6. Voltage multiplier Circuits

6.1 Introduction

A voltage multiplier is a circuit that produces a d.c. voltage equal to a multiple of the peak input voltage. It consist two or more peak detectors or rectifiers. Voltage multipliers found applications in circuits, where high voltage with low current is required such as picture tube in TV receivers, oscilloscopes, etc.

*A **voltage multiplier** is an electrical circuit that converts AC electrical power from a lower voltage to a higher DC voltage by means of capacitors and diodes combined into a network.*

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

- Voltage doublers
- Voltage tipplers
- Voltage quadrupler

6.2 Voltage doublers

A Voltage doubler produces a d.c. voltage almost twice the rms value of the input a.c. voltage. Voltage doubler can be of two types

- Half wave voltage doubler
- Full wave voltage doubler

6.2.1 Half wave voltage doubler

Fig shows the circuit for a half wave voltage doubler. During the positive half cycle of the secondary voltage diode D1 conducts and D2 is cut off. Now capacitor C_1 charges to the peak rectified voltage V_m, with polarity shown in the figure. During the negative half cycle, the secondary voltage comes in series with voltage across the capacitor C_1.Thus C_2 will try to charge towards $2V_m$ (V_m of the input and V_m of the capacitor C_1. After few cycles the voltage across the capacitor C_2 will be equal to $2V_m$. (see figure 6.2)

Since diode *D*2 acts as a short during the negative half-cycle (and diode *D*1 is open), we can sum the voltages around the outside loop.

$$\text{i.e. } -V_m - V_{C1} - V_{C2} = 0 \text{ or, } -V_m - V_m - V_{C2} = 0$$

from which, $V_{C2} = 2V_m$

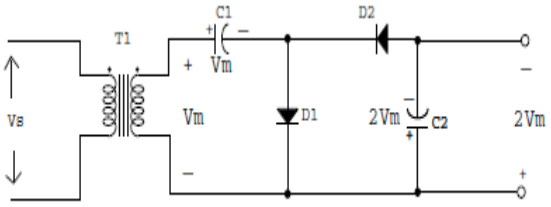


Fig. 6.1 Half wave voltage doubler

In the circuit capacitor C_1 will discharge in the negative half cycle. Again in the positive half cycle, it starts charging. Thus the half wave voltage doubler supplies the voltage to the load in one half cycles. Therefore regulation of the half wave voltage doubler is poor.

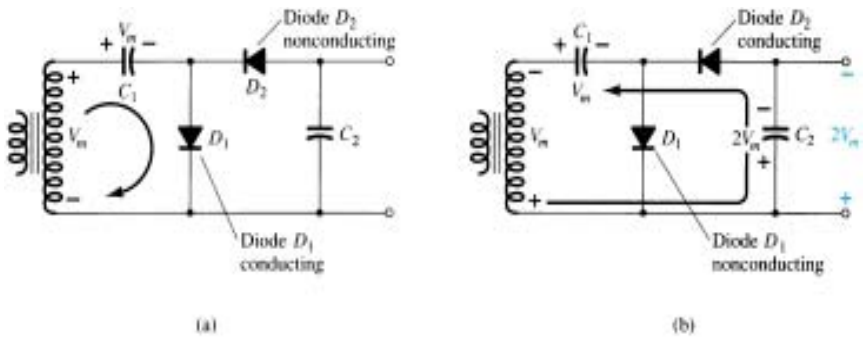


Fig. 6.2 Half wave voltage doubler during (a) positive and (b)negative half cycles of input

6.2.2 Full wave voltage doubler

Another voltage doubler circuit called full wave voltage doubler is shown in fig. During the positive half cycle of the secondary voltage diode D_1 conducts, charging the capacitor the capacitor C_1 to the peak voltage V_m. At this time diode D_2 is non-conducting. During negative half cycle diode D_2 conducts, charging capacitor C_2 to V_m, with polarity as marked, while diode D_2 is non-conducting. Since both capacitors C_1 and C_2 are in series, the final output voltage is approximately $2V_m$. This circuit is called full wave voltage doubler because one of the output capacitor is being charged during each half cycle of the input voltage

