EE 322 Advanced Electronics, Spring 2012
Homework #2 solution

HH 6.4

The maximum current through the pass MOSFET transistors is the maximum output current plus the 0.1 A current passing through the class A sink. That is 2.6 A. The maximum voltage across them is when the output voltage is zero, during which time the voltage is 40 V. The maximum power dissipation is thus

$$P_{\text{max}} = V_{\text{max}} \times I_{\text{max}} = 40 \times 2.6 = 104\,\text{W}$$

HH 6.5

Referring to Figure 6.29 we have

$$V_{\text{out}} = 1.25\,\text{V}\left(1 + \frac{R_2}{R_1}\right)$$

$$R_2 = \left(\frac{V_{\text{out}}}{1.25\,\text{V}} - 1\right) R_1$$

Let's choose $R_1 = 1\,\text{k}\Omega$. The maximum output voltage is 6 V, and the minimum is 4 V. That makes the range of values of R_2.

$$R_{2,\text{max}} = \left(\frac{6}{1.25} - 1\right) \times 1 = 3\,\text{k}\Omega$$

$$R_{2,\text{min}} = \left(\frac{4}{1.25} - 1\right) \times 1 = 2.2\,\text{k}\Omega$$

Thus R_2 should be the series connection of a $2.2\,\text{k}\Omega$ resistor and a $800\,\Omega$ potentiometer. A $800\,\Omega$ potentiometer is difficult to obtain, so let's scale all the resistor up by 25%. In that case we have

$$R_1 = 1.25\,\text{k}\Omega$$

$$R_{2,\text{fixed}} = 2.2 \times 1.25 = 2.75\,\text{k}\Omega$$

$$R_{2,\text{pot}} = 1\,\text{k}\Omega$$

HH 6.6

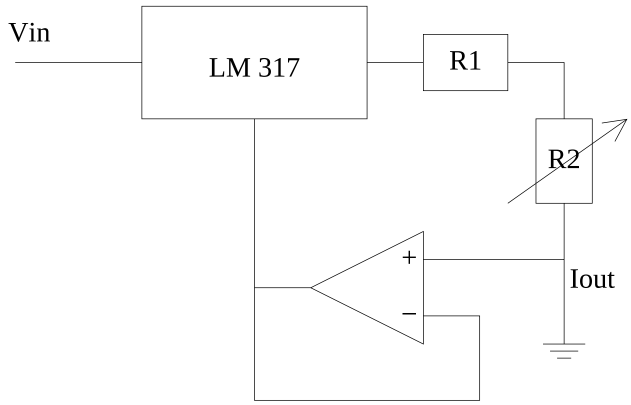
Referring to Figure 6.35, leave all components as they are given in the figure, and make

$$R_1 = 2.5\,\text{kA} \times V_{\text{out}} = 2.5 \times 10^3 \times 12 = 30\,\text{k}\Omega$$

For this regulator to function the inputs must exceed the outputs by at least the dropout voltage.

HH 6.7

Design an adjustable current source for output currents from $10\,\mu$A to $10\,$mA using a 317. If $V_{\rm in} = +15\,$V, what is the output compliance? Assume a dropout voltage of $2\,$V. We will use the circuit in Figure 6.38B. We will use two resistors, one fixed and one adjustable.



The voltage between the output pin and the adjust pin is $V_{\rm ref} = 1.25\,$V. The output current is then

$$I_{\rm out} = \frac{V_{\rm ref}}{R_1 + R_2}$$

The maximum current flows when the resistance is minimized,

$$I_{\rm out,max} = \frac{V_{\rm ref}}{R_1}$$

So that

$$R_1 = \frac{V_{\rm ref}}{I_{\rm out,max}} = \frac{1.25}{1 \times 10^{-3}} = 1.25\,{\rm k}\Omega$$

The minimum current flows when the resistance is maximized,

$$I_{\rm out,min} = \frac{V_{\rm ref}}{R_1 + R_2}$$

So that

$$R_2 = \frac{V_{\rm ref}}{I_{\rm out,min}} - R_1 = \frac{1.25}{10 \times 10^{-6}} - 1.25 \times 10^3 = 123\,{\rm k}\Omega$$

We can thus achieve the currents we want by using a $1.25\,{\rm k}\Omega$ resistor, R_1, in series with a $0 - 123\,{\rm k}\Omega$ potentiometer, R_2.

The compliance voltage range is the range of voltages on the output pin over which these currents can flow. The highest current is the most restrictive current. The maximum voltage on the output pin consistent with a $15\,$V input, and drop-out voltage of $2\,$V, and the voltage drop across feedback resistors is

$$
\begin{aligned}
V_{\text{out,max}} &= V_{\text{in}} - V_{\text{dropout}} - V_{\text{ref}} \\
&= 15 - 2 - 1.25 \\
&= 11.75\,\text{V}
\end{aligned}
$$