CHAPTER 5

DC REGULATED POWER SUPPLY

Objectives

After completing this course, you will be able to:

- Define the DC regulated power supply and its uses.
- To discuss the kinds of power supply.
- Explain the advantage and disadvantage of dc regulated power supply.
- Explain the characteristics of dc regulated power supply.

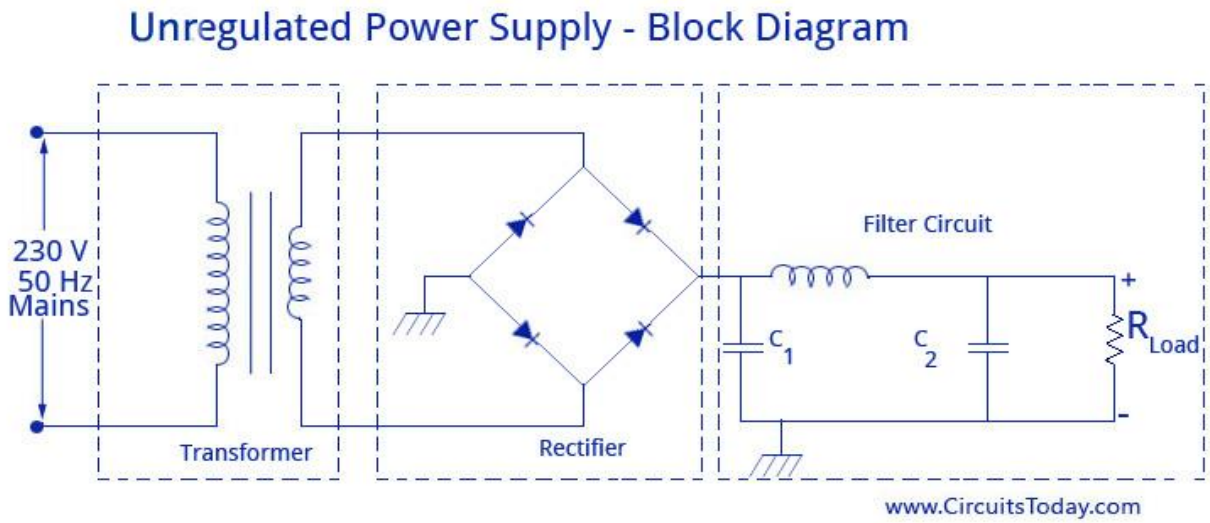
DC Power supply

Almost all basic household electronic circuits need an unregulated AC to be converted to constant DC, in order to operate the electronic device. All devices will have a certain power supply limit and the electronic circuits inside these devices must be able to supply a constant DC voltage within this limit. This DC supply is regulated and limited in terms of voltage and current. But the supply provided from mains may be fluctuating and could easily break down the electronic equipment, if not properly limited. This work of converting an unregulated alternating current (AC) or voltage to a limited Direct current (DC) or voltage to make the output constant regardless of the fluctuations in input, is done by a regulated power supply circuit.

All the active and passive electronic devices will have a certain DC operating point (Q-point or Quiescent point), and this point must be achieved by the source of DC power.

The DC power supply is practically converted to each and every stage in an electronic system. Thus a common requirement for all these phases will be the DC power supply. All low power system can be run with a battery. But, for a long time operating devices, batteries could prove to be costly and complicated. The best method used is in the form of an unregulated power supply – a combination of a transformer, rectifier and a filter.

As shown in the figure below, a small step down transformer is used to reduce



the voltage level to the devices needs. In India, a 1 Ø supply is available at 230 volts. The output of the transformer is a pulsating sinusoidal AC voltage, which is converted to pulsating DC with the help of a rectifier. This output is given to a filter circuit which reduces the AC ripples, and passes the DC components. But here are certain disadvantages in using an unregulated power supply.

Disadvantages of Unregulated Power Supply

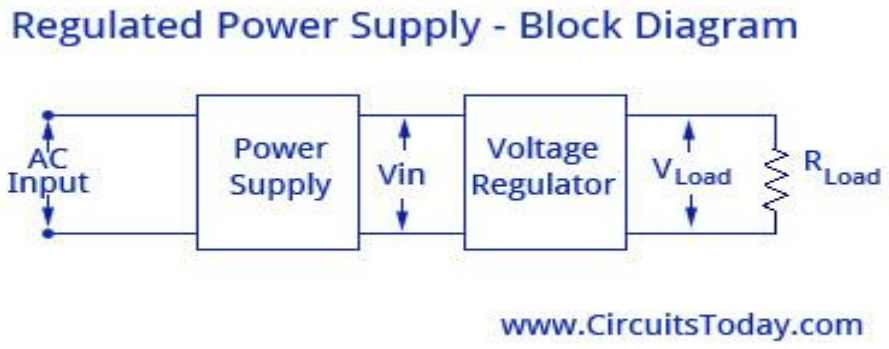
1. **Poor Regulation** – When the load varies, the output does not appear constant. The output voltage changes by a great value due to the huge change in the current drawn from the supply. This is mainly due to the high internal resistance of the power supply (>30 Ohms).
2. **AC Supply Main Variations** – The maximum variations in AC supply mains is give or take 6% of its rated value. But this value may go higher in some countries (180-280 volts). When the value is higher it's DC voltage output will differ largely.
3. **Temperature Variation** – The use of semiconductor devices in electronic devices may cause variation in temperature.

