DIODE VOLTAGE MULTIPLIER

What is VoltageMultiplier?

A voltage multiplier is an electrical circuit that converts AC electrical power from a lower voltage to a higher DC voltage, typically using a network of capacitors and diodes.

Types of Voltage Multiplier

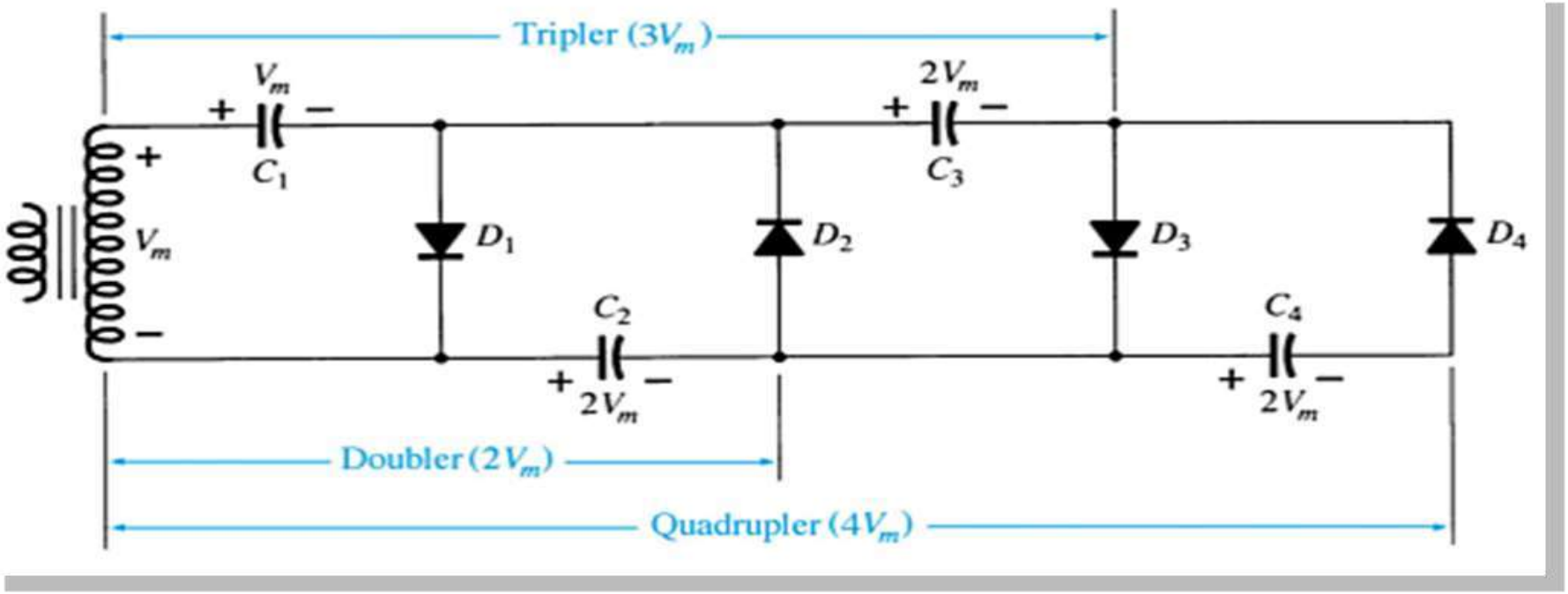
Depending on the output voltage, multipliers can be of different types

