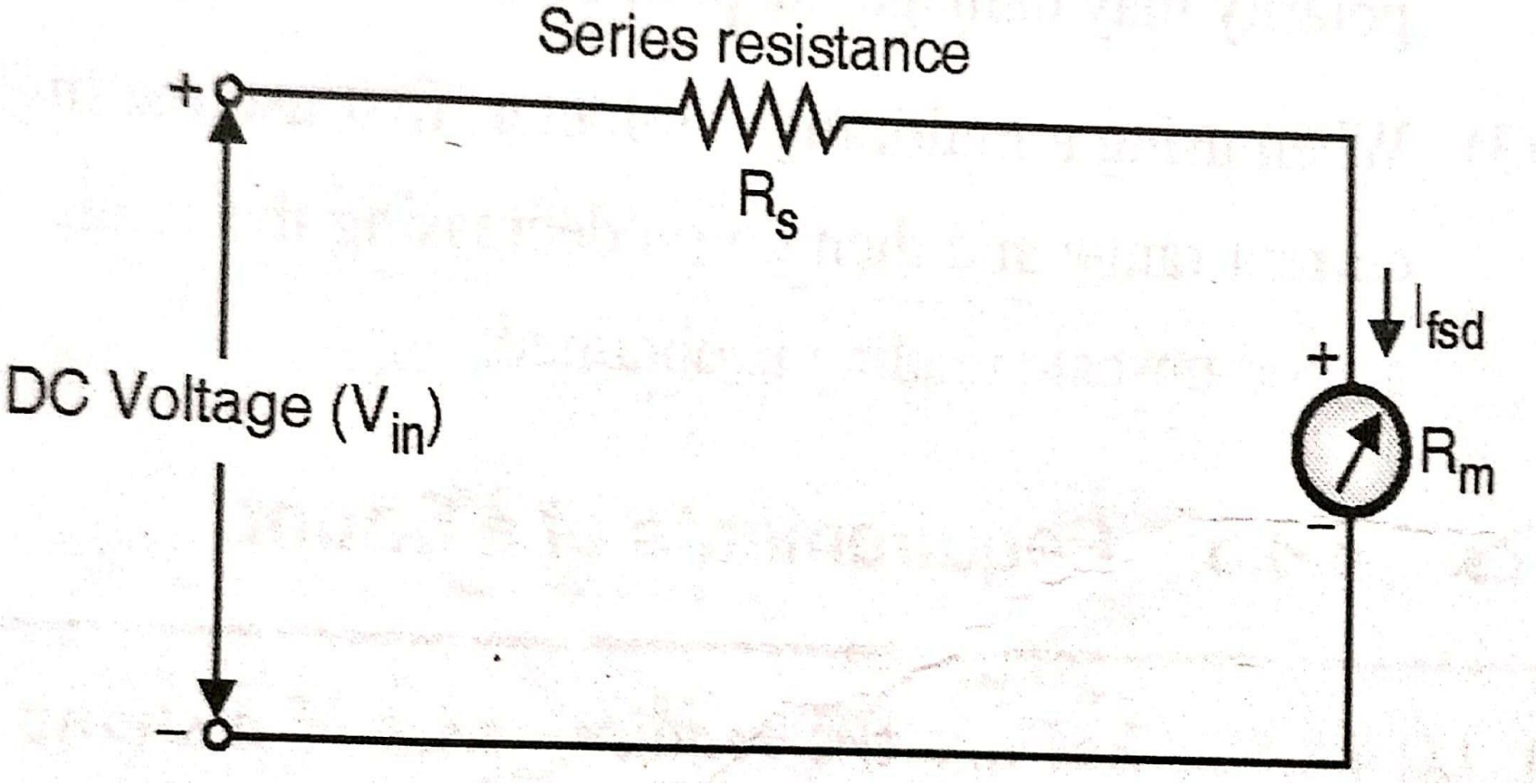
Basic D.C. Voltmeter



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Analog Ammeter

•As we know a word “meter” is associated with the measurement system. Meter is an instrument which can measure a particular quantity. As we know, the unit of current is Ampere. Ammeter means Ampere-meter which measures ampere value. Ampere is the unit of current so an ammeter is a meter or an instrument which measures current.

•Classification or Types of Ammeter

Depending on the constructing principle, there are many types of ammeter we get, they are mainly –

Permanent Magbet Moving Coil(PMMC) ammeter.

Moving Iron(MI) Ammeter.

Electrodynamometer type Ammeter.

Rectifier TypeAmmeter.