. These variations in dc output voltage may cause an inaccurate or erratic operation or even malfunctioning of many electronic circuits. For instance, in oscillators the frequency will shift, in transmitters output will get distorted, and in amplifiers, the operating point will shift causing bias instability.

The internal circuitry of a regulated power supply also contains certain current limiting circuits which help the supply circuit from getting fried from inadvertent circuits. Nowadays, all the power supplies use IC's to reduce ripples, enhance voltage regulation and for widened control options. Programmable power supplies are also available to allow remote operation that is useful in many settings.

Regulated Power Supply

Regulated power supply is an electronic circuit that is designed to provide a constant dc voltage of predetermined value across load terminals irrespective of ac mains fluctuations or load variations. A regulated power supply essentially consists of an ordinary power supply and a voltage regulating device, as illustrated in the figure.



The output from an ordinary power supply is fed to the voltage regulating device that provides the final output. The output voltage remains constant irrespective of variations in the ac input voltage or variations in output (or load) current.

Transformer

A step down transformer is used to step down the voltage from the input AC to the required voltage of the electronic device. This output voltage of the transformer is customized by changing the turns ratio of the transformer according the electronic device specs. The input of the transformer being 230 Volts AC mains, the output is provided to a full bridge rectifier circuit.

Full Wave Rectifier System

The FWR consists of 4 diodes which rectifies the output AC voltage or current from the transistor to its equivalent DC quantity. As the name implies the FWR rectifies both half's of the AC input. The rectified DC output is given as input to the filter circuit.

Filter Circuit

The filter circuit is used to convert the high rippled DC output of the FWR to ripple free DC content. A ∏ filter is used to make the waveforms ripple free.

In Short

The ac voltage, typically 230 Vrms is connected to a transformer which transforms that ac voltage to the level for the desired dc output. A bridge rectifier then provides a full-wave rectified voltage that is initially filtered by a ∏ (or C-L-C) filter to produce a dc voltage. The resulting dc voltage usually has some ripple or ac voltage variation. A regulating circuit use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains constant even if the input dc voltage varies somewhat or the load connected to the output dc voltage changes. The regulated dc supply is available across a voltage divider.

Often more than one dc voltage is required for the operation of electronic circuits. A single power supply can provide as many as voltages as are required by using a voltage (or potential) divider.

Power Supply Characteristics

There are various factors that determine the quality of the power supply like the load voltage, load current, voltage regulation, source regulation, output impedance, ripple rejection, and so on. Some of the characteristics are briefly explained below:

1. **Load Regulation** – The load regulation or load effect is the change in regulated output voltage when the load current changes from minimum to maximum value.

   Load regulation = Vno-load - Vfull-load

   Vno-load refers to the Load Voltage at no load

   Vfull-load refers to the Load voltage at full load.

From the above equation we can understand that when Vno-load occurs the load resistance is infinite, that is, the out terminals are open circuited. Vfull-load occurs when the load resistance is of the minimum value where voltage regulation is lost.

% Load Regulation = [(Vno-load - Vfull-load)/Vfull-load] * 100

2. **Minimum Load Resistance** – The load resistance at which a power supply delivers its full-load rated current at rated voltage is referred to as minimum load resistance.

