Voltage Multipliers

Objectives

1. To examine the characteristics of voltage multiplier circuits
2. To examine the application of a multiplier circuit as a dual-polarity power supply

Equipment

DMM
Oscilloscope
Center Tapped Transformer
4 - 1N4001 Rectifier Diodes
4 - 47 μF Capacitor (100 V_{DC})
100 μF Capacitor (100 V_{DC})
33 kΩ Resistor
68 kΩ Resistor

Reference

Introductory Electronic Devices and Circuits, Chapter 4

Theory

Voltage multiplier circuits are diode circuits that often function as power supplies is special applications. They have the advantages of being simple solid state circuits with fairly low parts count and being able to produce output voltages much higher than the input voltage. The disadvantages of the circuit include requiring fairly large value capacitors and being capable of fairly low current production.

The largest advantage of the multiplier circuit is the ability to produce voltages much higher than the "input" voltage. We will examine two doubler circuits and a voltage quadrupler in this lab, however as you have seen it is possible to build triplers, etc. Applications where we would need this large voltage include such items as electronic flash units for photography and biasing circuits for CRTs (cathode ray tubes) commonly used in everything from television to computer screens to our oscilloscope.

Another application we will examine is "splitting" the output from the voltage multiplier to produce a dual polarity power supply. This circuit provides a dual supply with very little additional circuitry.

Procedure

For this lab we will use the large breadboards. Remember we will be connecting the transformers to 120 V so be careful connecting and disconnecting the power for the circuits. Use the center tap on the transformer so you are only supplying approximately 12.5 V to the circuit.

1. Assemble the circuit in Figure 1 using 1N4001 diodes and 47 µF capacitors.

2. Using the oscilloscope measure the transformer output peak voltage (V_P) and record (remember you should be using the center tap and this value should be in the area of 10-12.5 V)

3. Measure the circuit output voltage (V_{AB}) with the DMM and record.

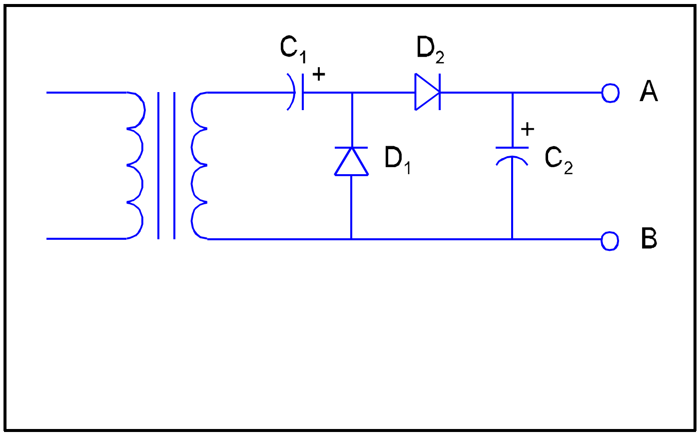

Figure 1 Half Wave Voltage Doubler

4. Use your oscilloscope to measure to measure the ripple voltage in the output (should be <u>extremely</u> small with no load).

5. Now use the 33 kΩ resistor as a load between points A and B (this should draw between ½ - 1 mA - a fairly small current draw).

6. Again measure both the output voltage with the DMM and the ripple voltage with the oscilloscope and record.

7. Now assemble the circuit shown in Figure 2 without capacitor C_3. Use 1N4001 diodes and 47 µF capacitors.

8. Using the oscilloscope measure the transformer output peak voltage (V_P) and record (remember you should be using the center tap and this value should be in the area of 10 -12.5 V)