Depending on this types of measurement we do, we have-

- **DC**
- **AC**

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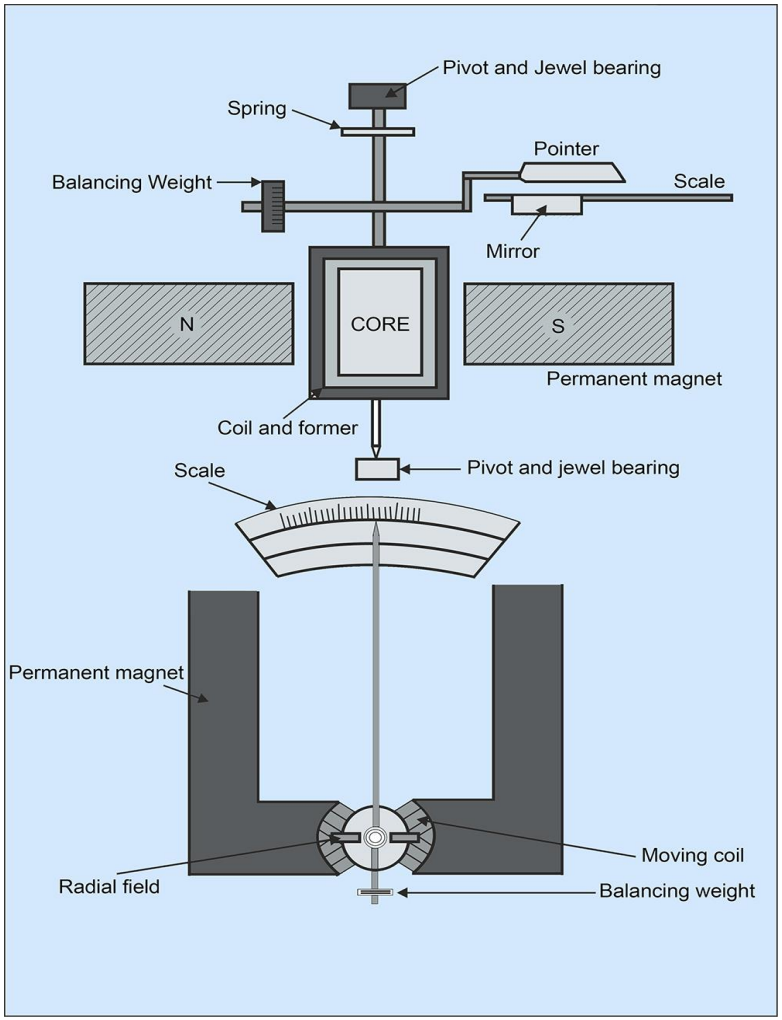
Permanent Magnet Moving Coil



Construction :

A coil of thin wire is mounted on an aluminum frame (spindle) positioned between the poles of a U shaped permanent magnet which is made up of magnetic alloys like alnico.

The coil is pivoted on the jeweled bearing and thus the coil is free to rotate. The current is fed to the coil through spiral springs which are two in numbers. The coil which carries a current, which is to be measured, moves in a strong magnetic field produced by a permanent magnet and a pointer is attached to the spindle which shows the measured value

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Applications

The PMMC has a variety of uses. It can be used as:

1) **Ammeter**:

When PMMC is used as an ammeter, except for a very small current range, the moving coil is connected across a suitable low resistance shunt, so that only small part of the main current flows through the coil. The shunt consists of a number of thin plates made up of alloy metal, which is usually magnetic and has a low-temperature coefficient of resistance, fixed between two massive blocks of copper. A resistor of the same alloy is also placed in series with the coil to reduce errors due to temperature variation.

2) **Voltmeter**:

When PMMC is used as a voltmeter, the coil is connected in series with a high resistance. Rest of the function is same as above. The same moving coil can be used as an ammeter or voltmeter with an interchange of above arrangement

3) **Galvanometer**:

The galvanometer is used to measure a small value of current along with its direction and strength. It is mainly used onboard to detect and compare different circuits in a system.

5) **Ohm Meter**:

The ohm meter is used to measure the resistance of the electric circuit by applying a voltage to a resistance with the help of battery. A galvanometer is used to determine the flow of current through the resistance. The galvanometer scale is marked in ohms and as the resistance varies since the voltage is fixed, the current through the meter will also vary.

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Comparison Chart

Parameters	Ammeter	Voltmeter
Definition	Ammeter is a current measuring device that measures current through the circuit.	Voltmeter is a voltage measuring device that measures the potential difference between two points in a circuit.
Series/Parallel connection	Ammeter is always connected in series.	Voltmeter is always connected in parallel.
Resistance	(a) Resistance of an ideal ammeter is zero. (b) Shunt resistance is very small. (c) Its resistance is less than that of the galvanometer.	(a) Resistance of an ideal voltmeter is infinity. (b) Series resistance is very high. (c) Its resistance is greater than that of the galvanometer.
Type of instrument	Ammeter is a low resistance instrument.	Voltmeter is a high resistance instrument.
Range	It is not possible to decrease the range of the given ammeter.	It is possible to decrease the range of the given voltmeter.
Deflecting torque	The deflecting torque is produced by the current that is to be measured directly.	The deflecting torque is produced by the current that is proportional to the voltage that is to be measured.
Accuracy	Less accurate	More accurate

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END OF UNIT 4