D.C. Power supply

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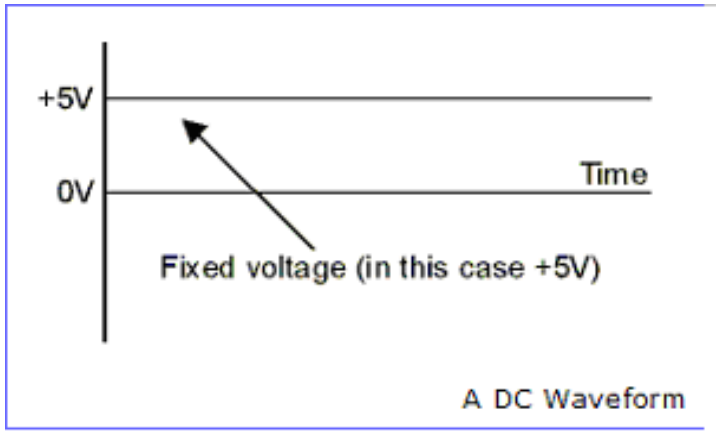
What is a Power Supply?

A device, which converts, regulates, and transmits the required power to the circuit to be operated.

What is DC?

Direct current (DC) is the unidirectional flow of electric charge.

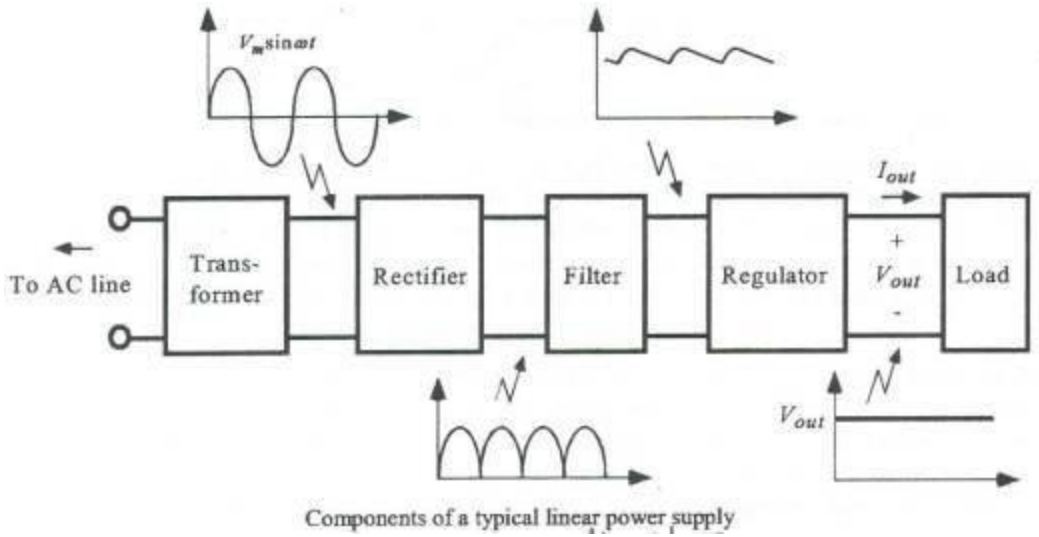
A Direct Current (DC) supply stays at a fixed, regular voltage all of the time.



Elements of a Power Supply

- Transformer
- Rectifier
- Filter
- Regulator

Block diagram of a Power Supply



Components of a typical linear power supply

TRANSFORMER

The AC line voltage available for commercial purpose is not suitable for electronic circuits.

Most of the electronic circuits require a considerably lower voltage.

The transformer is a device used to convert the ac line voltage to a voltage level more appropriate to the needs of the circuit to be operated.

At the same time, the transformer provides electrical isolation between the ac line and the circuit to be operated.
This is an important safety consideration.

Rectifiers

The output of the transformer is still an ac voltage, it has to convert to dc.

Rectifier is a device which convert AC voltage in to pulsating DC.

A rectifier utilizes unidirectional conducting device Ex : P-N junction diodes.

Types

Depending up on the period of conduction

- Half wave rectifier

The ripple factor is quite high(1.21). Rectifier efficiency is very low(40%)

- Full wave rectifier

Ripple factor is (0.48). Rectifier efficiency is high(81.2%)

Depending up on the connection procedure

- Bridge rectifier

Suitable for applications where large powers are required.