- Voltage Doublers

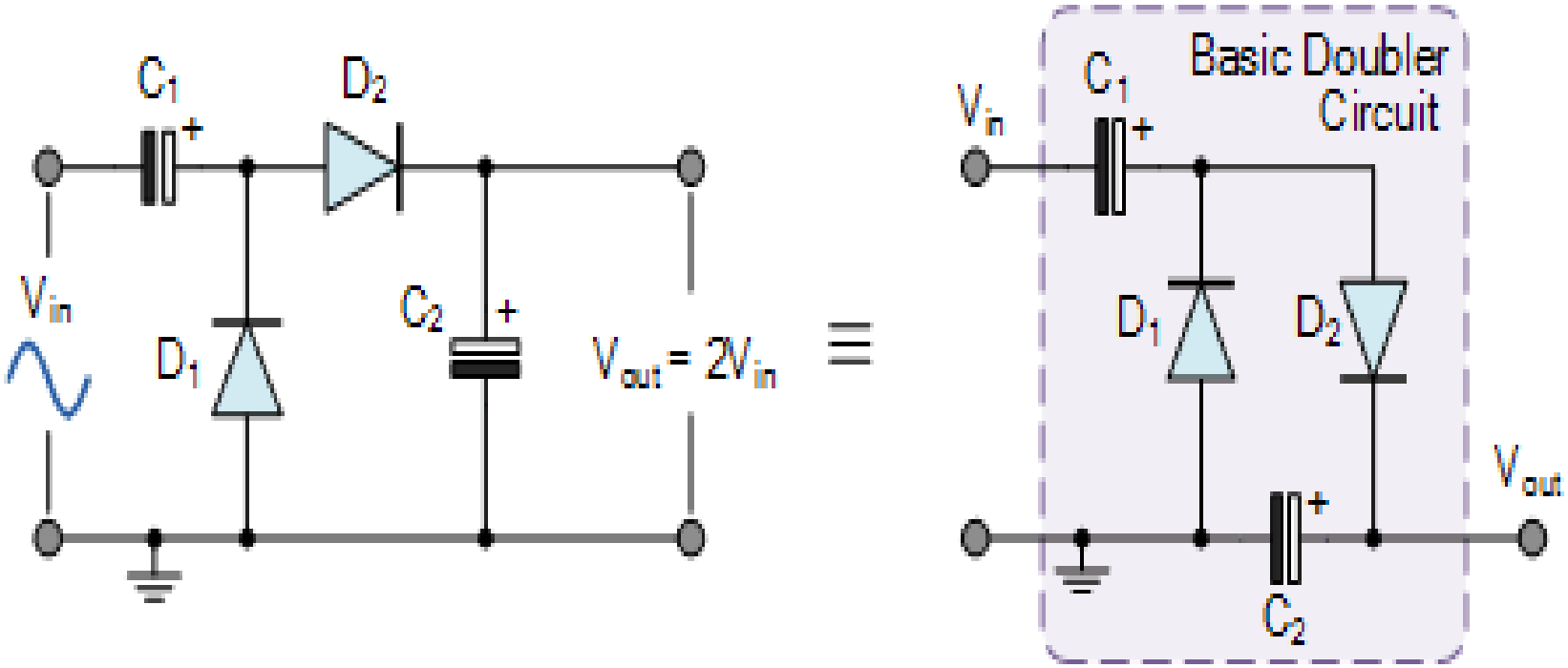
  - Half wave voltage doubler
  - Ful wave voltage doubler

