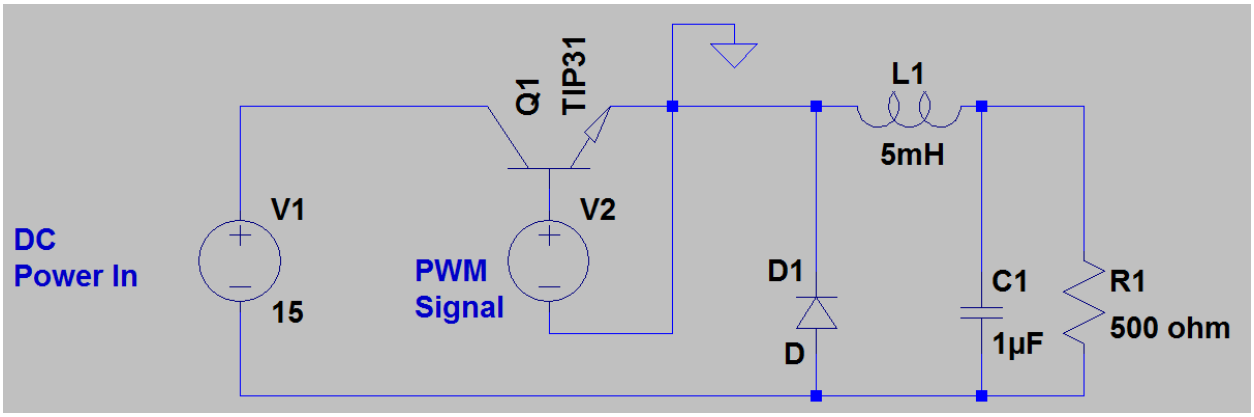
DC->DC Power Converters

Build a Buck Converter Circuit



- PWM Signal In: a 25kHz pulse frequency and a peak voltage of 2V. The PWM signal will come first from a signal generator. We will control k using the duty cycle knob.
- Power in: 15VDC.
- Load: 500Ω.
- Semiconductors: NPN power transistor, TIP31. Power diode, HFA15TB60.
- Passive elements: L=5mH (transformer secondary coil) and C=1.0µF electrolytic cap.

The PWM Signal

Before we build the circuit we will look at the output of the signal generator on the oscilloscope. Connect the output directly to channel 1 of the oscilloscope. Turn them both on and select a square wave and set the frequency of the square wave to 25kHz. You may need to adjust the trigger of the scope to get a clear look at the signal, a scale of 1V/div and 20µs should work well. Adjust the peak-to-peak amplitude of the signal to 2V. Activate the duty cycle adjustment by pressing duty cycle button and adjust the duty cycle using the knob. Make sure you understand how to control your signal and then me.

Construct the circuit

Do this neatly using the wires from the jumper wire kit to neatly construct the circuit, this will make trouble shooting much easier. Show me your circuit before you turn on the DC power supply. Note the location of the ground, this is set by the earth safety ground on the signal generator (the DC power supply has a floating ground). This, unfortunately, is the same ground as for the oscilloscope. The only way around this is to force the signal generator ground to float with an ungrounded plug. **Warning, safety ground is there for your safety. Never defeat this on device that can conduct a high current with a high voltage (like a CRT oscilloscope). Even modest currents (100mA - 200mA) can cause death.**