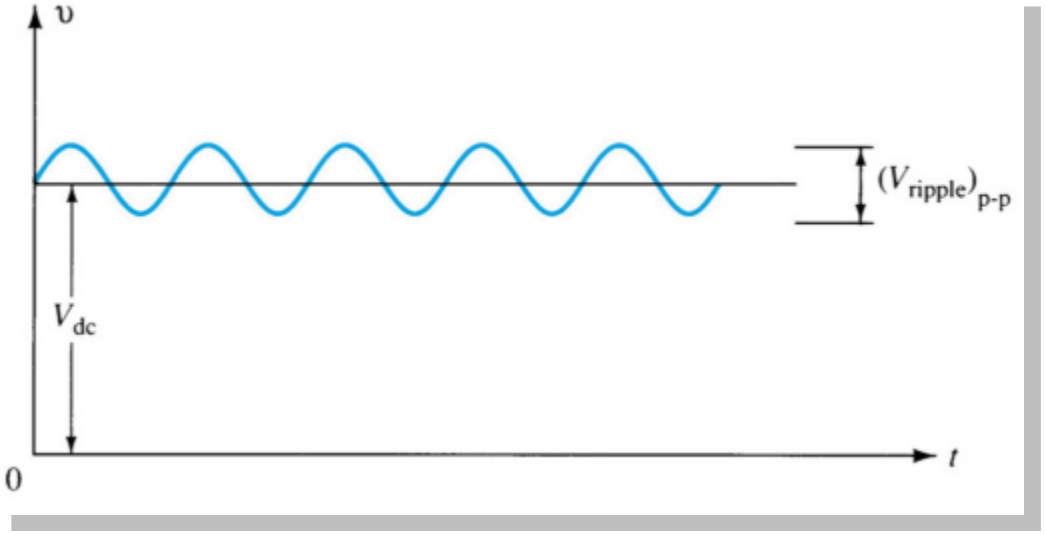
Filter Circuits

The output from the rectifier section is a pulsating DC.

The filter circuit reduces the peak-to-peak pulses to a small ripple voltage.

Ripple Factor

After the filter circuit a small amount of AC is still remaining. The amount of ripple voltage can be rated in terms of ripple factor (r).



$$\%\,r = \frac{\text{ripple voltage (rms)}}{\text{dc voltage}} = \frac{V_{r(rms)}}{V_{dc}} \times 100$$

Types of Filter Circuits

Capacitor Filter

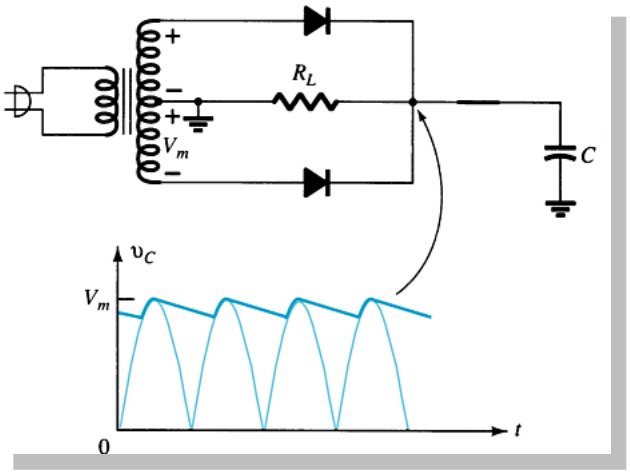
Capacitor Filter

RC Filter

Ripple voltage

$$V_{r(rms)} = \frac{I_{dc}}{4\sqrt{3}fC} = \frac{2.4I_{dc}}{C} = \frac{2.4V_{dc}}{R_L C}$$

The larger the capacitor the smaller the ripple voltage.



Ripple factor

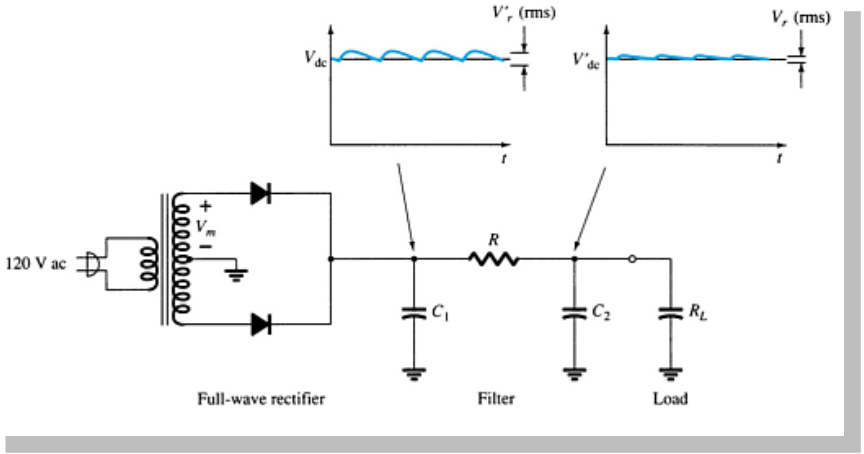
$$\%r = \frac{V_{r(rms)}}{V_{dc}} \times 100 = \frac{2.4I_{dc}}{CV_{dc}} \times 100 = \frac{2.4}{R_L C} \times 100$$

