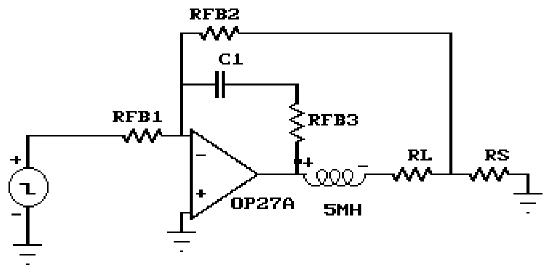
STABILIZING INDUCTIVE CURRENT SOURCES

The first and most subjective step in the design is selecting the desired value of the current sense resistor (Rs). The object here is to optimize the trade off between the greater losses incurred with a larger resistor, and the better bandwidth and accuracy that would be achieved.



$$Gain(I) = \frac{Rf2}{Rf1}$$

Gain(I)=Vin/VRs or Vin/current in L

The gain of the amplifier is calculated by:

$$Gain(A) = Gain(I)*1 + \frac{Rl+Xl}{Rs}$$

Where Xl=impedance of the inductor.
Where Rl=DC resistance of the inductor.
Gain(A)=Vin/Vout of amplifier

The Gain(A) at any frequency should never be allowed to rise 20db more than Gain(A) at DC. This will insure a stable amplifier. If the Gain(A) at any frequency is more than 20db+Gain(A) at DC then the amplifier will over shoot and possibly oscillate. If Gain(A)max is much less than 20db+Gain(A) at DC, then the amplifier will be slow.

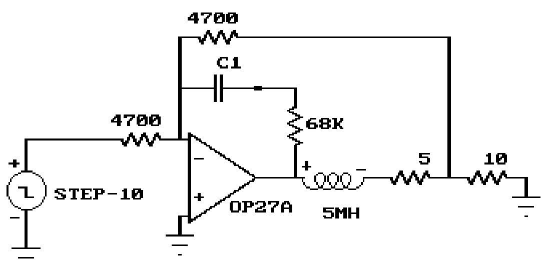
Let Rs=10 ohm, Rl=5 ohms L=5mH Rfb1=Rfb2 Rfb1=4700
This will give a Gain(I) of 1X.
The Gain(A) at low frequencies will be 1.5X.

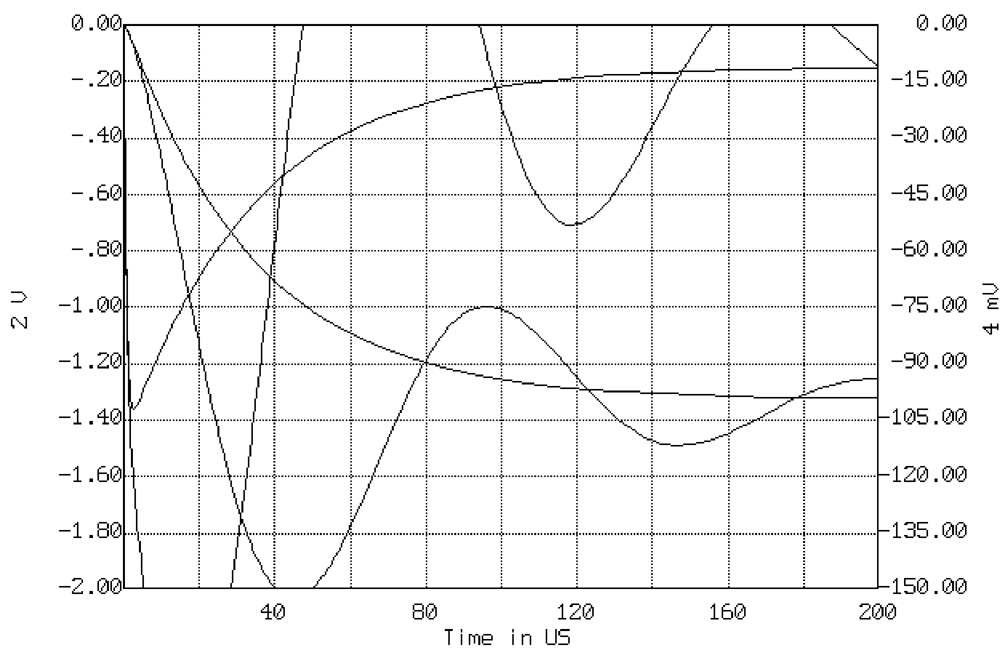
At higher frequencies the impedance of the inductor will push the Gain(A) up with no limit. The Gain(A) will start up at a frequency of(Rs+Rl)/2*3.14*L. In this example about 500Hz.