- Voltage Tipplers
- Voltage Quadrupler

Voltage Doubler, Tripler and Quadrupler



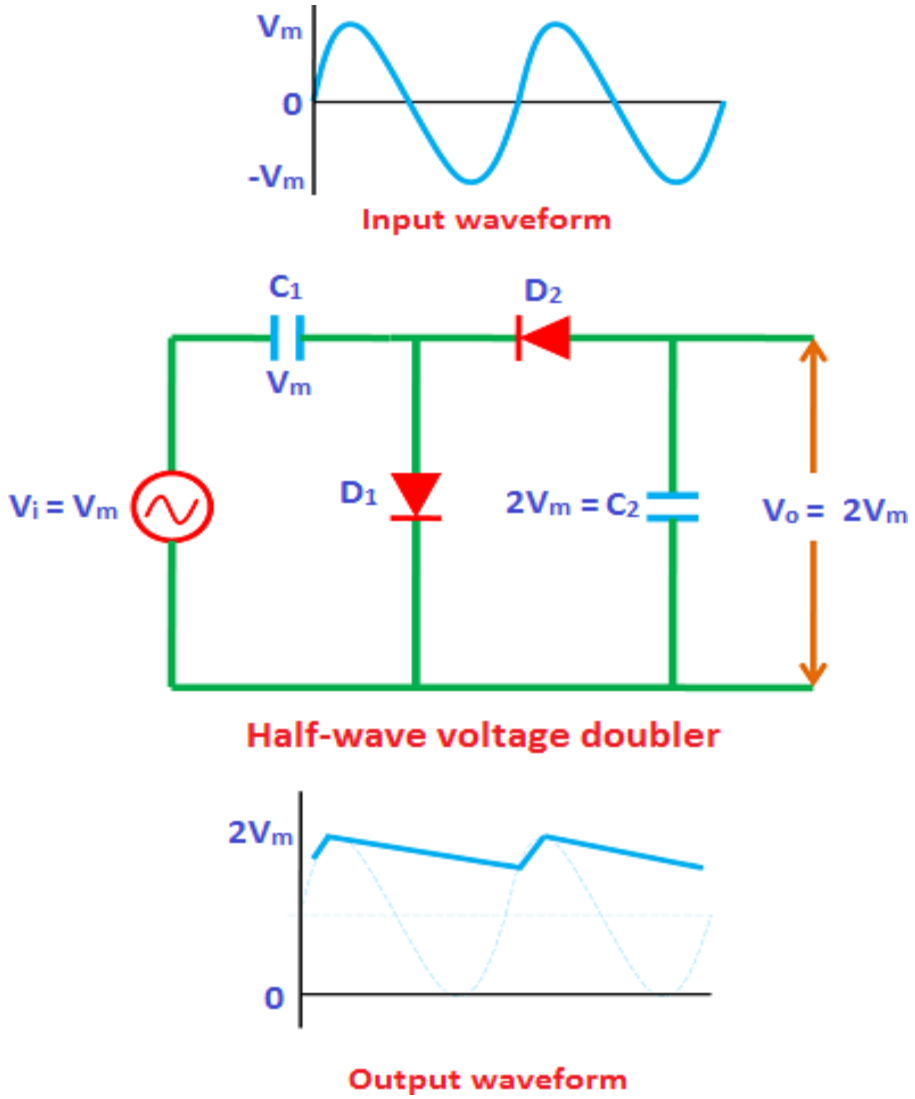
Voltage Doubler



Half wave Voltage Doubler

- **Positive Half-Cycle**
  - D_1 conducts
  - D_2 is switched off
  - Capacitor C_1 charges to V_m
- **Negative Half-Cycle**
  - D_1 is switched off
  - D_2 conducts
  - Capacitor C_2 charges to $2V_m$

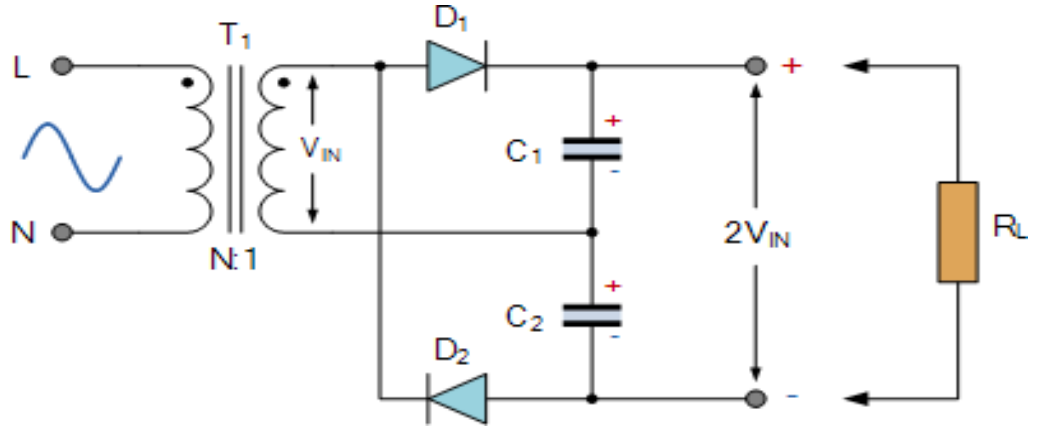
$$\mathbf{V_{out} = V_{C2} = 2V_m}$$

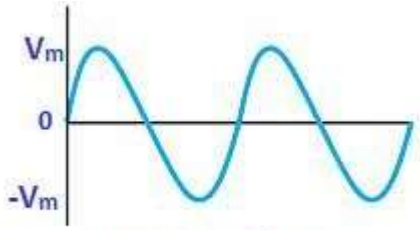


Full Wave Voltage Multiplier

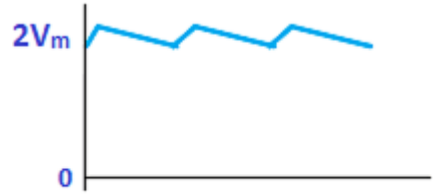
- **Positive Half-Cycle**
  - D_1 conducts
  - D_2 is switched off
  - Capacitor C_1 charges to V_m
- **Negative Half-Cycle**
  - D_1 is switched off
  - D_2 conducts
  - Capacitor C_2 charges to V_m

