Re: low noise amplifier for high impedance source

Source: http://sci.tech−archive.net/Archive/sci.electronics.design/2006−10/msg03519.html

- *From*: Winfield Hill <Winfield_member@xxxxxxxxxxx>
- *Date*: 16 Oct 2006 15:53:38 −0700

archiees wrote

> I am a student who has been working on a low noise preamplifier
> for a high impedance current source. I have put the model of the
> detection circuit here:
> http://img146.imageshack.us/img146/9748/detectmodelid8.jpg
> Its a differential ac current source with an instrinsic capacitance ~
> 20pF on each side. I use 1M ohm resistors to bias my input JFETs.
> The bandwidth I need is only from 10 Khz to couple of MHz.

archiees wrote...

> Thanks for your reply Phil.
> ** Do you really have a current source ???
> Yes, to my understanding. The source consists of 2 electrodes
> (Penning trap). Charged particles rotate between these
> electrodes and induce an image charge. This image charge is
> allowed to flow in an external circuit (like resistors) to
> constituting differential image currrent out of the electrodes.

The schematic you give in your .jpg drawing is

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.. |−−
.. ,−−−−−−−−−+−−−−−−−−−−−−−−>|−− JFET
.. | +−−/\/\−− gnd
.. | ICT +−−−||−−− gnd
.. | cs |−−
.. '−(−>)−−−−+−−−−−−−−−−−−−−>|−−
.. +−−/\/\−− gnd
.. +−−−||−−− gnd
```

where the resistors are 1M, and the capacitors 20pF. The
signal voltage developed across a low−value resistor like
1M will likely be much less than you like, as Phil implied.
Resistor noise density is i_n = (4kT/R)^1/2, so you'll want

a high R, like 100M or higher. The load capacitance will start reducing the signal (including the resistor noise) voltage above a frequency fc = 1 / 2pi R C, which is only 8kHz for 1M, and 80Hz for 100M. So clearly you want to lower value of the load C if you can.

One point, a portion of the JFET's capacitance, Crss, will be added to C, unless you employ tricks to prevent this.

Once you know the signal voltage vs. current, as a function of frequency, you can compare it to e_n, the JFET's voltage noise at that frequency. You will find low e_n JFETs have high capacitance. Just a little gotcha from Mother Nature.

For example, a classic 2n4392 has en = 3nV and Crss = 3pF. Compare this to a bf862 with en = 0.9nV and Crss = 1.9pF. Ooops!! Actually, that's a bad example, contrary to Mother Nature, as well as Murphy's Law, because the Philips bf862 JFET is far, far better than it should be! :−)

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Thanks,
− Win
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