Minimum Load Resistance = Vfull-load/Ifull-load

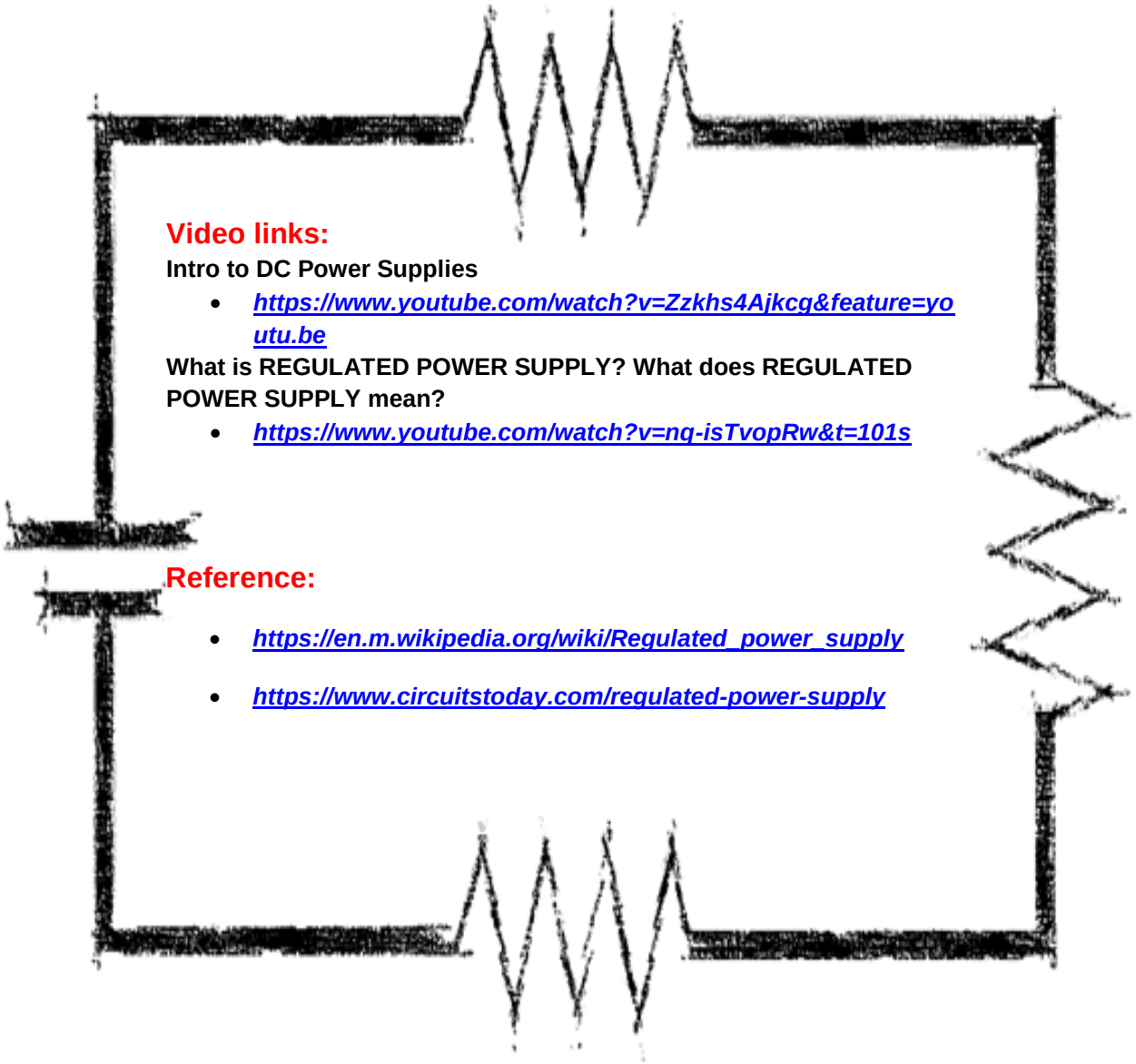
The value of Ifull-load, full load current should never increase than that mentioned in the datasheet of the power supply.

3. **Source/Line Regulation** – In the block diagram, the input line voltage has a nominal value of 230 Volts but in practice, here are considerable variations in ac supply mains voltage. Since this ac supply mains voltage is the input to the ordinary power supply, the filtered output of the bridge rectifier is almost directly proportional to the ac mains voltage.

The source regulation is defined as the change in regulated output voltage for a specified rage of lie voltage.

4. **Output Impedance** – A regulated power supply is a very stiff dc voltage source. This means that the output resistance is very small. Even though the external load resistance is varied, almost no change is seen in the load voltage. An ideal voltage source has an output impedance of zero.

5. **Ripple Rejection** – Voltage regulators stabilize the output voltage against variations in input voltage. Ripple is equivalent to a periodic variation in the input voltage. Thus,a voltage regulator attenuates the ripple that comes in with the unregulated input voltage. Since a voltage regulator uses negative feedback, the distortion is reduced by the same factor as the gain.



Video links:

Intro to DC Power Supplies

- ***https://www.youtube.com/watch?v=Zzkhs4Ajkcg&feature=youtu.be***

What is REGULATED POWER SUPPLY? What does REGULATED POWER SUPPLY mean?

- ***https://www.youtube.com/watch?v=ng-isTvopRw&t=101s***

Reference:

- ***https://en.m.wikipedia.org/wiki/Regulated_power_supply***
- ***https://www.circuitstoday.com/regulated-power-supply***