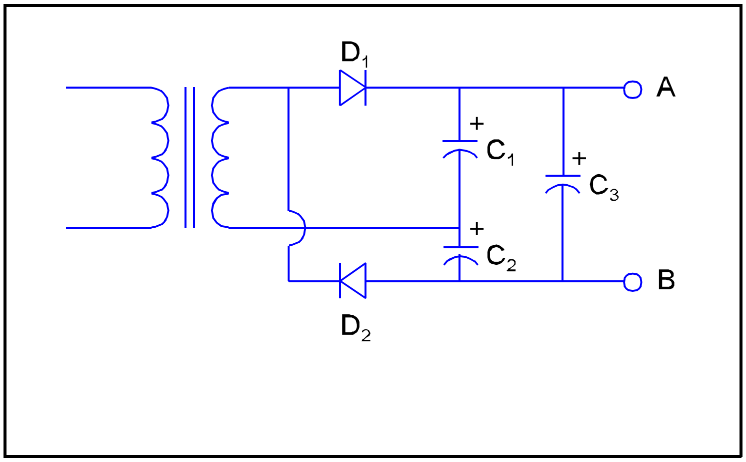

Figure 2 Full Wave Voltage Doubler

9. Measure the circuit output voltage (V_{AB}) with the DMM and record.

10. Use your oscilloscope to measure to measure the ripple voltage in the output (should be extremely small with no load).

11. Now use the 33 kΩ resistor as a load between points A and B (this should draw approx ½ - 1mA - a fairly small current draw).

12. Again measure both the output voltage with the DMM and the ripple voltage with the oscilloscope and record.

13. Now - after removing power - insert a 100 µF capacitor for C_3 and re-power the circuit.

14. Repeat step 12 for the circuit with C_3 installed.

15. Now assemble the circuit shown in Figure 3. Use 1N4001 diodes and 47 µF capacitors C_1 to C_4 and a 100 µF capacitor for C_5.

16. Using the oscilloscope measure the transformer output peak voltage (V_P) and record (remember you should be using the center tap and this value should be in the area of 12.5 V)

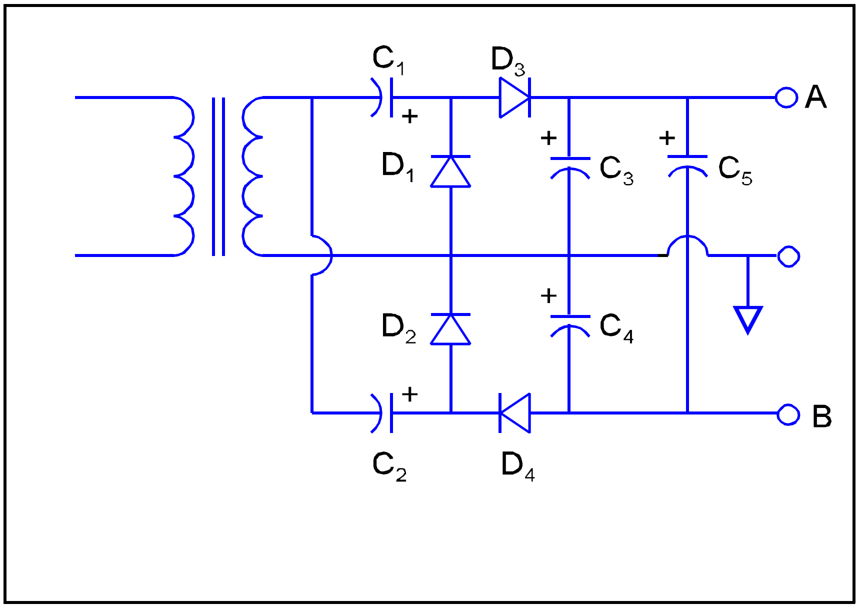

Figure 3 Voltage Quadrupler

17. Measure the circuit output voltage (V_{AB}) with the DMM and record.

18. Use your oscilloscope to measure to measure the ripple voltage in the output (should be extremely small with no load).

19. Now use the 68 kΩ resistor as a load between points A and B (this should draw approx ½ - 1 mA - a fairly small current draw).

20. Again measure both the output voltage with the DMM and the ripple voltage with the oscilloscope and record.

21. Remove the load resistor and measure and record the voltage between points A to ground (middle terminal in schematic) - V_A and the voltage from point B to ground - V_B.

22. Install the 68 kΩ load resistor between point A and ground.

23. Measure both DC voltage (V_A and V_B) and ripple voltage between the two outputs and record

Post-Lab write-up

24. For the write-up compare the three circuits and compare the performance of each. Things to consider when comparing the circuits would be:

    a. Parts count

    b. DC voltage

    c. Ripple voltage

25. Each circuit has advantages and disadvantages so your job is not to select the best one - that would depend on the application - but to explain the what the advantages and disadvantage of each are.