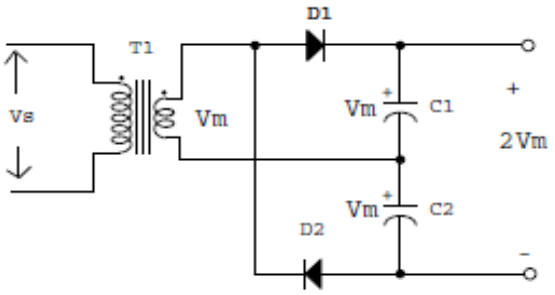


Fig. 6.3 Full wave voltage doubler

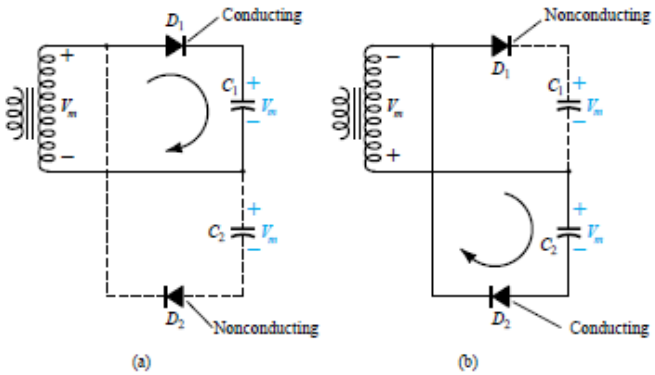


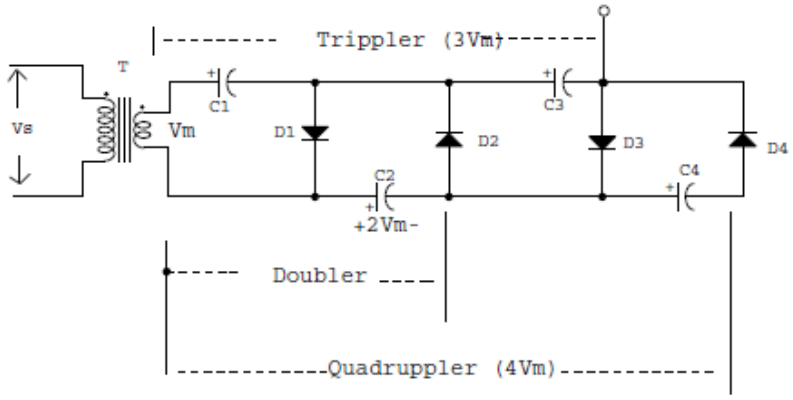
Fig. 6.4 during the positive half cycle and negative half cycle

6.2 Voltage Trippler/Quadruppler

Voltage trippler/quadruppler develops a d.c. voltage equal to three/four times the input na.c. voltage. Figure shows a voltage trippler/quadruppler circuit, it is an extension of the half wave voltage doubler.

During the positive half cycle, the diode D_1 conducts, charging the capacitor C_1 to V_m with polarity shown. During the first negative half cycle, the diode D_2 conducts charging the capacitor C_2 to $2V_m$. During

the second positive half cycle the diode D_3 conducts in addition to D1, charging the capacitor C_1 and the voltage across the capacitor C_2 charges capacitor C_3 to the same value $2V_m$. On the second negative half cycle diode D_2 and D_4 conducts and capacitor C_3 charges C_4 to $2V_m$. Thus the voltage across C_2 is $2V_m$, across C_1 and C_3 is $3V_m$, and across C_2 and C_4 is $4V_m$.



If additional section of diode and capacitor are used, each capacitor will be charged to $2V_m$. Measuring from the top of the transformer winding will provide odd multiples of V_m at the output, whereas measuring from the bottom of the transformer, the output voltage will provide even multiples of the peak voltage V_m.