$$\mathbf{V_{out} = V_{C1} + V_{C2} = 2V_m}$$



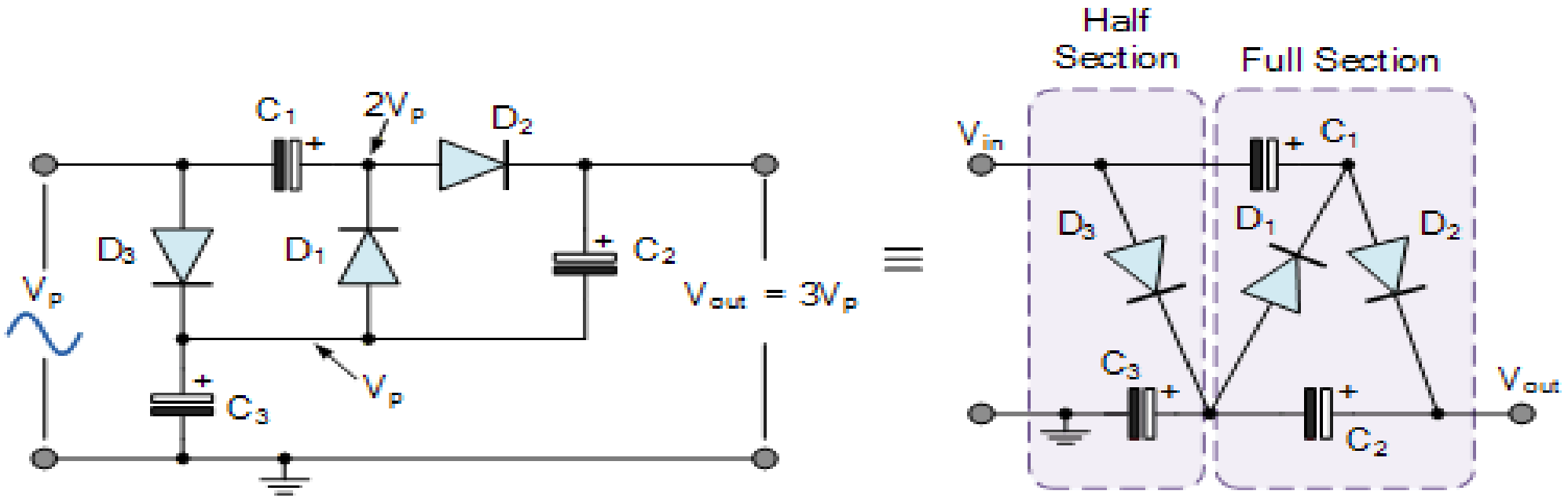


Input waveform



Output waveform

Voltage Tripler



Voltage Tripler

During first positive half cycle:

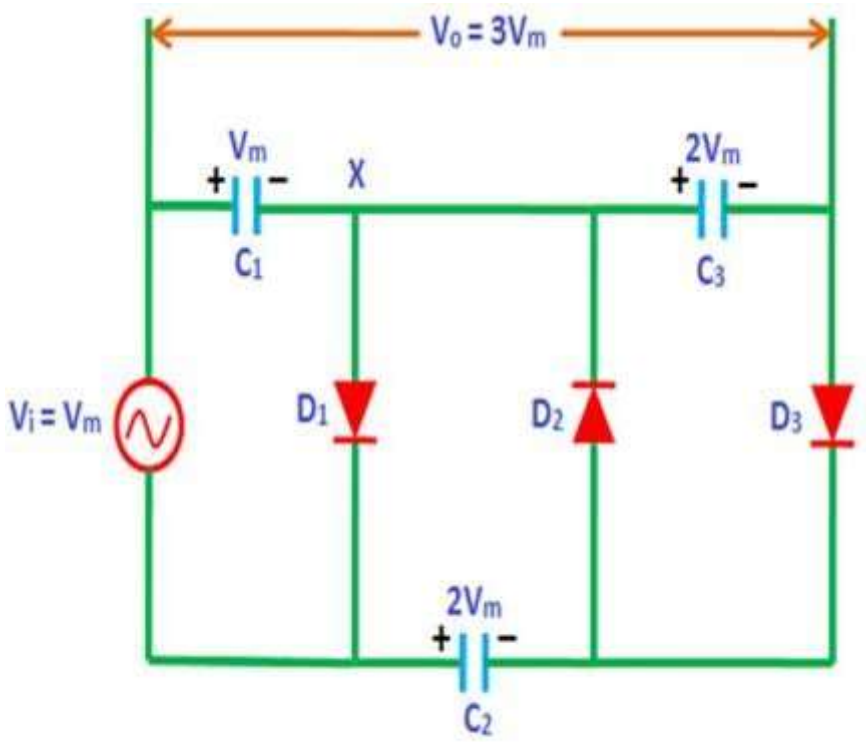
- Diode D_1 is forward biased whereas diodes D_2 and D_3 are reverse biased.
- Current will flows to the capacitor C_1 and charges it to V_m

During negative half cycle:

- Diode D_2 is forward biased whereas diodes D_1 and D_3 are reverse biased.
- Current will flows to the capacitor C_2 and charges it. The capacitor C_2 is charged to twice the peak voltage of the input signal ($2V_m$). This is because the charge (V_m) stored in the capacitor C_1 is discharged during the negative half cycle.

