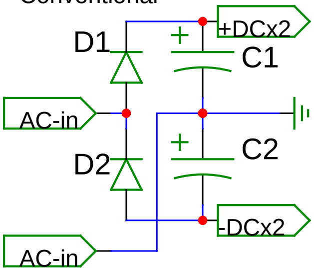
Various Voltage Multipliers

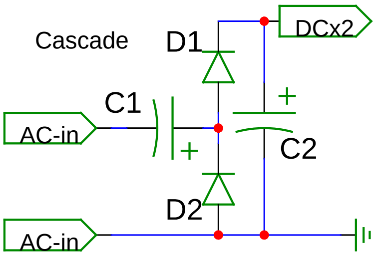
2008-02-12

* Some of these circuits can be used as a doubler or dual rail supply.
Simpler ones can have the diodes and capacitors reversed for negative versions.

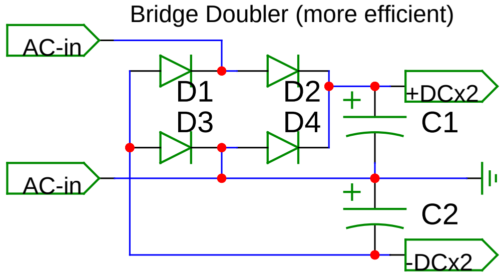
Conventional



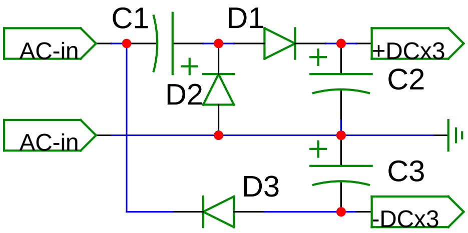
Cascade



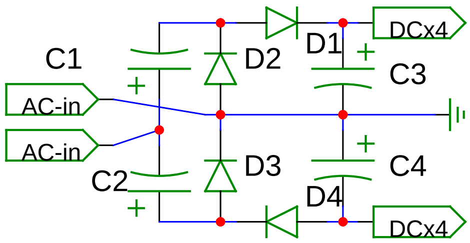
Bridge Doubler (more efficient)



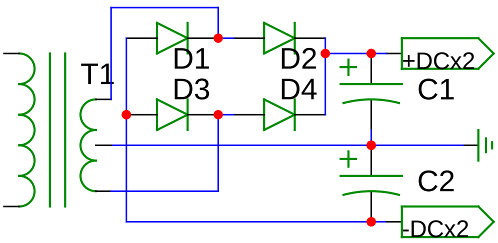
Voltage Tripler



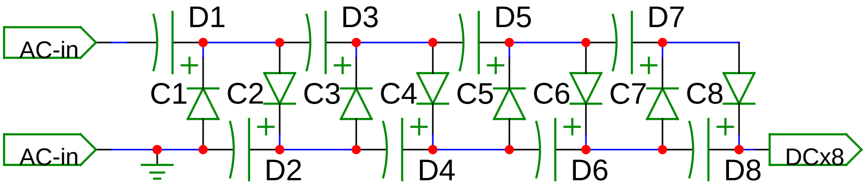
Voltage Quadrupler



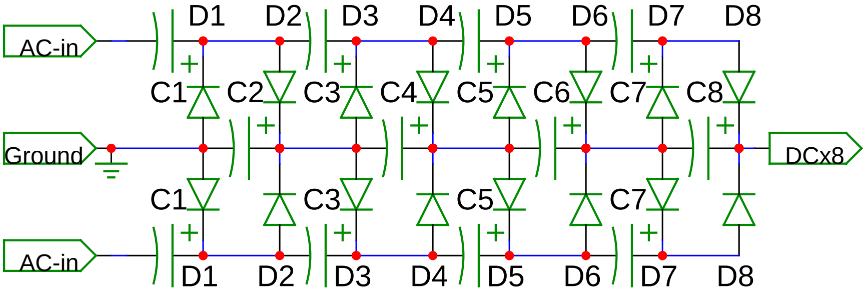
Bridge Doubler CT (more efficient)



Half Wave Cascade Multiplier (Half Wave Cockroft-Walton, 8x shown)



Full Wave Cascade Multiplier (Full Wave Cockroft-Walton, 8x shown)



Each multiplier stage consists of C1, C2, D1, and D2.

Half Wave Equations:
n: the total stage count.
Iload: load current in amperes.
C: capacitance in Farads.
Freq: frequency in Hz.
Vdrop = (Iload/(6*Freq*C)) * (4n^3+3n^2-n)
Vout = (2 * n) - Vdrop
Vripple = (Iload/(2*Freq*C))*n*(n+1)

The full wave version increases frequency. This has the benefit of reducing output ripple and voltage drop under load. The input is usually fed by a center tap transformer or two secondaries in series.

Capacitor Variation. To help reduce the increasing ripple with each stage, larger capacitors can be used at the bottom. If the first stage is n*C, then the next could be (n-1)*C, then the next could be (n-2)*C, and so on. The ripple equation them becomes: Vripple=Iload/C. To find the optimum number of stages given a certain input voltage and required output voltage, easy way: n=sqrt(Vpk*Freq*C/Iload). This works for n>5. For n<5, n=sqrt(3*Iload*(7*Iload+48*Freq*C*Vpk))/(12*Iload)-1/4. Without knowing the frequency and capacitors, n can be approximated by: n=3*Vout/4*Vpk.
Full Wave calculation changes. Vdrop = (Iload/(6*Freq*C))*(n^3+2n). If all stage capacitors are equal, Vripple=(Iload/(2*Freq*C)*n.
The optimum stage count: n = 0.521*Vout/Vpk.