RC Filter Circuit

Adding an RC section further reduces the ripple voltage and decrease the surge current through the diodes.

$$V'_{r(rms)} \approx \frac{X_C}{R} V_{r(rms)}$$

$V'_{r(rms)}$ = ripple voltage after the RC filter
$V_{r(rms)}$ = ripple voltage before the RC filter
R = resistor in the added RC filter
X_C = reactance of the capacitor in the added RC filter



Voltage Regulation Circuits

There are two common types of circuitry for voltage regulation:

- Discrete Transistors
- IC's

Discrete-Transistor Regulators

Series voltage regulator

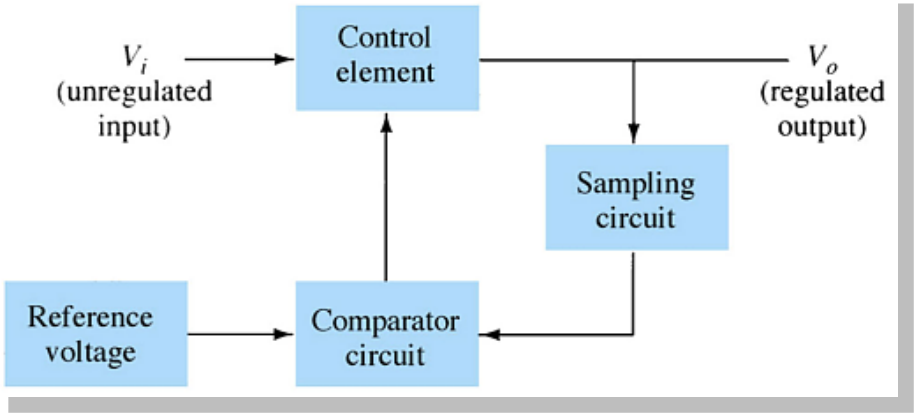
Current-limiting circuit

Shunt voltage regulator

Series Voltage Regulator Circuit

The series element controls the amount of the input voltage that gets to the output.

If the output voltage increases (or decreases), the comparator circuit provides a control signal to cause the series control element to decrease (or increase) the amount of the output voltage.



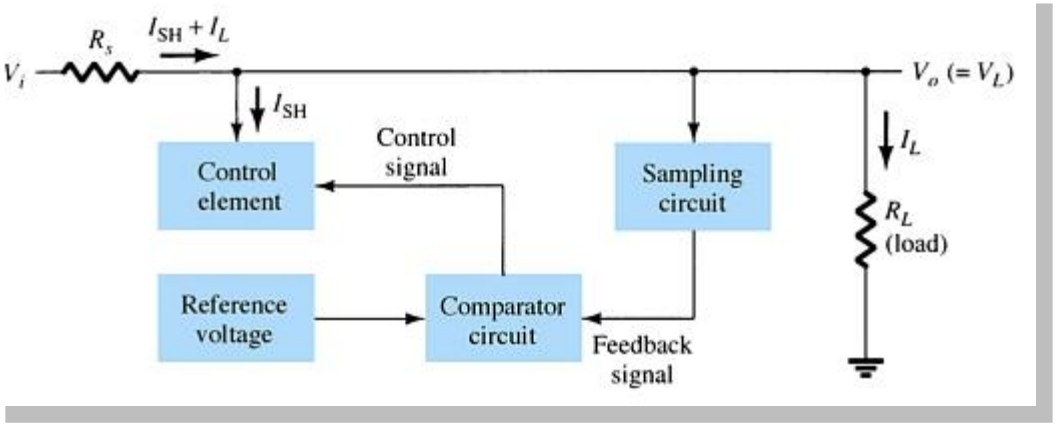
Current-limiting circuit

Current limiting is the practice in electrical or electronic circuits of imposing an upper limit on the current that may be delivered to a load with the purpose of protecting the circuit generating or transmitting the current from harmful effects due to a short-circuit or similar problem in the load.

Shunt Voltage Regulator Circuit

The shunt voltage regulator shunts current away from the load.

The load voltage is sampled and fed back to a comparator circuit. If the load voltage is too high, control circuitry shunts more current away from the load.



IC Voltage Regulators

Regulator ICs contain:

- Comparator circuit
- Reference voltage
- Control circuitry
- Overload protection

Types of three-terminal IC voltage regulators

- Fixed positive voltage regulator
- Fixed negative voltage regulator
- Adjustable voltage regulator

Points to note…

The most important consideration in designing a power supply is the DC voltage at the output.

It should be able to furnish the maximum current needed, maintaining the voltage at constant level.

The AC ripple should be low.

The power supply should be protect in the event of short circuit on the load side.

The response of the power supply to temperature changes should be minimum.