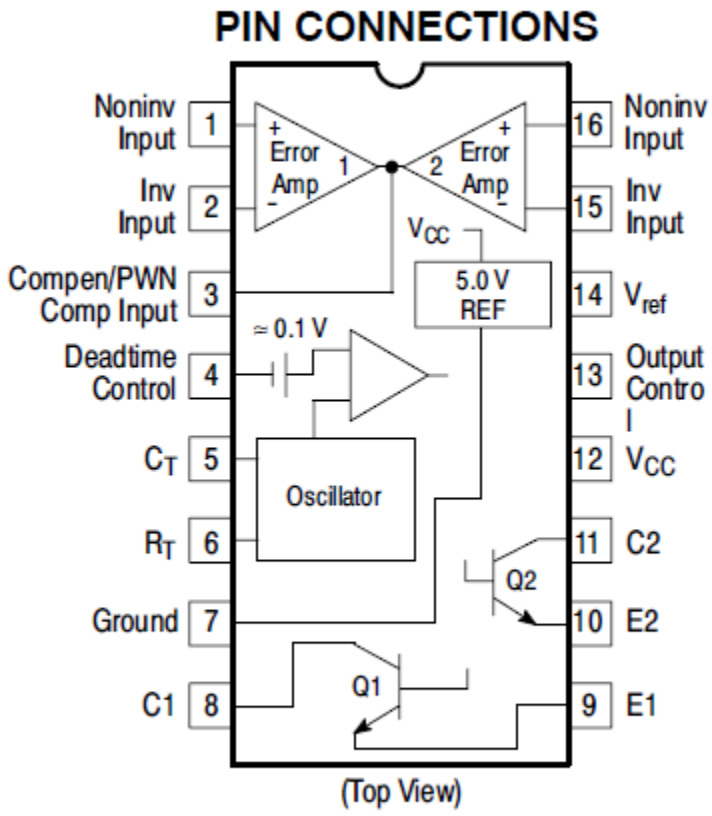
Circuit Test

With a 50% duty cycle (k=0.5) PWM signal, this is the default when the duty cycle adjustment is off, turn on the power to your circuit (V_s). Use the hand held volt meter to measure the voltage across your resistive load. Does this behave as you would expect? Turn on the duty cycle control and adjust the duty cycle through its full range. Does this behave as you would expect?

Data Collection

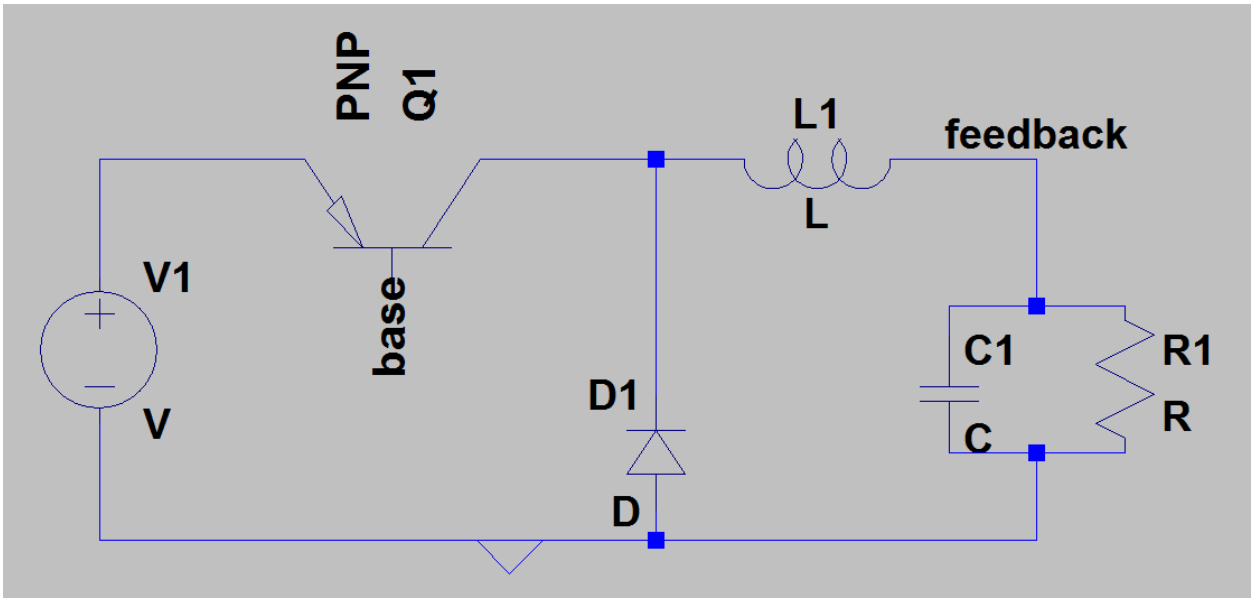
Find the efficiency on a DC basis (DC power out/DC power in) for k=0.5. How does it compare the the results of your simulation?

Using the TL494 for PWM signal



We will be drawing power from Vs both to run the control circuit and to give our DC->DC convert juice. This means that we will need to switch to a PNP transistor (TIP32), see below for circuit.

Power circuit



Our control circuit is on the next page. There are 3 important points of contact to the control circuit which I've labeled Vref, Feedback, and base of PNP.

- *Feedback* links the voltage produced for the load back to the control logic.
- *Base of PNP* is the control signal that is sent to the power circuit for switching the power transistor on and off
- *Vref* is the voltage that you choose to produce with the power circuit.

Your task is to build the control circuit and wire it up to your power circuit. Use the second channel of the DC power supply to control Vref.

When you finish this switch to the signal generator and use it to send a 60Hz AC signal into Vref. Use the Oscilloscope to see the results.