An RC (resistor and capacitor) should be placed form output to negative input of the amplifier to keep the Gain(A) held at 20db+Gain(A_{DC}). Resistor Rfb3 should be Rfb3=Rfb1*10*Gain(A_{DC}). This gives a value of about 68k.

The value of the capacitor is chosen to give a corner frequency that compensates for that of the inductor.
C=1/(2*3.14*Rfb3*F) Where the F is the same frequency found above in the formula F=(Rs+Rl)/2*3.14*L.

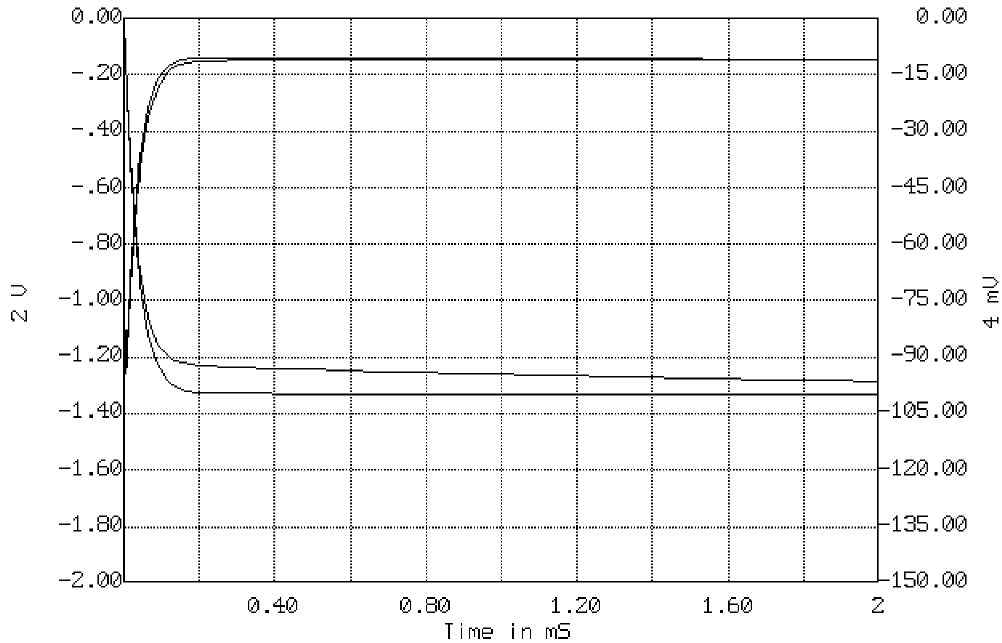
The inductance for L is the total of the centering inductor + deflection yoke + linearity coil. The value Rl is the total resistance of all of the above. These values maybe hard to determine. The values for Rfb1, Rfb2, Rfb3 and Rs will be easy. The value of C may have to be determined by experimenting. If the amplifier overshoots increase C. In the amplifier is too slow decrease C.