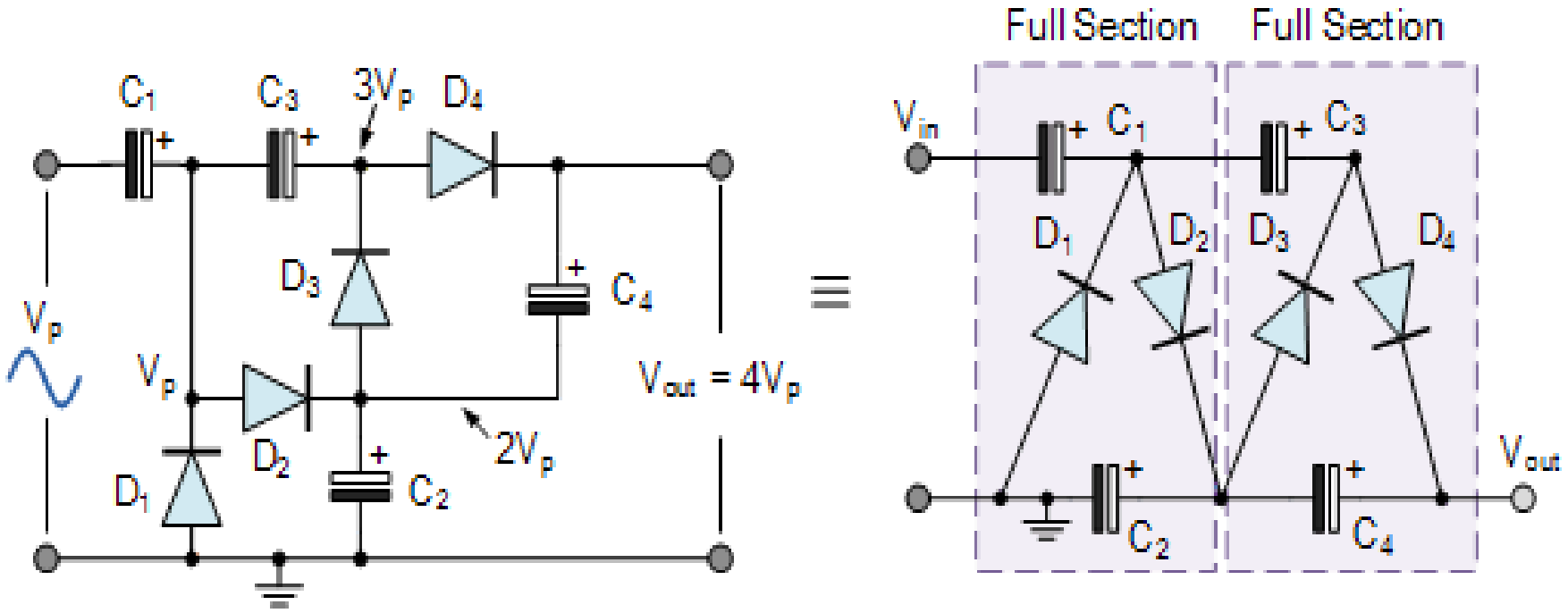
During second positive half cycle:

- Diode D_3 is forward biased whereas diodes D_1 and D_2 are reverse biased.
- As a result, the voltage ($2V_m$) across capacitor C_2 is discharged. This charge will flow to the capacitor C_3 and charges it to the same voltage $2V_m$.
- The capacitors C_1 and C_3 are in series and the output voltage is taken across the two series connected capacitors C_1 and C_3.
- The voltage across capacitor C_1 is V_m and capacitor C_3 is $2V_m$. So the total output voltage is equal to the sum of capacitor C_1 voltage and capacitor C_3 voltage
  i.e. $C_1 + C_3 = V_m + 2V_m = 3V_m$.



