FREQUENTLY ASKED QUESTIONS

April 4, 2017

Content Questions

In the input offset current diagram [like Eggleston Fig. 6.12], what is drawing current?

The op-amp inputs draw "bias" current, i.e., there is current I_B^- flowing into the op-amp inverting ($-$) input and current I_B^+ flowing into the op-amp non-inverting ($+$) input. This is in contradiction to the op-amp rule that no current flows into the inputs, but that rule is an idealization. Inside the 741 op-amp (and similar), there are actually bipolar transistors, and the op-amp inputs actually go right into bipolar transistor bases (see the schematic on p. 7 of the 741 data sheet). So the bias currents are the transistor base currents, which are small but non-zero.

Op-amps made of FETs will typically have much smaller input bias currents.

What is an analog multiplier, and what does it actually look like?

An analog multiplier is a circuit that gives an output equal to (or proportional to) the product of inputs, $V_{\text{out}} = V_{\text{in }1} \times V_{\text{in }2}$. See question below for how one might be made.

Can you elaborate a bit on how to use the JFET as a multiplier?

Yes, that went by pretty fast.

Here is how to make a multiplier with a JFET (and an op-amp): make an amplifier op-amp circuit, such that the gain is proportional to the feedback resistor R. If this feedback resistor is then a variable resistor with value determined by the second input voltage, then the output will be proportional to the product of the two inputs.

A JFET in the linear regime (see Fig. 5.2 of Eggleston) is effectively a variable resistor with value determined by V_{gs} (i.e., the slope of the I_d vs V_{ds} curve depends on V_{gs}). So this is what you would use as your feedback "resistor".

In practice, one can get integrated circuits that do multiplication (and that are made directly out of transistors on a chip).

What is the feedback function?

A feedback network is just a four-terminal network that you put between output and input... so it can have in general any kind of transfer function $F(j\omega)$... it could be just a resistor, or a fancy op-amp circuit, or anything—it does its function just the way it would normally do it.

What are some real-world applications for the multiplier and/or gyrator?

Multipliers are useful (even without feedback) if one wants a variable gain (say, to turn up the volume): tweaking one voltage will control another.

Gyrators are useful as circuit elements that behave like inductors. Classic inductors (little coils) can be bulky and expensive, and often won't fit into small packages. Gyrators can also compactly simulate other reactive circuit elements.

How does the current flow through a gyrator?

It flows down the chain of impedances, and from the op-amp outputs. For ideal op-amps, there will be no current into the op-amp inputs.