C=100pF and 4700pF

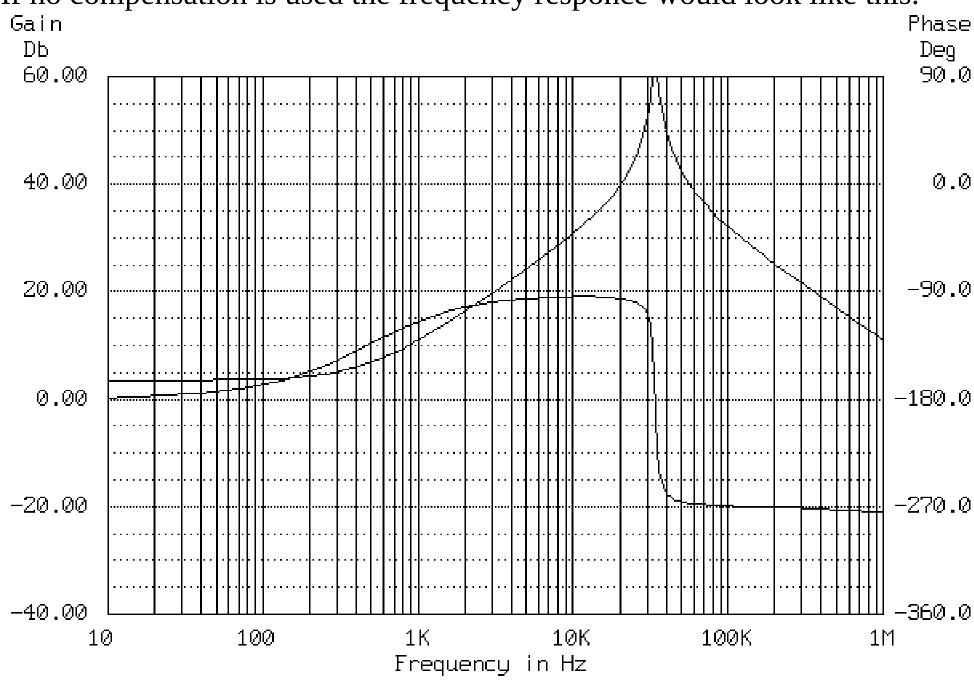
When C=4700pF the output of the amplifier drops to -1.35 volts and then swings back to -.18 volts. The voltage on Rs reaches level in about 180uS. If C is too small then the amplifier over shoots and rings.



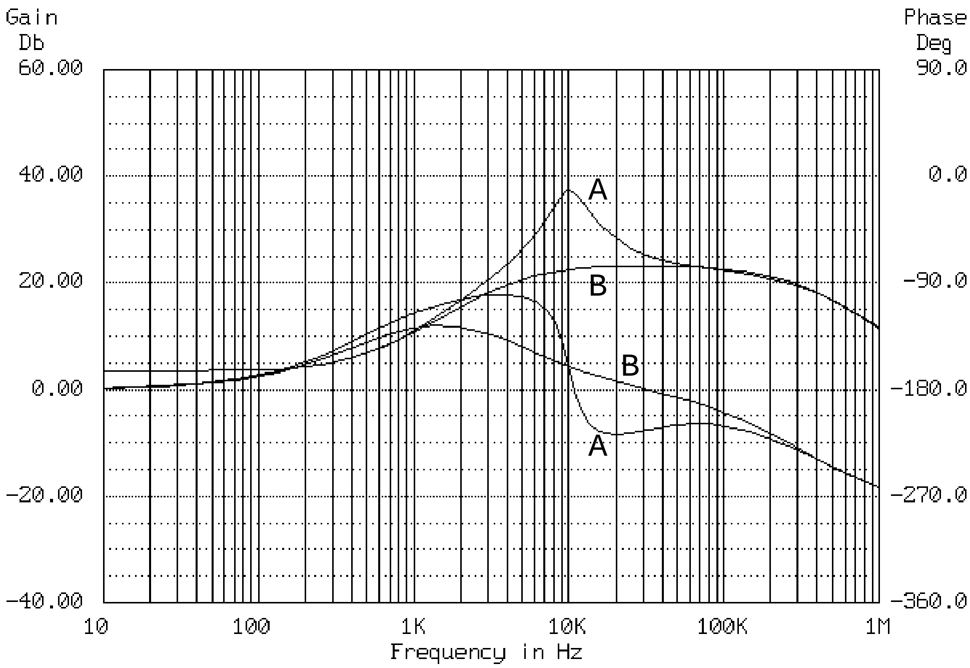
C=4700pF and .03uF

When C=4700pF the amplifier quickly responds. With a too large a Capacitor the amplifier has not reached level in 2mS.

If no compensation is used the frequency responce would look like this.