Voltage Tripler

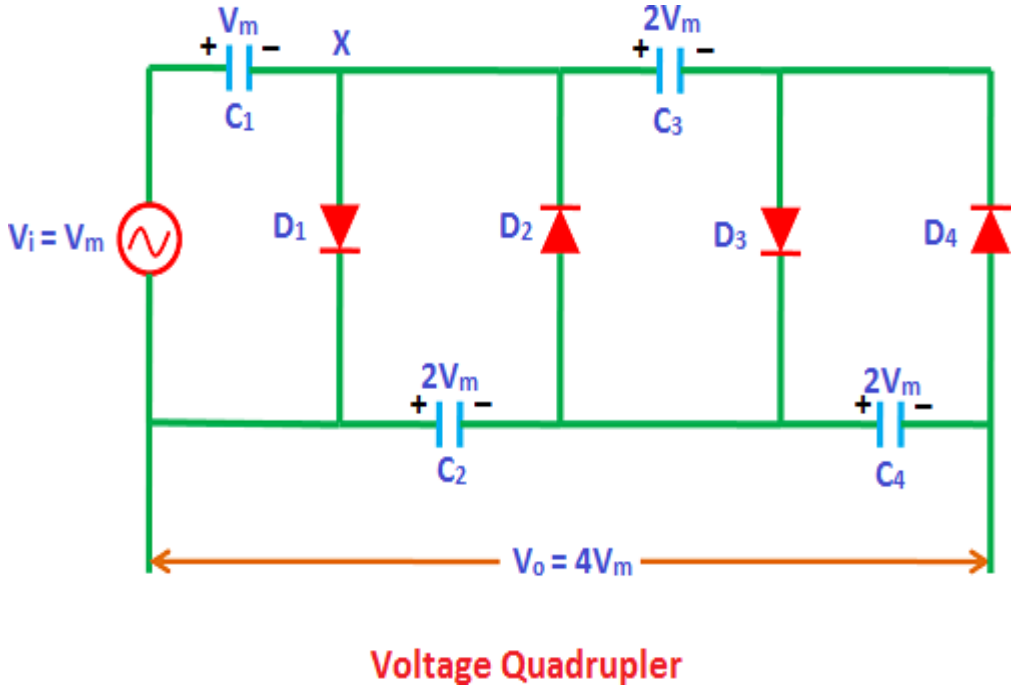
Voltage Quadrupler



Voltage Quadrupler

During first positive half cycle:

- Diode D_1 is forward biased whereas diodes D_2, D_3 and D4 are reverse biased.
- Current will flows to the capacitor C_1 and charges it to the input voltage I.e. V_m.



Voltage Quadrupler

During first negative half cycle:

- Diode D_2 is forward biased and diodes D_1, D_3 and D_4 are reverse biased.
- Current will flows to the capacitor C_2 and charges it. The capacitor C_2 is charged to twice the peak voltage of the input signal ($2V_m$). This is because the charge (V_m) stored in the capacitor C_1 is discharged during the negative half cycle.
- Therefore, the capacitor C_1 voltage (V_m) and the input voltage (V_m) is added to the capacitor C_2 I.e Capacitor voltage + input voltage = $V_m + V_m = 2V_m$. As a result, the capacitor C_2charges to $2V_m$

During second positive half cycle:

- Diode D_3 is forward biased and diodes D_1, D_2 and D_4 are reverse biased.
- As a result, the voltage ($2V_m$) across capacitor C_2 is discharged. This charge will flow to the capacitor C_3 and charges it to the same voltage $2V_m$.

During second negative half cycle:

- Diodes D_2 and D_4 are forward biased whereas diodes D_1 and D_3 are reverse biased.
- As a result, the charge ($2V_m$) stored in the capacitor C_3 is discharged. This charge will flow to the capacitor C_4 and charges it to the same voltage ($2V_m$).
- The capacitors C_2 and C_4 are in series and the output voltage is taken across the two series connected capacitors C_2 and C_4.
- The voltage across capacitor C_2 is $2V_m$ and capacitor C_4 is $2V_m$. So the total output voltage is equal to the sum of capacitor C_2 voltage and capacitor C_4voltage I.e. $C_2 + C_4 = 2V_m + 2V_m = 4V_m$.

Practicle Applications

Voltage multipliers are used in:

- Cathode Ray Tubes (CRTs)
- Laser systems
- X-ray systems
- LCD backlighting
- Power supplies
- Oscilloscopes
- Particle accelerators
- Copy machines

Disadvantages

- Need Protection Circuit
- Low Current
- Delay Greater than transformer
- Costdepend upon Capacitors

Advantages

- Low Cost
- Produce High Voltage
- Alternative of Transformer