The Gain(A) is 3.5db at DC. The gain starts up at a point set be the inductor. In this example with no high frequency feedback (C=open) the gain reaches +60db at 34KHz. Notice the sharp phase shift. This amplifier will oscillate. The gain drops at the right hand edge of all these graphs because of the open-loop gain of the amplifier. The amplifier used in the example has a open loop gain of 10db at 1MHz. If a slower amplifier with a open loop gain of 0db at 100KHz were used then the Gain(A) would be 20db at 5KHz and no compensation wood be needed.

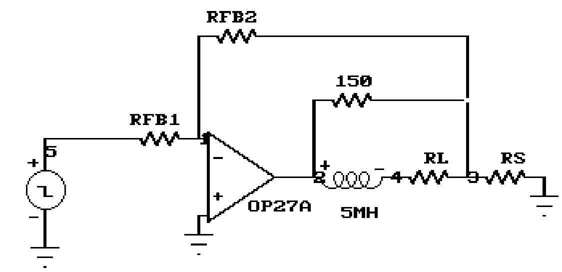


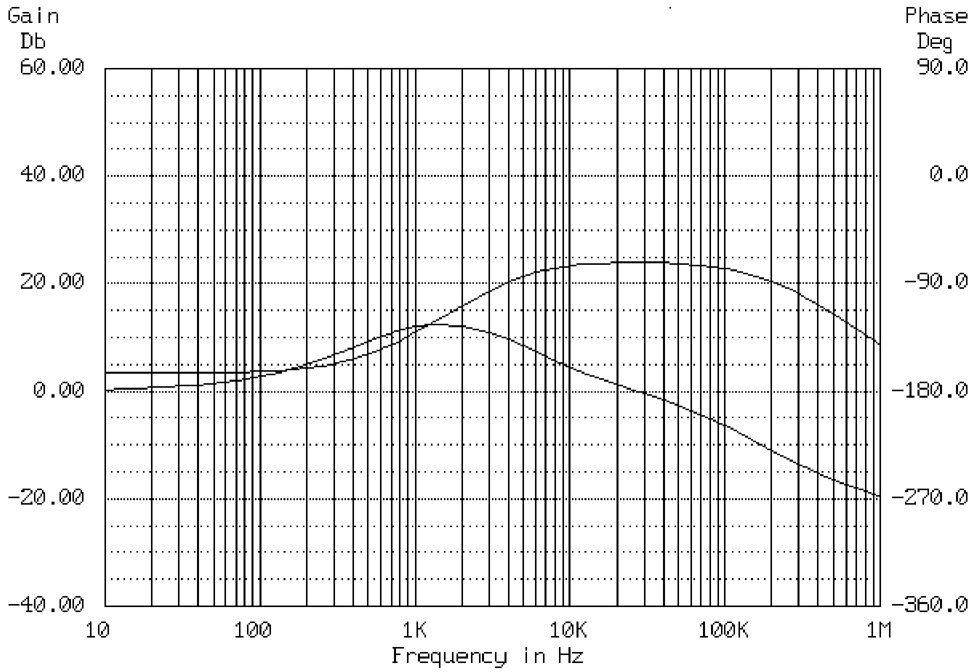
Curves A:C=100pF
Curves B:C=4700pF

With C=100pF there will be a ring at about 10KHz. Notice the peek in gain and the phase shift. There will be ringing at 10KHz. When C=4700pF the gain is held at 20db more than that at DC.

A second method of STABILIZING INDUCTIVE CURRENT SOURCES

The second method of stabilizing a current source is much easer. I have only used this method <u>once</u> but I think that it will work better then the old method. Resistor Rs and capacitor C are not needed. Place a resistor Rr across the inductor. The value of Rs=10*(Rs+Rl). In this method the value of L is not important.


RFB2
150
RFB1
5
RL
RS
OP27A
5MH


Gain
Db
Phase
Deg
60.00
40.00
20.00
0.00
-20.00
-40.00
90.0
0.0
-90.0
-180.0
-270.0
-360.0
10
100
1K
10K
100K
1M
Frequency in Hz